Use of the seed viability equation to relate different storage conditions and predict shelf life of a seedlot

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Introduction

In the UK, like other countries, some treated seed is not used in the season it is produced and is stored for around 18 months before it is planted in the subsequent season. Stocks of unopened boxes of seed are stored in warehouse conditions at roughly 50% RH and 20°C on average. However this is not always the case, as some seed can be stored on farm under various conditions.

Any seed, if not stored properly can deteriorate quite rapidly, especially if the storage conditions are damp and/or warm. Understanding what difference a few degrees in temperature or a few percentage in relative humidity, has on storage potential is useful when storing seed and managing stocks. The seed viability equation developed by Ellis and Roberts describes how seed populations deteriorate over time at different conditions of seed moisture and temperature. We have used the principles set out by the equation to calculate how long it will take under different conditions for seeds to deteriorate to the same level, and results from initial storage tests are confirming these predictions.

$$v = K_i - {}^{p}\!/_{10^{K_E - C_W \log m - C_H t - C_Q t^2}}$$

v = final viability (expressed as %, NEDs or probits) after p days storage.
P = storage time (days)
m = % moisture content (fresh weight basis)
t = temperature (°C)
K_i = initial viability of the seed lot at p = 0 days (seedlot constant)
C_H and **C_Q** = species-specific temperature constants
K_E and **C_W** = species-specific moisture content constants.

Ellis & Roberts (1980) Viability Equation

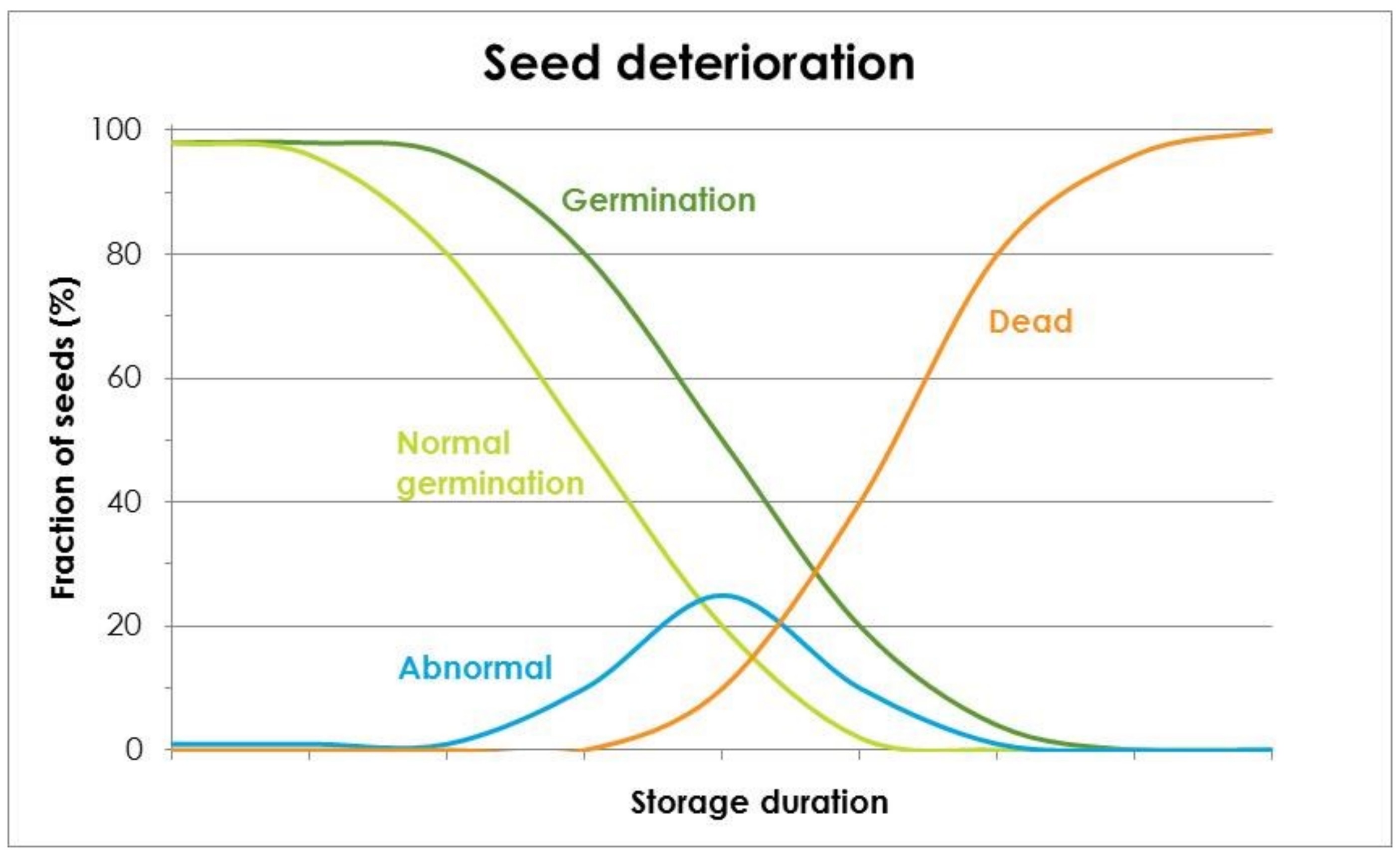

Fig 1. Representation of how various quality parameters of a seedlot change as it deteriorates over time.

The output of the viability equation in basic terms is similar to **Harrington's Rule:** Seed longevity decreases by one-half for every 1% increase in moisture content or every 5.6°C (10°F) increase in temperature.

Methods

Using the equation or rule above it is possible to calculate how long it will take, under various conditions, to cause the same amount of deterioration to seeds.

A common way of controlling moisture of seeds during storage is to control the relative humidity (RH); this can be done in various ways. In this work samples were stored in sealed containers over various different saturated salt solutions, to give certain RH's. But in order to use the viability equation you need to know the moisture of the seeds at that relative humidity. So the relationship between moisture and RH needed to be established for sugar beet seeds.

Storage or aging conditions	20°C 54%RH	25°C 43%RH	30°C 51%RH	Aging 40°C 76%
Durations of storage to give equivalent deterioration	9 months	10 months	3 months	2 days
	19 months	20 months	6 months	4 days
	28 months	31 months	10 months	6 days

Table 1. Equivalent storage durations under different conditions

The table shows by aging seed samples for a few days at high temperatures and humidity they will have the same amount of deterioration as after several months at lower temperature and moisture conditions. Those aged samples can then be tested to see how they will perform under any germination or vigour test.

Results

3 varieties were primed to differing intensities, then samples were stored under different conditions of temperature and humidity for various durations (as specified in Table 1). Following aging or storage, samples were germination tested and the time to 50% germination was measured. If the samples have the same amount of deterioration from the different storage conditions then the germination speed should be the same.

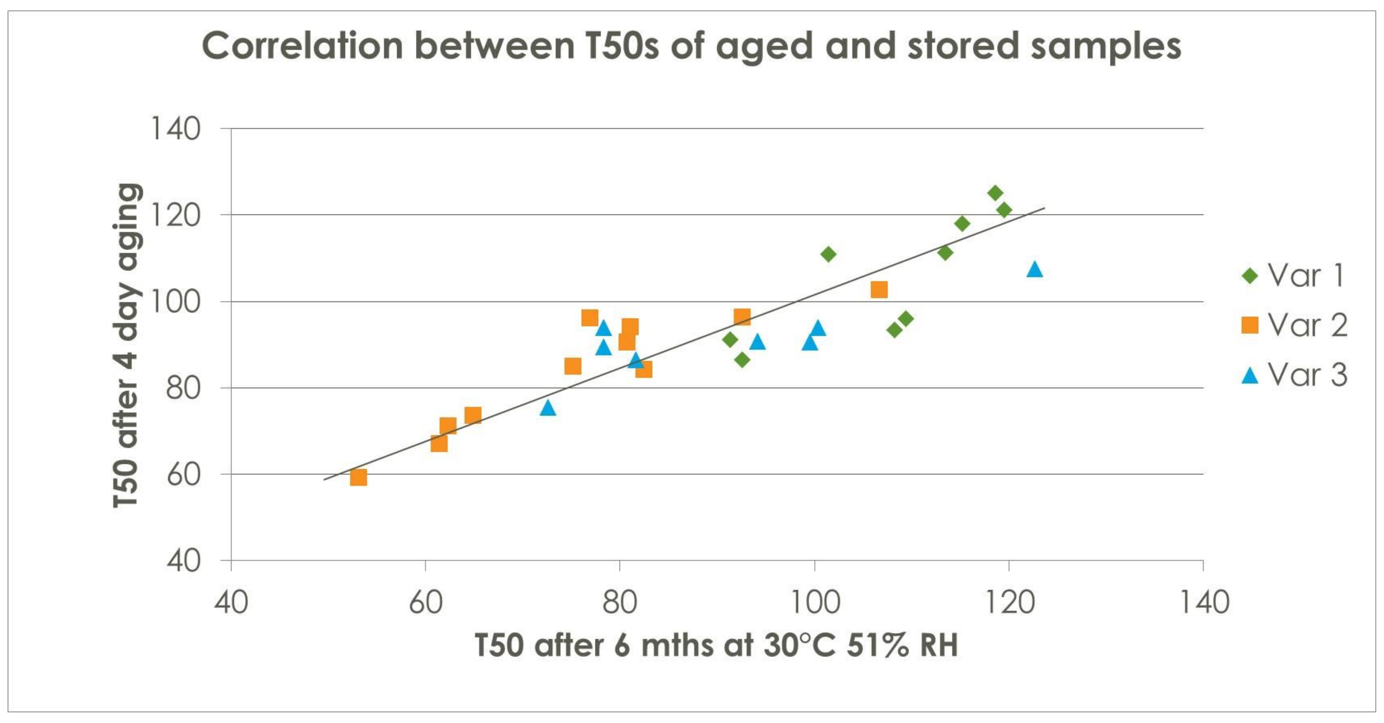

Fig 3. Correlation between the time to 50% germination (T50) of samples aged for 4 days and the T50s of the same samples stored for 6 months at 30°C and 51% RH

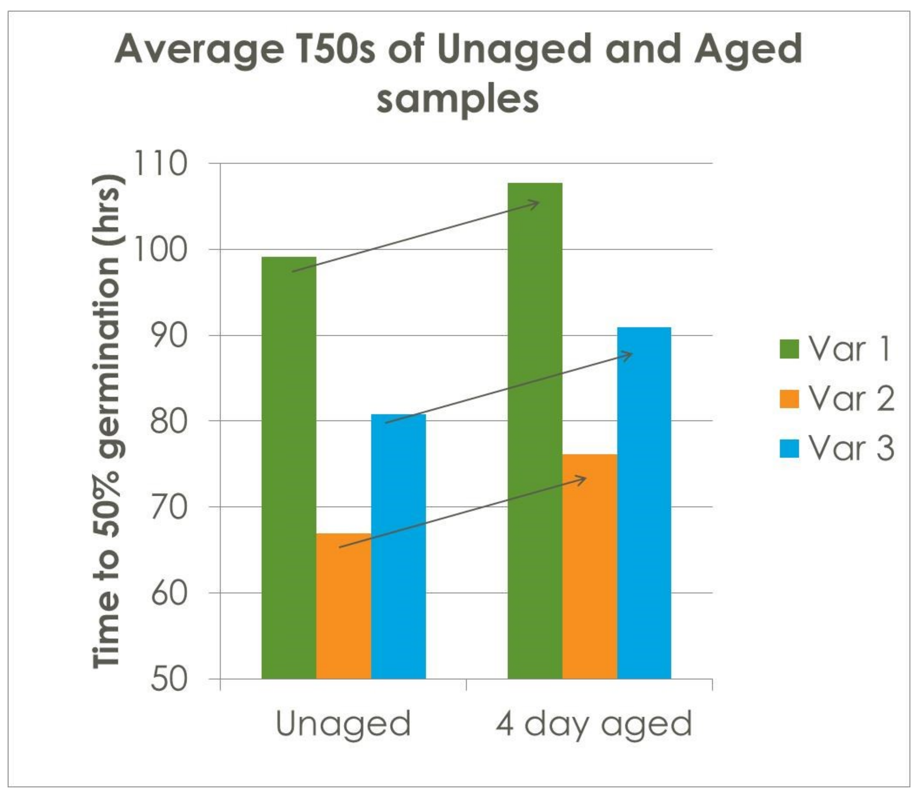

Fig 2. Average time to 50% Germination (T50) of samples before and after aging. The 4 day aged samples are slower to germinate.

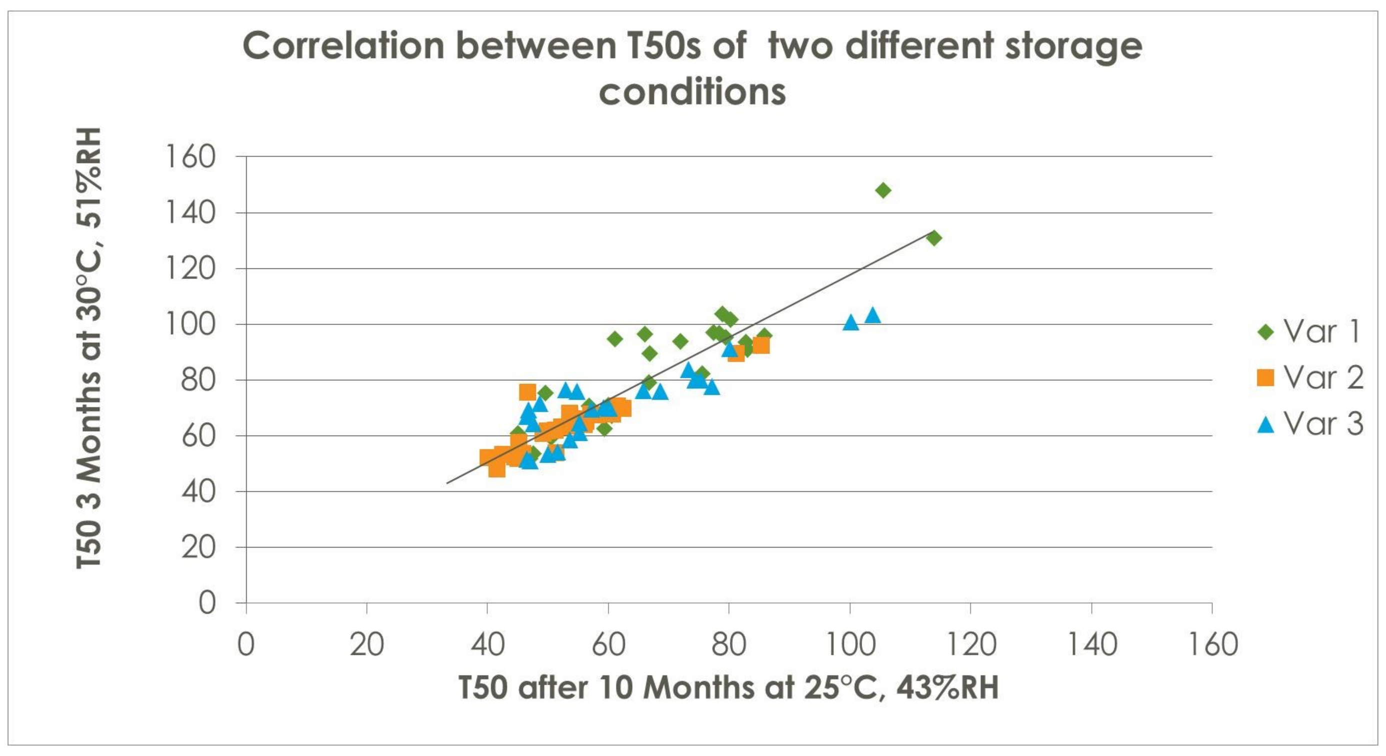

Fig 4. Correlation of time to 50% germination of samples after storage at 25°C and 43% RH for 10 months against 3 month storage at 30°C and 51% RH. These durations of storage were predicted to give the same amount of deterioration.

Conclusions

It has been shown that it is possible to calculate, using the viability equation, the durations of storage under various conditions that should give the same amount of deterioration. By using high moisture and temperature, the seed can be aged to produce a range of samples that can be tested to see how a seed lot is likely to perform after certain periods of storage at different conditions. It is critical that there is precise control of the aging conditions.