# Viability model and effect of two drying procedures on seed longevity of *Secale montanum* seeds

Marzieh Dehghan, Farzad Sharif-Zadeh

Department of Agronomy and Plant Breeding, Crop and Animal Science College, University of Tehran, Karaj, Iran
dehghan_mahya@yahoo.com , sharifzadef@gmil.com

**Abstract:** This experiment was conducted to evaluate the ability of the Ellis and Roberts seed deterioration model to predict the longevity of *Secale montanum* seeds under different storage conditions. Seed lots used in this investigation were dried in two different methods including sun and shade drying, immediately after harvest. The seed moisture content of both seed lots was adjusted to 11, 13 and 15% by humidification above water in a closed container at $20^{O}$C. After equilibrium had been achieved for 3 days at 5 $^{O}$C in a sealed container, seed moisture content was determined. In each seed lot and moisture level, sub samples of about 200 seeds were sealed hermetically in aluminum packets. Storage temperatures were 25, 35 and 45. The interval of sampling depended on the storage conditions. Seed survival curves were then fitted to the observations by probit analysis. In each seed lot dried seed survival curves conformed to cumulative negative normal distributions and the results showed that survival curves could be constrained to a common origin. The results of this research showed that the standard deviation of the subsequent survival curves was unaffected by drying treatments. Seed viability constants to predict seed longevity in this species was estimated.

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**Keywords:** drying, *Secale montanum,* seed longevity, seed viability constants, viability model

## 1- INTRODUCTION

The Ellis-Roberts deterioration model is based on the relationships of temperature and moisture effects on deterioration not influenced by genotype or seed lot, nor condition before storage. (When the storage temperature and moisture content is constant)(Ellis and et al 1982). The equation V=Ki-$p/10^{K_E - C_W LOG10m - C_H t - C_Q t2}$, where v is the probit percentage viability after p days of storage at m% moisture content (mc,f.wt.basis) and t(c˚).ki is a constant which stands for the initial quality of each seed lot before storage. ke is a species constant , cw indicates the logarithmic response of seed longevity to moisture content. CH and CQ are the constants of a linear and quadratic temperature term, respectively (Ellis et al 1986, Krrak and voss1987). Slopes of survival curves were dependent solely upon the current storage temperature and moisture content (Hong et al1999). Every year large volumes of high quality seed are lost for planting purpose because of excess moisture. A seed crop is often harvested when the seed moisture content is higher than desirable for safe storage .Safe seed moisture content varies with crop species, but generally 14% or less is considered satisfactory for short term storage (Kelly 1988). In most developing countries farmers are very poor, They produce their own seed crops for the next years sowing. After harvesting and threshing, traditionally they dry the seeds on floor. Perennial rye is a pasture plant that produces a lot of seeds and in Iran often seeds dry on floor in uncovered or covered room and is preserved for next year sowing. Maybe decrease in viability during storage (in constant conditions)is different. The objective of this work was to determine whether or not two different drying methods can be different in the velocity of viability loss and determining seed viability constants for *Secale montanum* under certain storage conditions.

## 2- MATERIALS AND METHODS

Seeds of perennial rye (*Secale montanum*) were obtained from seed production station of *Secale montanum* in Arak, Markazi province, Iran. Seeds were dried on floor in two groups: one group in sun (uncovered floor) and another group in shade (covered floor) for10 days. Initial germination percentages and moisture content were recorded as 76% and 5.8% for sun dried seeds and 74% and 7.3% for shade dried seeds, respectively. For each moisture content (11, 13, and 15%) Twelve grams of seeds were weighed for both sun and shade dried seeds. Seed moisture content (mc) were adjusted from their initial values by humidification above water in a closed container at $20^{O}$C and after certain times for each moisture content and seeds were weighed for desired moisture content levels. Then seeds were placed in laminated aluminum foil, pressed and placed in refrigerator for integrating moisture content among all seeds in the package for 3 days. Seed moisture content was detected by the high constant temperature oven method prescribed by the International Seed Testing Association (ISTA 2004), in which three 4-5 gr ground seed samples were dried in a mechanically ventilated oven at 130-133 C˚ for two hours After that the sub samples containing a minimum of 200 seeds were sealed in laminated aluminum foil packets and stored in incubators maintaining at 25, 35, 45. Seeds were germinated at 20 $^{O}$C for 7 days on two layers of filter paper moistened with 4.5 ml distilled water in 90 mm Petri dishes. Seed survival curves were then fitted to the observations by probit analysis. Also Seed viability constants to predict seed longevity in this species were estimated.

## 3- RESULTS

Table 1 displays the frequency distribution of seed death in time (sigma) at each moisture content and temperature, it shows that seeds with 13% moisture content and stored at 45 C˚ required 60.72 and 61.25 days for the germination to drop by one probit, for sun and shade dried seeds, respectively, while at 11% moisture content at 45 C˚, those values were 92.85 and 93.05 days, respectively. These constants define the equation for the two seed lots (table 2).

Seed survival curves (probit scale) obtained at 25, 35 and 45 C˚ for shade and sun dried seed are depicted in Figures 1 and 2, showing the effect of moisture content and temperature on seed storability.

Figure 3 shows the comparison between sun and shade dried seeds in each environment (moisture content and temperature) in probit scale, (germination percentage data).

The F has been calculated by getting the difference between the common line model and the separate line model, the difference is not significant for all similar environment in sun and shade dried seeds (25 C˚, F=1.71, 1.045, 0.64, for mc 11, 13, 15, 35 C˚, F=2.3, 1.68, 0.35, for mc 11, 13, 15%, 45 C˚,F=2.13, 2.45, for mc 11 and 13% respectively). It means that the declining slope of lines, in each environment is similar and the drying method before storage did not effect the slope of viability lines.

Table 1. Moisture content (mc%), temperature (c˚) and sigma (number of days for the percentage of seed germination to be reduced by one probit) for *Secale montanum.*

| Temperature(c˚) | Mc (%) | Sigma (day) | Temperature(c˚) | Mc (%) | Sigma (day) |
|---|---|---|---|---|---|
| 25 | 11 | 359.99 | 25 | 11 | 354.014 |
| 25 | 13 | 235.42 | 25 | 13 | 233.061 |
| 25 | 15 | 163.63 | 25 | 15 | 162.911 |
| 35 | 11 | 172.2 | 35 | 11 | 174.048 |
| 35 | 13 | 112.61 | 35 | 13 | 114.58 |
| 35 | 15 | 78.27 | 35 | 15 | 80.094 |
| 45 | 11 | 92.85 | 45 | 11 | 93.051 |
| 45 | 13 | 60.72 | 45 | 13 | 61.25 |

Table 2. Seed viability constants and viability equation for *Secale montanum* seeds

| | ke | cw | ch | cq |
|---|---|---|---|---|
| constants | 6.1139 | 2.5771 | 0.03856 | 0.00013 |
| equation | $6.1139-2.5771\log10m-0.03856t-0.00013t^2$ | | | |
| | $R^2$=0.9891 | | | |

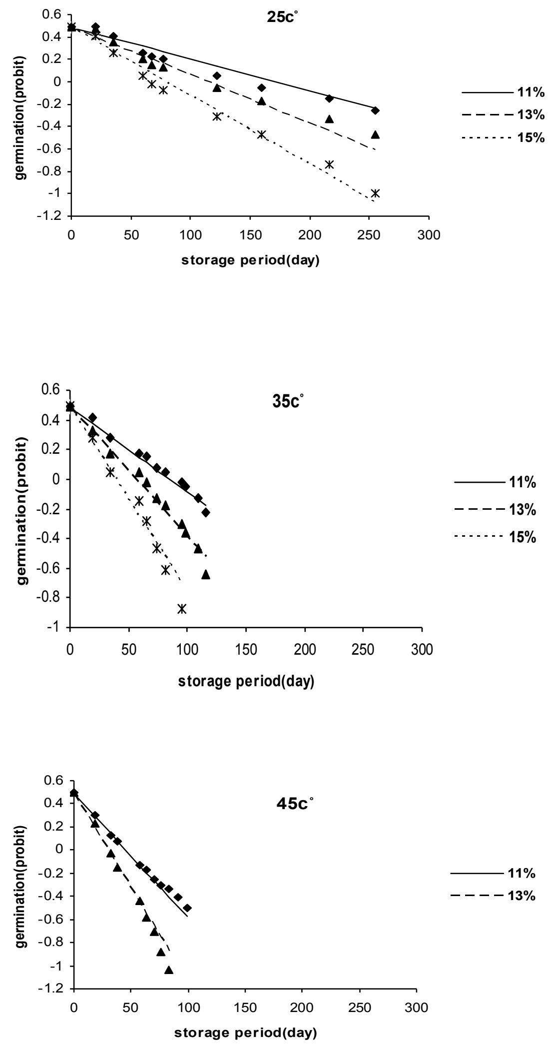
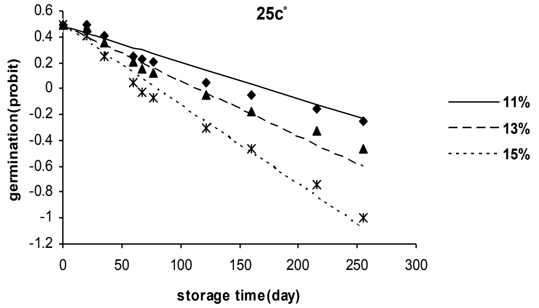
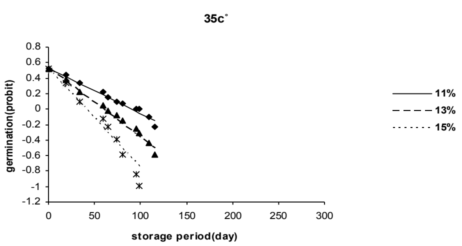



Figure 1. Probit survival curves for shade dried *Secale montanum* seeds stored at mc 11, 13 and 15%; lines and symbols mean predicted and observed germination percentages, respectively.



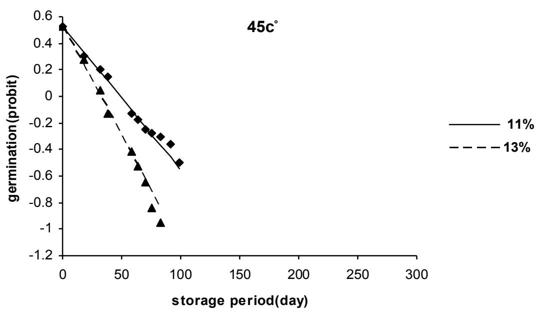
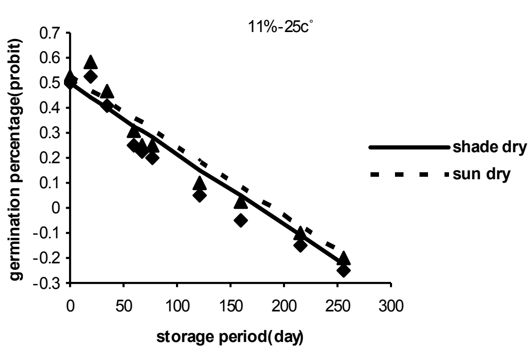
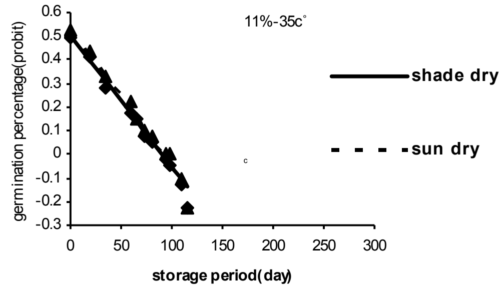
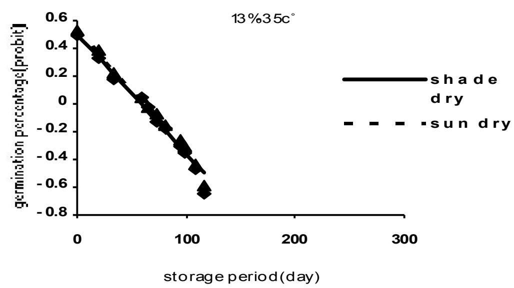
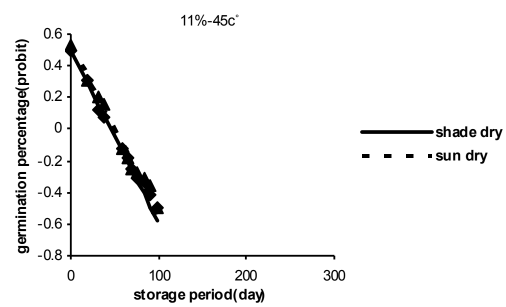



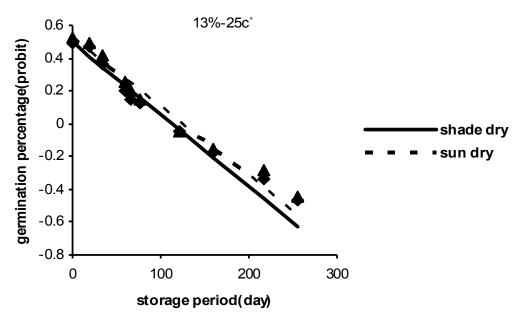

Figure 2. Probit survival curves for sun dried *Secale montanum* seeds stored at mc 11, 13 and 15%; lines and symbols mean predicted and observed germination percentages, respectively



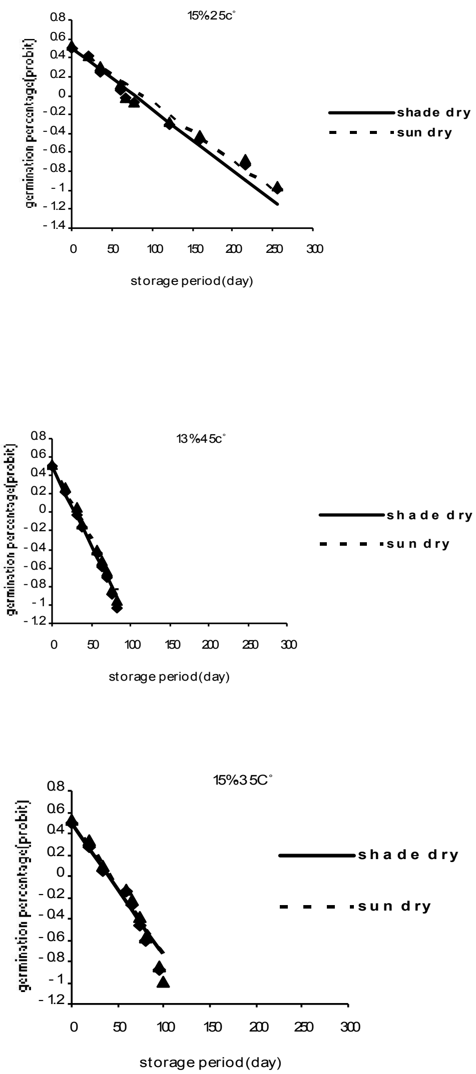



Figure 3. The comparison between sun and shade drying seeds of *Secale montanum* seeds in each environment (mc and temperature) in probit scale (germination percentage data)

Values for predicted and observed viability after storage were similar for the two seed lots and the correlation ($R^2$) was 97% for two seed lot (figure 4 and 5).

Longevity curves obtained at 25, 35 and 45 C° for the two seed lots showed the effect of mc and temperature on seed storability (figure 6 and 7), the slopes of the fitted regression lines at the same storage temperature are similar for sun and shade drying themselves and are similar between two groups of seeds (-2.50, -2.54 for sun and shade dried seeds respectively), and corroborating the high precision of the results.

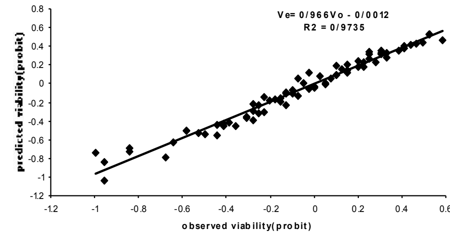



Figure 4. Observed and predicted perennial rye seed viability values by the viability equation

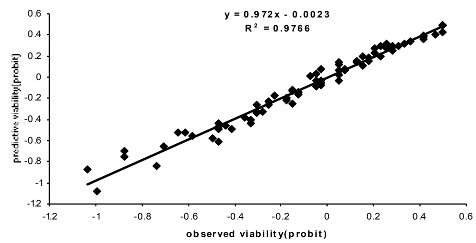



Figure 5. Observed and predicted perennial rye seed viability values by the viability equation for shade dried seeds

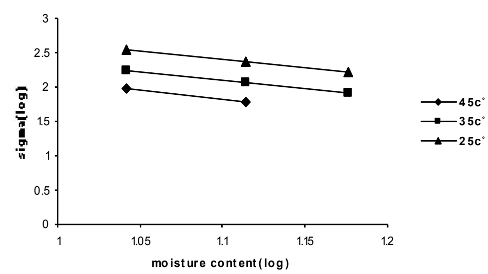



Figure6. Relation ship between the logarithm of seed moisture content and the logarithm of sigma for sun dried *Secale montanum* seeds. Solid lines represent the regression lines for each storage temperature

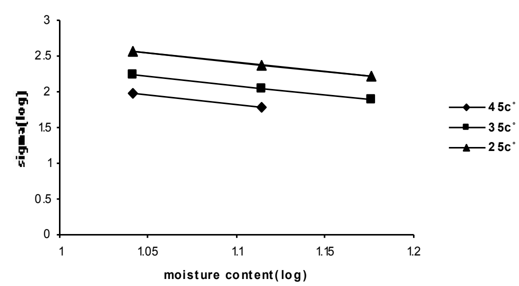



Figure7. Relation ship between the logarithm of seed moisture content and the logarithm of sigma for shade dried *Secale montanum* seeds. Solid lines represent the regression lines for each storage temperature

For the best fit for viability equation at 45 C° the mc 15% was deleted. The slopes show that in different temperatures, the rate of reduction is the same for each groups of seeds as well as between two groups of seeds.

As a conclusion the two seed lots (sun and shade dried seeds) were not different with respect to seed viability loss during storage in constant condition.

**4- DISCCUSSION**

Analyses showed that among temperatures 45 C° for 15% moisture content in sun and shade dried seeds by the use of $X^2$ distribution test the temperatures were deleted. The $X^2$ tests p=0.01 for those conditions and also the latest points of the data for germination percentage, were significant were 13% mc at 45 C° and 15% mc at 35 C°, for both seed lots. Usberti et al. (2006) showed that at 40 and 50 C̊ residual deviances significantly decreased after removal of results for 2.17mc and 3.74% mc of cotton seed lots. Fanttinati and Usberti (2007) showed that for 11.3% moisture content at 40 and 50 C° sigma (frequency distribution of seed death in time) were 17.3% and 5 days, respectively, *Eucaleptus grandis* seeds.

These constants (see table 2) are different from the constants for barley (Ellis 1981) or lettuce (Kraak and Vos 1987), but the value of Ke is similar to this value for Lupinus polyphyllus (6.21) (Ellis 1988) and onion (6.97) (Ellis and Roberts 1981).

The normal distribution in seed longevity and the survival curves obtained show a negative cumulative sigmoid format, confirming the observation made by Ellis (1984). When moisture content and temperature were reduced, predictable increasing in seed longevity was observed. Increasing temperature and moisture content resulted in seed longevity reduction, more pronounced at the highest moisture contents (11% and 15% at 45 C°). Similar results were obtained in groundnut (Usberti and Gomes 1998). Also it was showed the similarity between observed and predicted viability for cotton seeds ( Usberti and et al. (2006).

This was in agreement with one assumption of the viability model, that all seeds regardless of initial quality have the same rate of deterioration in constant condition during storage (Ellis and Roberts1980).

**Corresponding Author:**
Marzeih dehghan,
Department of Agronomy and Plant Breeding, Crop and Animal Science College, University of Tehran, Karaj, Iran
Telephone number: 09173039130
Email: dehghan_mahya@yahoo.com

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