Germination capacity of threshed material from an *Arrhenatherion* meadow

Petra Haslgrübler[1], *Bernhard Krautzer*[1], *Wilhelm Graiss*[1]

[1] Raumberg 38, 8952 Irdning, LFZ Raumberg – Gumpenstein

Abstract

In the last few decades there has been a significant decrease of biodiversity in Europe. To counter this trend, harvested seed mixtures of potential donor sites can be used to establish semi-natural grassland. But it is important to guarantee a certain level of seed quality and successful germination as well as the regionality of the provenance of the harvested seed mixtures.

Seed material was harvested via on-site threshing from an *Arrhenatherion* meadow, stored under room temperature and 400 randomly selected seeds of the harvested mixtures were tested in two germination trials in a climate chamber for four weeks. Three different substrates (potting soil, sand and filter paper) were tested in the first trial. The germinated seedlings were counted as monocotyledons and dicotyledons. Potting soil showed the highest germination rate. In the second germination trial, the germination capacity of the seed mixture was tested on potting soil with and without pre-chilling after addition of potassium nitrate (KNO_3), addition of gibberellin acid (GA_3), and without addition of chemicals. In general, the germination capacity of the pre-chilled variants was lower. Variants with KNO_3 developed a higher rate on monocotyledons, variants with GA_3 showed a slightly rise of dicotyledonous seedlings. The germination capacity of treated variants was lower compared to the variant without pre-chilling or chemical treatment.

Key words: germination, pre-chilling, gibberellin acid, potassium nitrate, biodiversity, restoration, semi-natural grassland

Introduction

Site-specific restoration is a successful way to combat the increasing biodiversity loss. Nowadays, a lot of examples exist all over Europe (Kirmer & Tischew 2006). It is important to choose the right harvesting method depending on target vegetation and site-specific conditions (e.g. protection against erosion, development of semi-natural and low maintenance vegetation). Without common knowledge about the quality control of harvested material, this paper deals with possible quality criteria for on–site threshing (OST) material from an *Arrhenatherion* community. There is no existing normative regulation for this kind of revegetation material. The OST material was tested in two trials to assess its germination capacity. In the first germination trial the substrate was tested, in the second one different dormancy breaking treatments were examined.

Material and Method

The *Arrhenatherion* donor site "Welser Heide" is situated in Upper Austria (48° 18' N, 14° 03' E). Until the end of the 1980ies, 30 % of the area was still under agricultural use. Since 1998 the whole area is not fertilised and mown once a year at the end of June. Within a couple of years, it changed from a nutrient-rich and species-poor meadow to a species-rich *Arrhenatherion* community. Red list and rare species appeared (e.g. *Dianthus carthusianorum*, *Numenius arquata*) which were already extinct or not found any more in Upper Austria (Plasser *'et al.'* 2006).

During 1971-2000 the mean annual precipitation was 753.8 mm with a yearly average temperature of 8.8°C. The tested material (OST) was threshed with an appropriately adapted

combine harvester (Wintersteiger classic thresher) on July, 1st, 2009 at a time of optimum seed maturity. The threshed material was subsequently dried and stored by room temperature (20-22°C) under dry conditions. Before the germination trial started, the purity and the thousand seed weight (TSW) of the seed mixture was determined. Existing literature for previous successfully applied germination treatments was studied (ISTA 2009, Godefroid '*et al.*', 2010) but information was available only for some single species. To test the germination capacity of our seed mixtures, we used a combination of different treatments. The germination trials were monitored for four weeks and all experiments were carried out with four replicates. In the first germination trial, three different types of substrate were tested; potting soil, quartz sand and filter paper. Quartz sand (ME 0.5 - 2.0, Quarzwerke) is a natural resource, washed, hydro classified, sieved, and free of carbon and organic waste. Potting soil (Torboflor® EASY) is nutrient rich for the first four weeks. The added biocatalyst Zeolith is highly resistant, absorbs pollutants, saves important nutrients and the bioactive clay stabilises the water storage capacity. The filter paper (Lactan) is classified according to ISTA (2009). 4 x 100 randomly selected seeds were sown in white cups (15.5 cm x 11 cm), after adding the respective substrates. The results of the first germination trial were used to select the substrate for the second germination trial.
In the second germination trial different dormancy breaking treatments (KNO_3 0.2 %, GA_3 0.05 %, without additives, and all variants in combination with / without prechilling) were tested. The prechilled variants were stored for one week covered in the cooling chamber under controlled temperature of 3-4°C. The germination trial was done in a climate chamber (KBWF 720, Binder) (Table 1). The seedlings were counted once a week and divided into monocotyledons and dicotyledons. One-way ANOVA was used to compare germination rates of different substrates. A generalised linear model (GLM) was used to test results of the second germinations trial and if the prechilling treatment significantly influences the germination rate of the seed mixture. All tests were calculated with Statgraphics 15.1.

Table 1: climate chamber conditions for the assessment of the germination capacity

1st germination trial 'substrate'	2nd germination trail 'dormancy breaking treatment'
Day light (14.200 lux) / Night: 8h / 16h	Day light (14.200 lux) / Night: 12h / 12h
Humidity: 85 % ± ≤ 2.5	Humidity: 85 % ± ≤ 2.5
Temperature: 20°C / 30°C ± 0.1 - 0.5°C	Temperature: 20°C / 30°C ± 0.1 - 0.5°C
Duration: April, 06th 2010 – April, 26th 2010	Duration: August, 19th 2010 – September, 16th 2010
	Pre-chilling: August, 12th 2010 – August, 19th 2010 (3-4°C)

Results

The OST material had an average purity of 60 % pure seeds with an average TSW of 1.04 g. In the first germination trial, we found no statistically significant differences between substrate groups (Table 2). All variants in the first germination trial 'substrate' reached a total germination capacity between 58 % and 68 %. The results of the germination trial show that the substrate potting soil had the highest and also a homogenous germination rate. Therefore, this substrate was selected for the second germination trial.

Table 2: Germination capacity of threshed material from an Arrhenatherion grassland dependent on different substrates and results of one-way ANOVA.

substrate	Mean total	SD	F	Sig.
Quartz sand	59.50	± 10.08	3.033	0.098
Potting soil	68.25	± 3.59		
Filter paper	58.00	± 2.58		

In the second germination trial, the results revealed significant differences between all variants ($F = 3.060$, $P = 0.036$). The GLM showed significant differences between the treatments (OST, KNO3 and GA3) and the prechill variants. The interaction between prechill and treatment is not significant (Table 3). The mean total values show that all variants reached a germination capacity between 41 % and 56 % (Table 4). Best results were obtained by the variants without any dormancy breaking treatment (OST). Prechilling had in general a decreasing effect on germination. The variants treated with GA_3 showed a slightly higher percentage of herbs but the total germination capacity was slightly lower. In the variants treated with KNO_3, monocotyledons reached a higher percentage.

Table 3: Germination capacity of threshed material from an Arrhenatherion grassland; results of the GLM

GLM	treatment *	prechill **	prechill*treatment
F	4,65	5,62	0,19
Sig.	0,0235	0,0291	0,8323

Table 4: Germination capacity means of threshed material from an Arrhenatherion meadow with different treatments devided into Monocotyledon and Dicotyledon.

Variant	OST	OST - prechill	KNO3	KNO3 - prechill	GA3	GA3 - prechill
Monocotyledon	26,5	26	31,75	28,5	24	18
SD	± 2.08	± 5.35	± 6.99	± 5.74	± 3.16	± 9.76
Dicotyledons	29,75	24	23,25	22,5	24,75	23
SD	± 5.12	± 8.21	± 6.18	± 4.43	± 5.85	± 10.36
Mean total	56.25 *	50 **	55 *	51 **	48.75 *	41 **
SD	± 3.10	± 3.92	± 11.69	± 5.89	± 5.25	± 2.55

Discussion

The results presented confirm, that on-site threshing of potential donor sites is an effective way to harvest seed mixtures for use in restoration of semi-natural grasslands. The harvested material contained 60 % of pure seeds and the seeds reached a germination capacity of 68 % in the first trial and 56 % in the second trial after four weeks, which can be considered high in comparison to the assessments of Heilinger and Florineth (2003).
Variants treated with GA_3 showed a slightly higher germination of dicotyledonous seedlings because it is known to break dormancy of herbs. On the other hand, KNO_3 is used in dormancy breaking treatments of monocotyledons (ISTA 2009), thus resulting in higher number of monocotyledon seedlings in KNO_3 treatments.
In our germination trial, most of the seeds germinated within the first two weeks, allowing the conclusion that an observation period of four weeks was sufficient. No quality standards for harvested seed mixtures from semi-natural grassland are defined yet. To guarantee a fast vegetation development on receptor sites and a protection against erosion, a minimum germination capacity of 50 % should be used as quality criteria for directly harvested seed mixtures.

References

GODEFROID S., VAN DE VYVER A., VANDERBORGHT T. (2010) Germination capacity and viability of threatened species collections in seed banks. *Biodiversity Conservation 19*, 1365 - 1383

HEILINGER K. and FLORINETH F. (2003) Qualitätsprüfung von nicht gezüchtetem Saatgut, *Rasen Turf Gazon 3*, 56-66.

ISTA (2009) International seed testing association; Handbook of Seedling Evaluation 3rd Edition. Switzerland

KIRMER A. and TISCHEW S. (Hrsg.) (2006) Handbuch naturnahe Begrünung von Rohböden. Teubner Verlag Wiesbaden

PLASSER M., STRAUCH M., SCHUSTER A. (2006) Die wiedergewonnene Welser Heide ! Der Welser Flugplatz vor dem Hintergrund der Landschaftsentwicklung im Unteren Trauntal, ÖKO L Zeitschrift für Ökologie, Natur- und Umweltschutz, 3-14