Quality characteristics of seed material harvested from Molinion litter meadows

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Abstract

Sufficient information about the quality characteristics of on-site harvested seed material from valuable donor sites for restoration of endangered grassland communities is a precondition for its successful use. In order to determine the necessary seed rate and the best-suited application method, information about thousand seed weight, purity and germination capacity of the material is essential. Seed mixtures from a herb-rich *Molinion* litter meadow, harvested with two different methods: i) on-site threshing (OST) and ii) seed stripping (SS), were assessed. The purity of stripped material exceeded 60% and was around 20% higher compared to OST. The germination capacity of the harvested pure seeds treated with and without pre-chilling was investigated. Slight differences between harvesting methods could be observed, whereas pre-chilling of the seed material caused a significant increase in germination capacity of the seed material. The total germination rate did not exceed 30%. Litter meadows contain a high percentage of dormant seeds. This refers to the practical experience that optimal restoration success can be reached if reseeding of *Molinion* meadows takes place at the end of the season.

Keywords: restoration, donor site, purity, germination capacity

Introduction

Nature conservation areas are valuable resources for the maintenance and promotion of biodiversity. About 15 to 25% of the areas used for agriculture in Europe can be included within this category, but only a small share of these areas are also designated as protected. The restoration and re-introduction of valuable local plant species from available donor sites is therefore seen as being of great political and ecological importance. The main objective of the restoration of semi-natural grassland areas lies in the establishment of ecologically valuable plant communities of regional origin. Suitable and usable restoration procedures are also important for the maintenance and safeguarding of the genetic diversity through the transfer of seed material. An essential prerequisite, however, is the careful selection of suitable donor areas of the greatest possible ecological value. In former times, the biomass of litter meadows was used as a straw substitute. This type of grassland dominated the bottom of many inner-alpine valleys. The re-establishment of the ecological valuable litter meadows has become an important issue, especially in the framework of the NATURA 2000 programme. There is an increasing demand for the enlargement of such rare areas, especially in the Styrian Enns valley. Basic knowledge concerning the seed quality of diaspore material harvested from suitable donor sites is essential for success.

Materials and methods

The experimental site is a *Molinion* litter meadow, cut once per year, located in the central part of Austria, (47°56'N, 14°19'E; 636 m a.s.l). During the year of harvest the mean annual air temperature was 6.7°C and annual precipitation was 968 mm. The pH-value is slightly acidic (6.0). Two different harvesting techniques were applied: i) a 'Wintersteiger Classic'

plot combine thresher (OST) with a cutting width of 150 cm, and ii) a 'Prairie habitats 610' pull-type seed stripper (SS) with 120 cm width drawn at a speed of 3 km h^{-1} and used on 15 September 2009. After harvesting, the material was air dried and cleaned with a 6 mm sieve. The material was stored over 17 months in a cooling chamber at 2-5°C with 3-4 g m^{-3} absolute humidity. Homogenous samples of the harvested seed were taken and all assessments carried out according to the rules of the International Seed Testing Association (ISTA, 2011). For the purity assessment, ten seed samples per harvesting technique were divided into chaff and filled seeds. For determination of the thousand seed weight (TSW), 10×100 randomly chosen filled seeds were counted and weighed. For the germination capacity (GC) test 12×1.25 g samples per harvesting method were taken and sown in bulb trays (40×60×6 cm) on an organic growing substrate. To study the effect of pre-chilling, the bulb trays were stored outdoors under snow cover between 2 February and 22 March 2011. They were then transferred to the greenhouse, and compared to the same amount of fresh-sown samples. The duration of the germination trial was six weeks and the samples were counted once a week. The statistical analyses were done with the statistics language R 2.15.1. A Shapiro-Wilk Test was performed, showing a normal distribution of the data. Purity and the TSW were tested with an independent samples t-test to determine the 95% confidence interval. The two-way ANOVA was used to assess differences between pre-chilled and untreated seeds.

Results and discussion

Determination of the purity of harvested seed material is generally important to ascertain the volume of pure seeds in the material, which then defines the actual sowing volume of the entire material.

The rotating brush of the seed stripper did not have any strong mechanical impact on the vegetation. However, the huge amount of biomass caused repeated seizure of the rotating brush of the seed stripper. Therefore, mainly full ripe seeds were brushed out and the proportion of chaff, on average, did not exceed 32% (Table 1). Due to the more intensive mechanical impact of the combine plot thresher, the OST harvesting material contained nearly double the proportion of chaff but the total yield of pure seeds (187 kg ha^{-1}) was considerably higher than for the SS method (48 kg ha^{-1}). Consequently, the TSW of pure seeds was significantly lower in the OST variant.

Table 1. Results of TSW and purity of the harvested OST and SS material.

Harvesting method	Mean value	95% Confidence interval
OST – TSW (g)	0.94	0.830-1.046
SS – TSW (g)	1.83	1.687-1.975
OST - pure seeds (%)	45.36	40.15-50.56
SS - pure seeds (%)	68.09	62.99-73.19

Differences in mean TSW and pure seeds are significant (*t*-test, $P < 0.001$)

Table 2**.** Results of the two-way ANOVA of the germination capacity trial.

Treatment	Df	Sum Sq	Mean Sq	*F*-value	*P*-value	Partial Eta Sq
Harvesting method (HM)	1	98.30	98.30	3.88	0.055	0.081
Pre-chilling (PC)	1	1304.27	1304.27	51.50	< 0.001***	0.539
HM×PC	1	12.72	12.72	0.50	0.482	0.011
Residuals	44	1114.41	25.33			

Significance level: * $P<0.05$, ** $P<0.01$, *** $P<0.001$; R^2: 0.56; adjusted R^2: 0.53

The results of the two-way ANOVA showed no significant influence of the harvesting method on germination capacity (Table 2), whereas the positive effect of pre-chilling on germination capacity was highly significant. The germination capacity of untreated seeds of the *Molinion*

litter meadow did not exceed 20%, independent of the harvesting method (Figure 1). The treatment pre-chill increased the spontaneous germination to more than 30%. Seed dormancy is an innate seed property that defines the environmental conditions in which the seed is able to germinate (Finch-Savage and Leubner-Metzger, 2006). This should guarantee that germination occurs when conditions for establishing a new plant generation are likely to be suitable. Due to the late cut of the litter meadows end of August/early September, the plant stands are dominated by late-maturing species. The short remaining vegetation period does not ensure suitable conditions for the establishment of young seedlings. Frost dormancy prevents germination in autumn, shifting it to the following spring with comparatively better conditions for seed establishment.

Together with the TSW and the data from purity assessment, the knowledge about germination capacity is important in order to determine the necessary seeding amount of harvested seed mixtures from donor sites. To ensure the rapid development of dense vegetation, 2-5g m^{-2} pure seeds (about 1000-2000 germinating seedlings, also depending on erosion risk) are recommended (Scotton *et al.*, 2012). For the restoration of a new litter meadow with our assessed seed material, a seeding amount of 5-7 g m^{-2} for SS and 8-10 g m^{-2} for OST material would be necessary, assuming a low erosion risk at the restoration site.

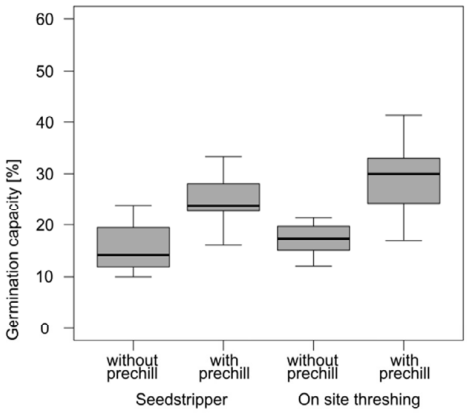

Figure 1. Germination capacity of untreated and pre-chilled seeds harvested from a *Molinion* litter meadow.

Conclusions

For the restoration of *Molinion* litter meadows with harvested seed mixtures, seeding rates of at least 5-8 g m^{-2}, depending on harvesting method, can be recommended. Due to the high share of frost germinators, the seeding of receptor sites should be undertaken in late autumn.

References

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