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Longevity of seeds - intraspecific differences in the Gatersleben genebank collections

Manuela Nagel[1*], Mian Abdur Rehman Arif, Maria Rosenhauer and Andreas Börner

Abstract

The federal *ex situ* genebank of Germany in Gatersleben is with some 150 000 accessions one of the largest of the world. About 130 000 accessions are kept as seeds. Information about optimum storage conditions, germinations and seed longevities are important for running processes. The current study is dedicated to the seed longevity of barley, wheat, rye, sorghum, flax and oilseed rape. Unfortunately, there is only a tendency for the long-life behaviour of a species. Seed longevity itself is strongly influenced by the genotype of species which can be depending on factors as plant height and husk.

Keywords

Genebank, genetic diversity, intraspecific variability, seed storage

Introduction

Nowadays the trait 'seed longevity' is a primary feature for a running genebank. Information about longevity of species is important for storage periods, reproduction cycles and germination test intervals. Nevertheless, the trait itself was not considered highly relevant until the beginning of the 20th century. At that time, the Russian botanist and ecologist Nicolai I. Vavilov recognized, as one of the first, that our plant genetic resources are in particular danger and need to be conserved for the future (MAXTED et al. 1997). These efforts were followed by the establishment of modern genebanks around the world (LININGTON and PRITCHARD 2001), which led to an increasing interest in the storage behaviour of seeds. HAFERKAMP et al. (1953), PRIESTLEY et al. (1985), STEINER and RUCKENBAUER (1995), WALTERS et al. (2005) and NAGEL and BÖRNER (2010) investigated seed longevities of crop plants under ambient, cold and ultra-dry storage conditions. Consistently they agree that the longevity of seed is different between species and depends on the storage conditions. Depending on the conditions and the species the viability can last between months and decades. Moreover, different discoveries have demonstrated that under certain conditions seeds can survive for hundreds of years. The seeds of a date palm (*Phoenix dactylifera* L.) provide a famous example of extreme longevity. These seeds were discovered beneath a Heriodin fortress in Israel and germinated after 2000 years (SALLON et al. 2008). Furthermore, 200-year-old seeds could germinate in the Millennium Seed Bank at the Royal Botanic Gardens Kew. The material originated from a trip to the Cape of Good Hope in 1803. A Dutch merchant brought the seeds by ship to London where they were stored in the Tower of London and later on in the National Archives (KEW 2006). However, the longevity of seeds has always defined for the species.

The following study will show, differences not only exist between species, but also between the genotypes within a species. The material under study belonged to the *ex situ* genebank for agricultural and horticultural crop plants in Gatersleben, which houses some 150 000 accessions, covering over 3000 species within 890 genera. In general, orthodox seeds are conserved at -15°C, while vegetatively reproduced plant materials are maintained by *in vitro* culture and cryo-conservation. Seed storage accounts for about 90% of the stored material (BÖRNER 2006).

Material and methods

For investigating the intraspecific variability of seed longevity, Gatersleben genebank accessions of barley (*Hordeum vulgare* L.), wheat (*Triticum aestivum* L.), rye (*Secale cereale* L.), sorghum (*Sorghum bicolor* L.), oilseed rape (*Brassica napus* L.) and flax (*Linum usitatissimum* L.) were used. The material was stored in glass jars topped with silica gel at 8±2% seed moisture content. Number of accessions, countries of origin, harvest year and storage temperature are given in *Table 1*.

Table 1: **Species, number of accessions, countries of origin, harvest year and storage temperature of material used for germination test**

Species	Accessions	Countries of origin	Harvest year	Storage temperature
Barley	50	14	1974	±0°C, since 2008: -15°C
Wheat	41	18	1974	±0°C, since 2008: -15°C
Rye	36	9	1982	±0°C; since 1998: -15°C
Sorghum	5	4	1978	±0°C, since 2006: -15°C
Oilseed rape	45	6	1983	-15°C
Flax	52	12	1978	-15°C

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For investigating the intraspecific variability seeds were tested in three replications consisting of 50 seeds each. Each replication was germinated according to the ISTA (International Seed Testing Association) rules. The germination percentage was calculated from the proportion of normal appearing seedlings (ISTA 2008).

Results and Discussion

Germination after 26 up to 33 years of storage was assessed among the different crop species (*Figure 1A-F*). Most crops showed high germination when germinated within 5 years post harvest, but germination of most accessions within species separated strongly after 20 years. In particular, wheat germination resulted between 0 and 87% after 34 years of storage (*Figure 1B*) and barley accessions germinated between 43 and 95% after 35 years (*Figure 1A*). A paired t-test showed significant differences between genotypes of the species after the recent germination test.

In general, as has been documented by ROBERTS (1972), germination decreased over storage time in a sigmoid fashion, as visible in *Figure 1E*, whereby the parameters of these curves seemed to be species specific. Especially rye accessions (*Figure 1C*) had already reduced germinations (between 8 and 47%) after 27 years. Similarly, most oilseed rape accessions (*Figure 1E*) had germinations below 50%. Only few remained over 50%. Contrary to those species, different barley genotypes (*Figure 1A*) decreased slightly in their germination and remained predominantly over 50%. Therefore, a tendency for the long-life of a seed is given for the species but, as seen, the genotypes of a species differ within.

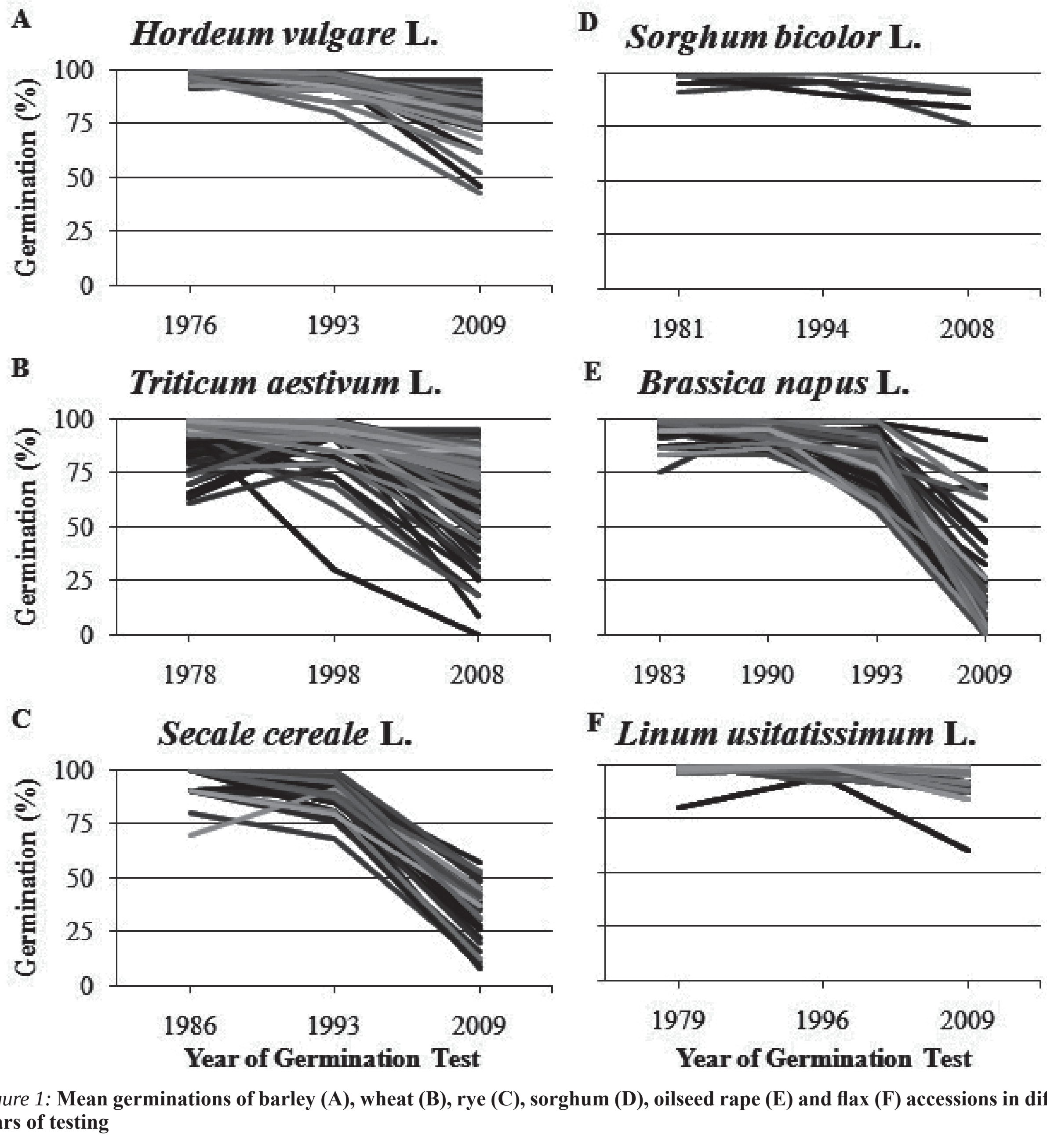

Figure 1: **Mean germinations of barley (A), wheat (B), rye (C), sorghum (D), oilseed rape (E) and flax (F) accessions in different years of testing**

Due to the same harvest year, the same cleaning methods and storage conditions of the genotypes of the species under investigation it can be assumed that differences in germination are genetically based. First aging and germination tests with barley mapping populations give a hint that traits like plant height, husks just as abiotic and biotic factors during the season can influence the seed longevity (NAGEL et al. 2009). Therefore, the viability equation as published by ELLIS and ROBERTS (1980) can forecast a longevity tendency but the behaviour of a specific genotype depends on more factors than moisture content, storage temperature and initial viability and is unpredictable at the moment.

Conclusion

The investigations on genebank material showed that the seed longevity is not only different between species it also differs between genotypes of a species. Although barley and flax seeds show a long-living tendency and rye and oilseed rape a more short-living trend the genotypes vary in germinations. On basis of the identical harvest years and conditions as cleaning as storage conditions, genetic factors for seed longevity can be assumed.

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