

Chapter

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***Ex Situ* Preservation in Permafrost as a Complement to Seed Storage at The Nordic Gene Bank**



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Summary

The Nordic Gene Bank (NGB) is a regional gene bank and a centre for plant genetic resources for the five Nordic countries: Denmark, Finland, Iceland, Norway and Sweden. The mandate of the NGB is to conserve and document Nordic material of value to agriculture and horticulture thus providing a basis for the future use of the genetic variation. Furthermore, the NGB initiates and co-ordinates activities promoting a better understanding of plant genetic resources including activities such as characterisation and evaluation. This chapter considers the NGB's duplicate seed storage in the permafrost of Svalbard.

Introduction

The Nordic Gene Bank was established in 1979 and merged with Internordic Plant Breeding (SNP) in 1993. During the initial period, the principal activities of the NGB were to trace and transfer existing collections of material from various Nordic institutions as well as collecting wild crop relatives, mainly fruit and berries. At the same time, seed storage activities were established and routines and techniques for seed management and conservation were studied and developed.

During the later years of the 1980s, most of the available information on the material was registered in a database and prepared for publication. Since the early 1990s, several projects on characterisation and evaluation of the collection have been carried out and gradually published.

Ex Situ Conservation of Seeds in Seed Storage

Ex situ is the prevailing conservation method for the NGB. The central seed store of the Nordic Gene Bank is located at Alnarp, in southern Sweden. By definition, Nordic material comprises modern varieties and breeders' lines of Nordic origin as well as varieties and clonal material of vegetatively propagated crops and wild relatives of the domesticated species. The NGB also stores certain genetic stocks and special collections of practical and scientific value. One such internationally valuable special collection is that of *Pisum* brought together by Swedish pea geneticists (Blixt, 1972). Furthermore, special collections of cereals are also maintained at the NGB. An international collection of wild *Triticeae* includes populations from all over the world

including species of *Hordeum* and hybrid species (von Bothmer *et al.*, 1995). The largest one, comprising about 15,000 accessions, is the result of extensive mutation research on barley during 50 years beginning from the 1930s (Lundqvist, 1992). The NGB also provides safe duplicate storage as a service for other gene banks. The material is then stored separately as 'black box' material according to agreements with depositors.

The total NGB collection contains approximately 30,000 accessions. The material in the seed store is organised into three different collections: active, base and 'safety' base.

The *active collection* is for distribution on request and for characterisation and evaluation as well as all work relevant to gene bank operations. Consequently, multiplication of the material is a major undertaking. The accessions are stored in aluminium foil laminated bulk bags and small distribution bags. The distribution bags contain approximately 250 living seeds and bulk bags, 20,000 living seeds per accession. The large bulk bag is divided into more distribution bags when necessary.

The *base collection* comprises the genetically most original seeds and is used exceptionally for rejuvenation (= regeneration) when seed viability of the active collection has dropped to a critical level. The accessions maintained for long-term preservation contain approximately 20,000 living seeds.

Finally, the *safety base collection* is a safeguard against any accidental loss of material. Consequently, duplicates from the base collection are stored separately in a geographically distant place (Svalbard). About 500 living seeds are usually packed for each safety base collection.

Material in Field Gene Banks

Maintenance of vegetatively propagated crops, such as fruit and berries and some vegetables, is carried out nationally in collaboration with research institutes and botanical gardens. Potato is however an exception. NGB takes full responsibility for the conservation of this material, which is stored *in vitro*.

Safety Base Collection in an Arctic Coal Mine

In the early 1980s, the NGB began to look for a place to establish a reliable and cost effective storage facility for the duplication of the base collection. This was found in an area of permafrost in one of the coalmines of Store Norske Spitsbergen Kulkompani A/S (SNSK) in Longyearbyn in Svalbard. Svalbard is situated about 1,000 km north of mainland Norway and the subterranean temperature is permanently below zero. Seed storage in permafrost at Svalbard thus provides a natural and reliable means of refrigeration that is not dependent upon an electrical energy supply.

An agreement was signed between NGB and SNSK, and a specially treated metal container was installed in an abandoned mine gallery where there is a constant temperature of approximately -4°C . The first shipment of seeds for storage arrived at Svalbard in November 1984.

The steel container stands behind two locked wooden doors in the empty mine. The temperature in the steel container is checked every month. The seed samples are stored in hermetically sealed Pyrex glass ampoules, packed in wooden boxes. Each ampoule contains 500 seeds. Additional material from the NGB base collection is packed every year and shipped to Svalbard.

100 Year Trial of Seed Longevity in Permafrost

Deterioration of orthodox seed is known to occur in air-dry storage resulting in failure of germination. Low moisture and low temperature will slow down but not stop the process of the deterioration (Cromarty *et al.*, 1982).

In order to compare the germinability loss of the Svalbard collection with that of the base collection held at the NGB in Alnarp, a 100-year testing programme was set up.

The experiment was initiated in 1987. The material consists of a number of cultivars from a range of species presented in Table 50.1. Each cultivar is represented by 25 sealed glass ampoules each containing 1,000 seeds. All 25 ampoules originate from the same seed lot. Every $2\frac{1}{2}$ years during the first 15 years and subsequently every fifth year, the viability of the stored seeds is being checked according to the International Seeds Testing Association (ISTA) method using 4×100 seed examples. In addition, occurrence of pathogens on the seed surface is being checked during the first 20 years of the experiment. Statens Frøkontroll in Norway carry out all analyses.

Table 50.1 Nordic cultivars and their species used at storage experiment in permafrost

Plant species	Nordic Cultivar
<i>Hordeum vulgare</i>	Inga Abed , Tunga
<i>Triticum aestivum</i>	Vakka, Solid
<i>Secale cereale</i>	Pektus , Vioma
<i>Lolium perenne</i>	Pippin, Riikka
<i>Phleum pratense</i>	Tammisto, Bodin
<i>Poa pratensis</i>	Annika, Hankkijan Kyosti
<i>Trifolium pratense</i>	Jokioinen, Molstad
<i>Pisum sativum</i>	Weitor parti 10468, Hankkijan Hemmo
<i>Beta vulgaris</i>	70500, Hilleshog 81458
<i>Brassica napus</i>	Jupiter, Linrama
<i>Allium cepa</i>	Hamund, Owa
<i>Lactuca sativa</i>	Hilro, Attraktion
<i>Cucumis sativus</i>	Gigant, Rhensk
<i>Daucus carota</i>	Nantes Fancy, Regulus
<i>Brassica oleracea</i> var. <i>botrytis</i>	Savit, Pari

Results and Discussion

The first data on germination of the seed samples is illustrated in Figures 50.1 to 50.6. The viability of the different plant species and cultivars under permafrost storage conditions has during the last 12½ years been very close to their initial value although some fluctuation of the germination percentage has occurred. Some genotypes seem to lose their viability relatively fast, such as *Secale cereale* cv. Vioma in Figure 50.1b. As a consequence, such genotypes should be replaced with a new sample more often in the safety base collection. Some of the samples show an apparent large decrease in viability followed by an increase (Figures 50.1, 50.3 and 50.4). This would appear to be due to the differing interpretation of abnormal/normal germinating seeds over time. As a consequence, these results should be viewed with caution.

The permafrost trial will be evaluated in more detail in the future. So far, the results are promising. It should be emphasised that using permafrost storage is a safe and cheap way to maintain plant genetic resources for the future.

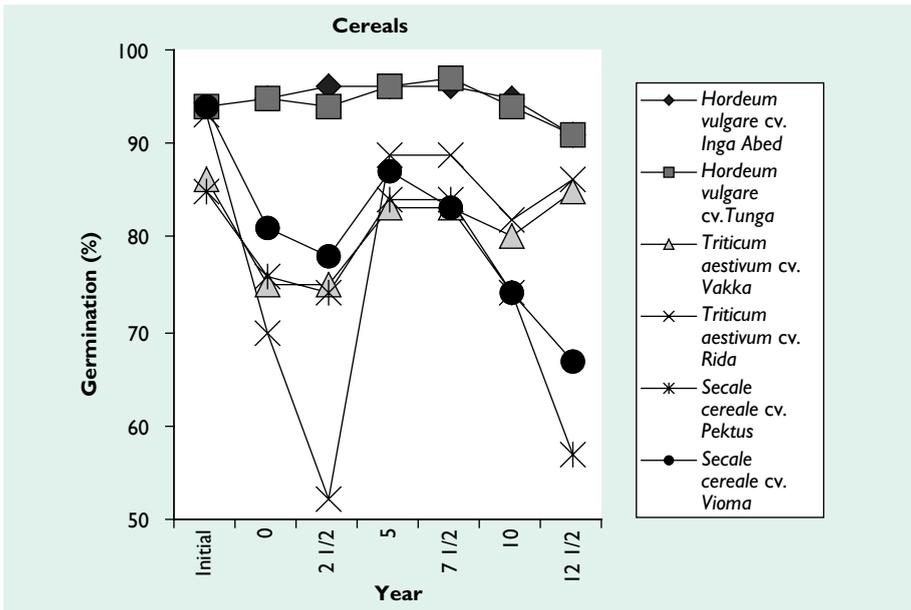


Figure 50.1 The germination percentages for cereal crops at Svalbard in permafrost conditions during 12½ years.

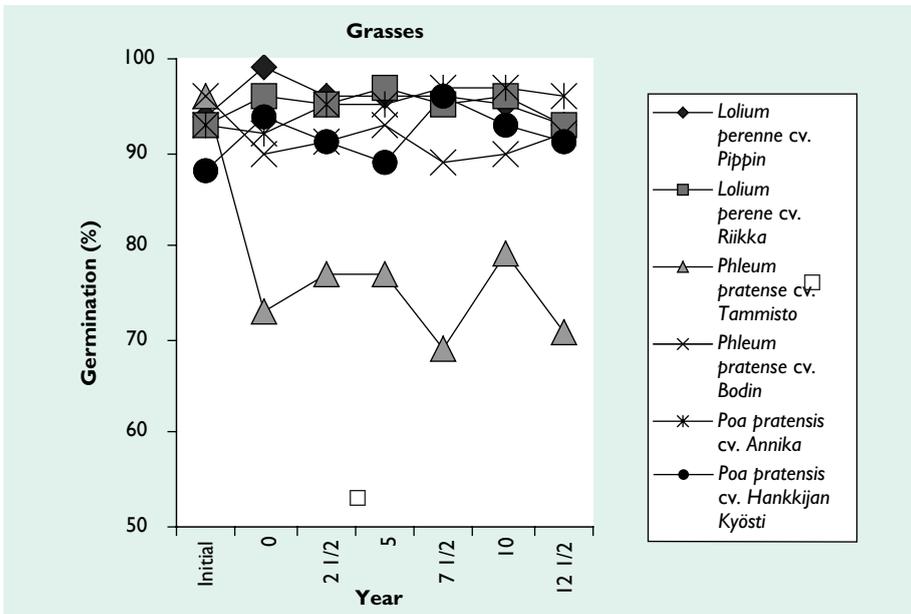


Figure 50.2 The germination percentages for grass crops at Svalbard in permafrost conditions during 12½ years.

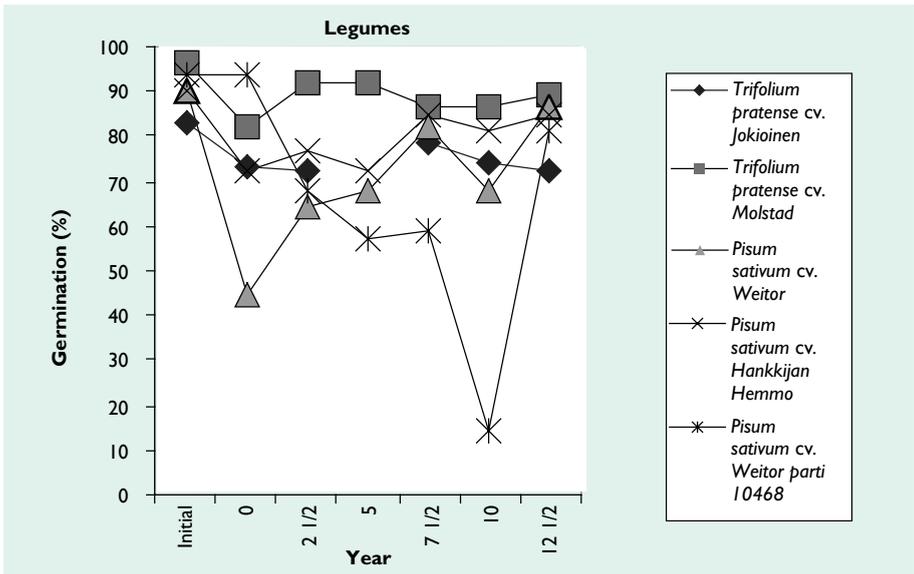


Figure 50.3 The germination percentages for legume crops at Svalbard in permafrost conditions during 12½ years.

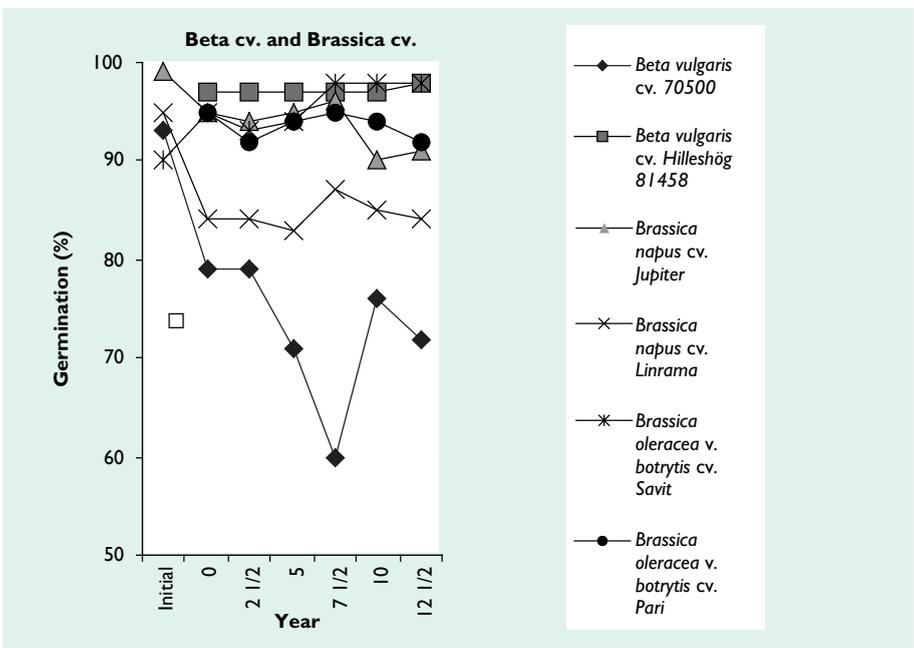


Figure 50.4 The germination percentages for beet cv. and Brassica crops at Svalbard in permafrost conditions during 12½ years.

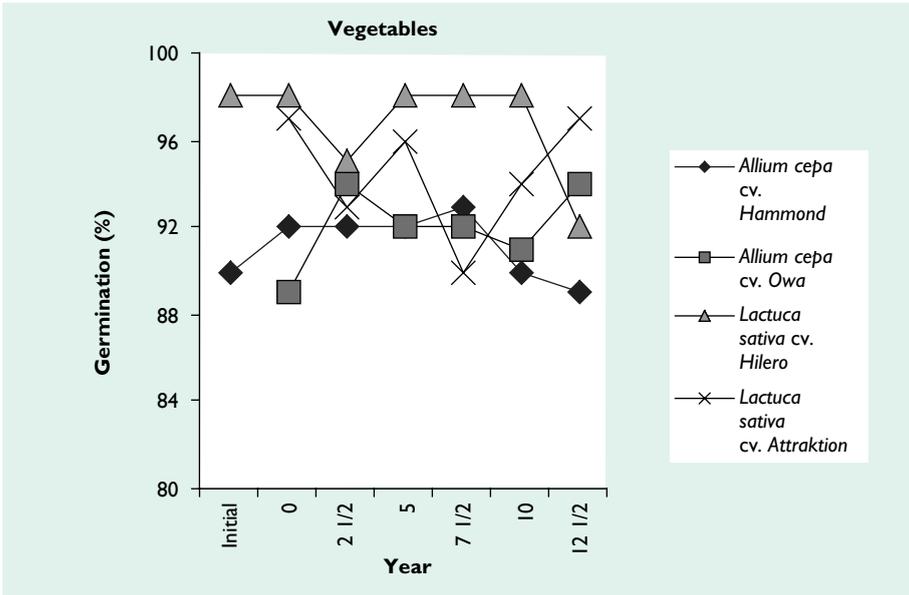


Figure 50.5 The germination percentages for vegetable crops at Svalbard in permafrost conditions during 12½ years.

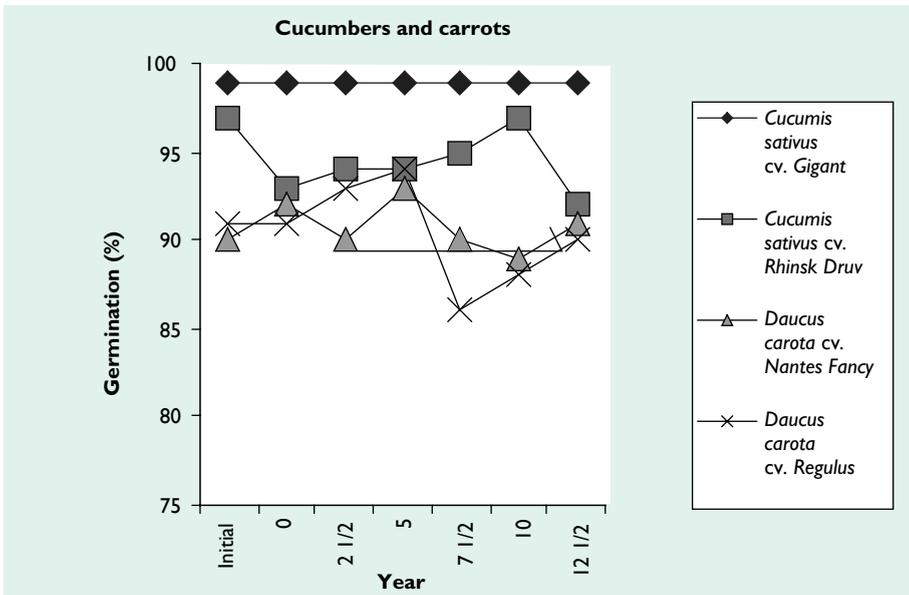


Figure 50.6 The germination percentages for cucumber and carrot crops at Svalbard in permafrost conditions during 12½ years.

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