LiveSeeding

Training in organic seed quality & health

Module 12: **Seed maturity and harvest**

Unit 13.2: **Optimising storage conditions**

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Topic

12.1 – Introduction & Seed vigour, maturation and protection

12.2 – When to harvest

13.1 – Why and how to dry seeds

13.2 – Optimising storage conditions

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Purpose of seed storage

- Safe seeds for the next cropping season (farmer)
  - *3 – 10 months*
- Safe seeds for future sales (seed company)
  - *1-3 years*
- Safe seeds for seed production (seed company)
  - *1-5 years*
- Safe seeds for breeding and coming generations (gene bank)
  - *1 – 100 years*




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Seed ageing during storage

Seeds deteriorate (age) during storage

1. Decline in seed vigour
2. Germination / emergence slows down
3. Less uniformity in seedling emergence
4. Less emerging seedlings
5. **Lower yield or even crop failure!**

Seed ageing during storage

The rate of deterioration (ageing) during storage depends on:

1. The crop
   - Onion seeds are for instance more vulnerable compared to tomato seeds
   - Within a crop there is genetic variation in sensitivity
2. Seed production and harvesting
   - Less mature harvested seeds are more vulnerable
3. Seed storage conditions
   - Storage humidity
   - Storage temperature
   - Oxygen
   - Light

What happens during dry seed storage?

Type of deterioration induced during storage:

- DNA damage,
- Protein oxidation,
- Lipid peroxidation
- Cell membrane damage
- Mitochondrial membrane damage
- ..

Mostly oxidation!

Stimulated by high temperatures, humidity and oxygen

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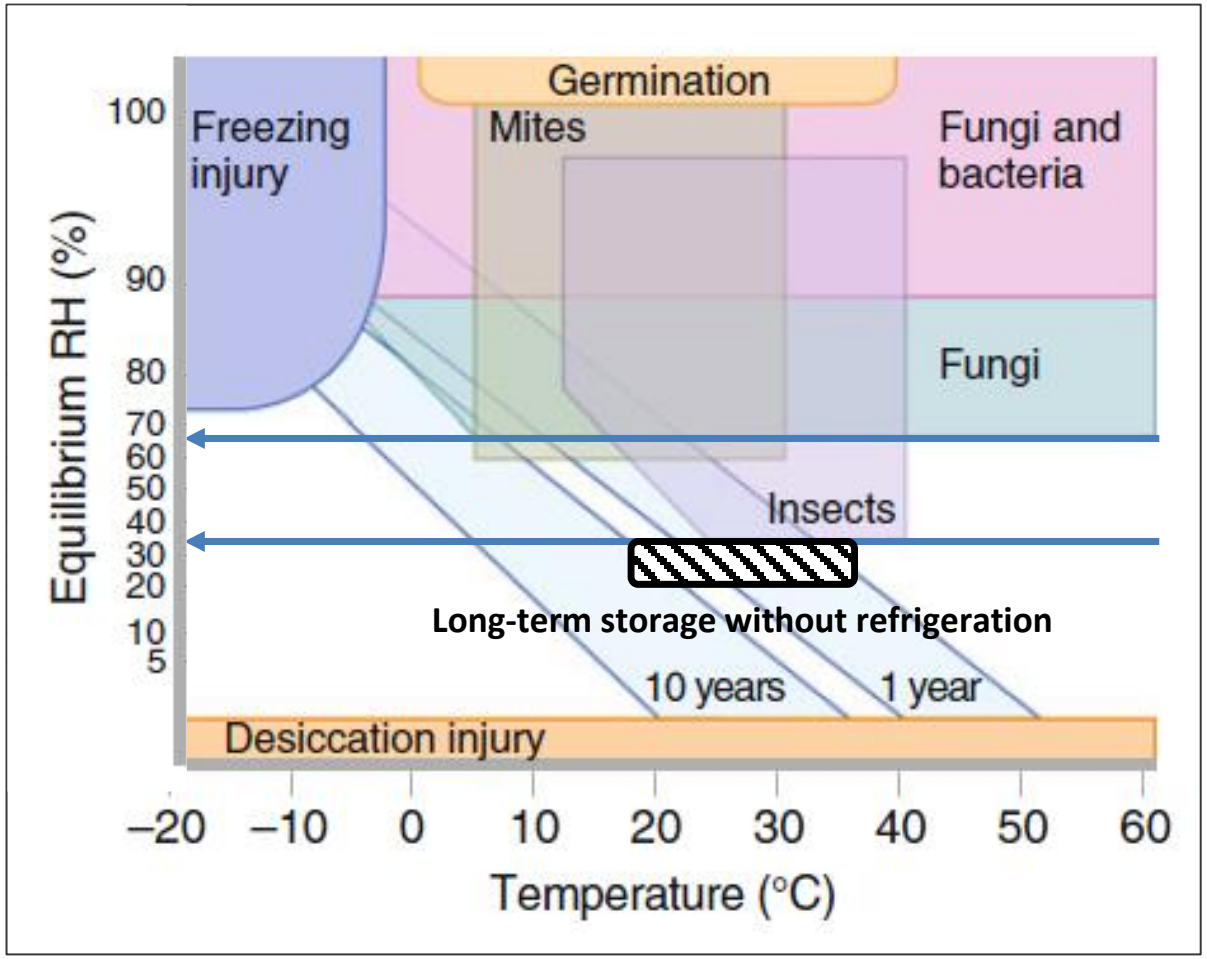
How to reduce seed deterioration

- Seeds need to be dried at least below 60% eRH
- Optimal humidity during storage is at 15 - 30% RH



Source: Roberts EH (1972) Viability of Seeds. Chapman and Hall Ltd., Syracuse, NY, pp 14-58.

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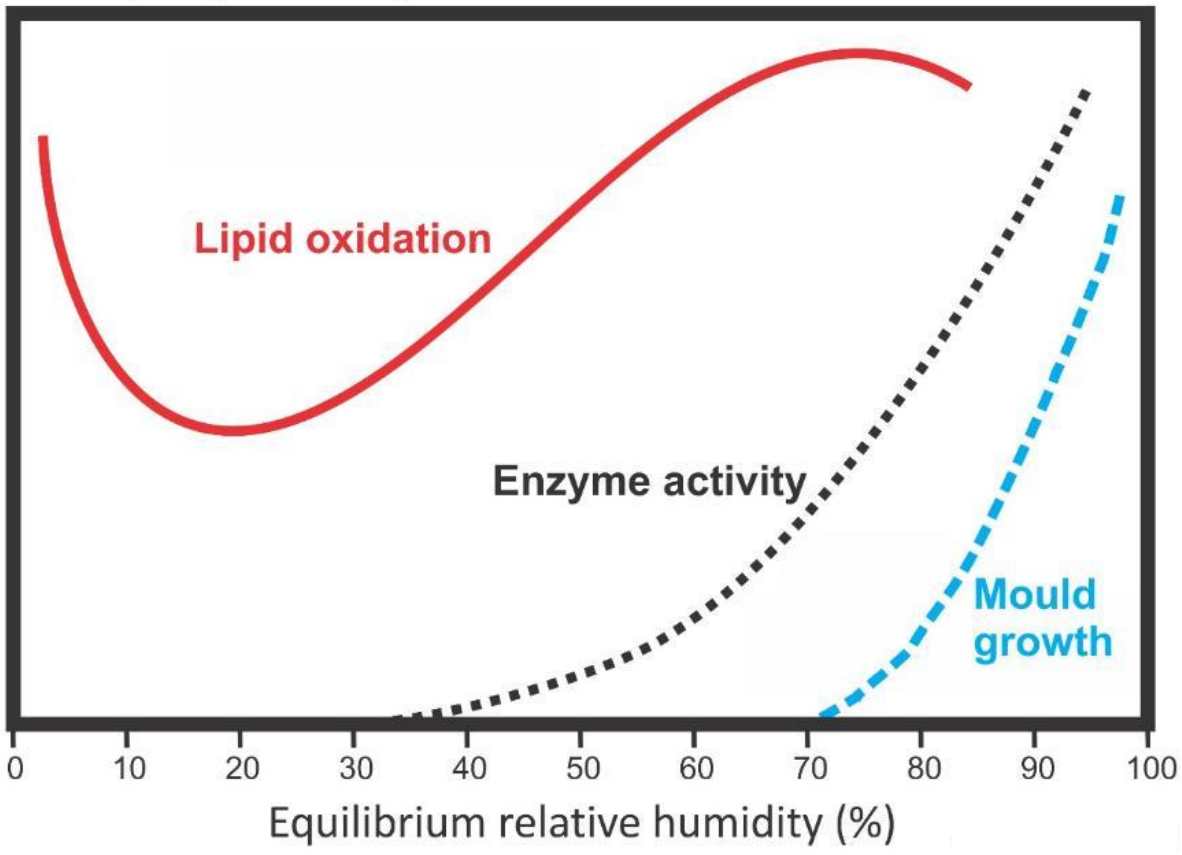
Optimal seed moisture level

- Humidity effect on lipid oxidation is not straightforward: it is lowest at around 15-30% RH, but increases strongly under ultra-dry conditions
- At around 35% RH, enzymes become active, indicating metabolic activity
- Seed lot size and value determine if relative expensive low RH storage is feasible

Oxidation, enzyme activity and moulds in relation to seed moisture level



After: Labuza, T.P. (1971) Kinetics of lipid oxidation in foods. CRC Critical Reviews in Food Science and Technology, 2: 355-405

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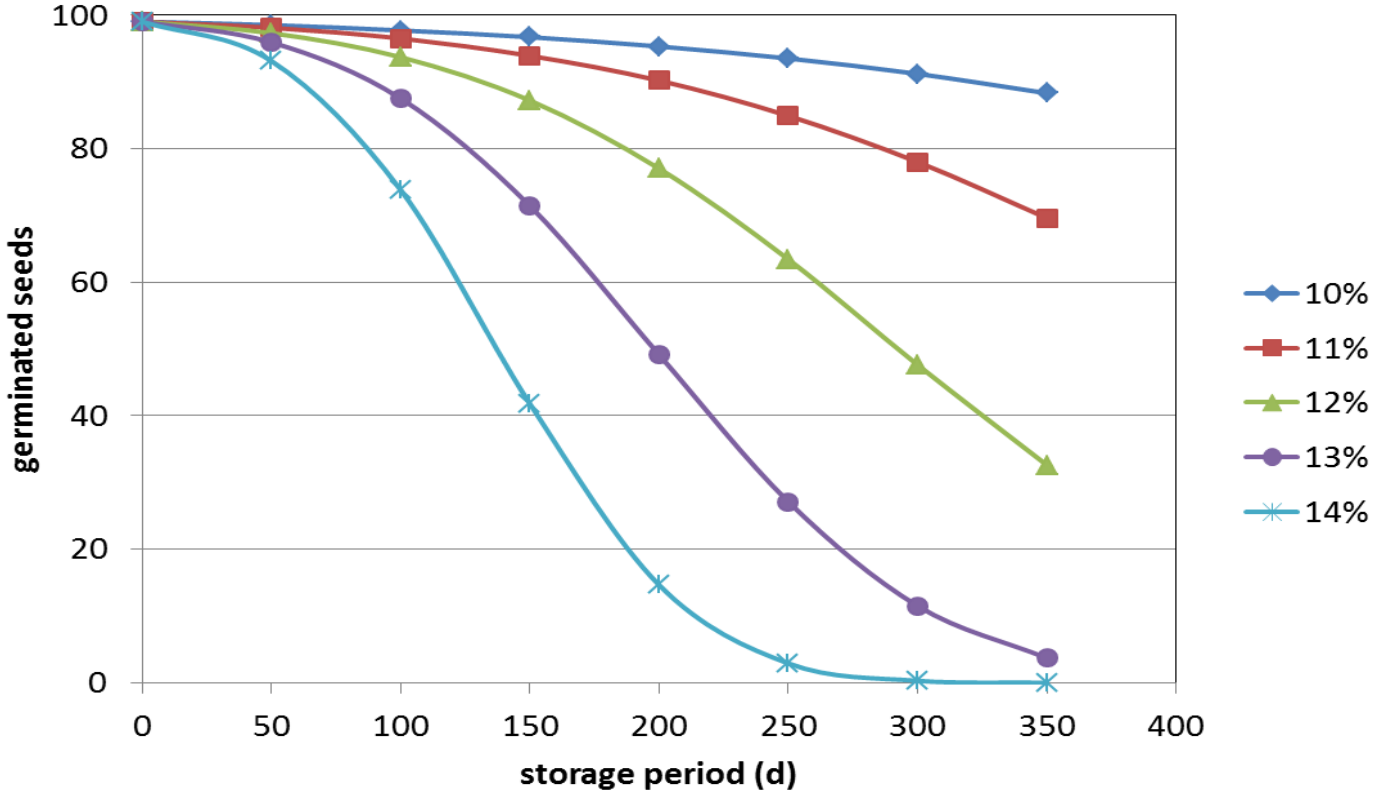
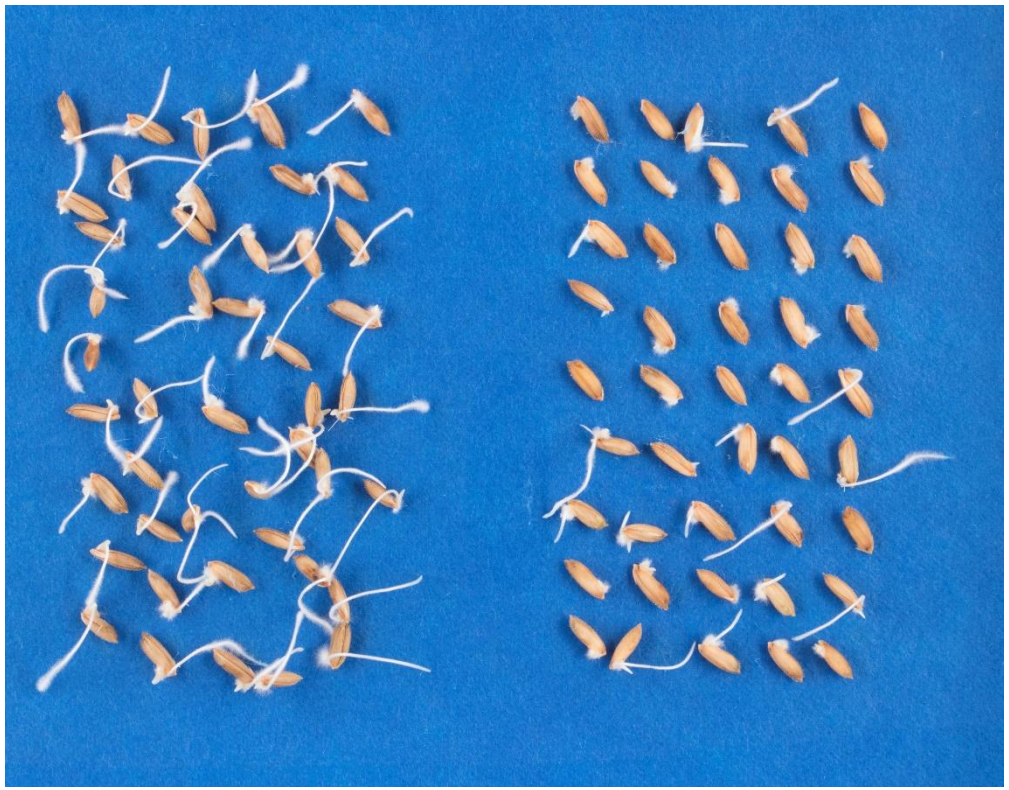
Effect of moisture content on seed ageing





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Storage in a cold room or fridge?

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Variation in seed life span

Seed Type	Longevity Under Proper Seed Storage Conditions
Artichokes	5 years
Arugula	3 years
Beans	3 years
Beets	4 years
Broccoli	3 years
Brussels Sprouts	4 years
Cabbage	4 years
Carrots	3 years
Cauliflower	4 years
Celery/Celeriac	5 years
Chard	4 years
Collards	5 years
Corn	2 years

Seed Type	Longevity Under Proper Seed Storage Conditions
Cress	5 years
Cucumbers	5 years
Eggplant	4 years
Endive/Escarole	5 years
Fennel	4 years
Kale	4 years
Kohlrabi	4 years
Leeks	1 year
Lettuce	5 years
Melons	5 years
Mustard	4 years
Okra	2 years
Onions	1 year

Seed Type	Longevity Under Proper Seed Storage Conditions
Peas	3 years
Peppers	2 years
Pumpkins	4 years
Radish	5 years
Rutabagas	4 years
Spinach	2-3 years
Summer Squash	4 years
Tomatoes	4 years
Turnips	5 years
Watermelon	4 years
Winter Squash	4 years

Source:
www.highmowingseeds.com

Indication for seed storage at <10°C and < 40% RH

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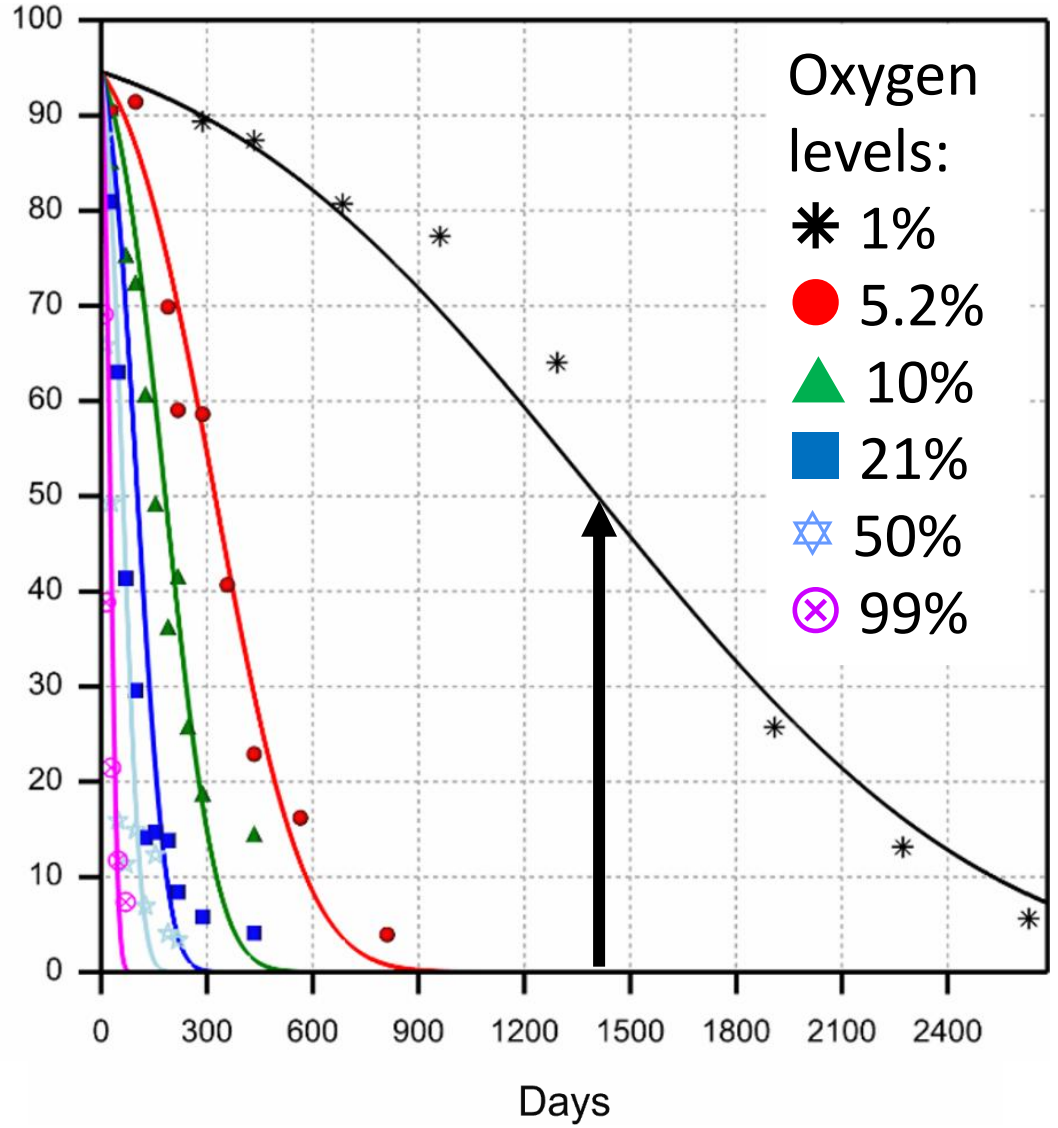
Oxygen and primed celery seeds survival

Germination of primed celery seeds stored for 7 years at 33% RH and various oxygen concentrations

Source: Groot, et al. 2025. The Plant Journal, 122, https://doi.org/10.1111/tpj.70066



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How to store seeds under low oxygen levels

- Vacuum packaging
- Nitrogen gas or carbon dioxide flushing
- Use of oxygen absorbers (iron powder)

The storage containers should be moisture-proof and air (oxygen) tight!

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Factors affecting seed survival in storage

Seed moisture level (RH)

"Shelf-life doubles for every 1% decrease in seed moisture content"

Storage temperature

"Shelf-life doubles for every 10°F (5.5°C) decrease in temperature"

Oxygen

"Shelf-life increases by a factor of 1.78 with each halving of the oxygen level"

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What storage conditions to use

1. What minimal seed quality is needed?
2. How long do you want to maintain that minimal quality?
3. What is the (commercial) value of your seeds?
4. What material and equipment is available and at what costs?

General recommendation:

High value, low volume seed lots store at 20-35% RH and 20 °C

Low value, high volume seed lots store below 60% RH

Ageing starts already at harvesting

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Priorities in organising seed storage

recap

1. Make your seeds dry and KEEP THEM DRY!
2. Store seeds either in a humidity conditioned warehouse or packed in moisture proof containers
    a. eRH should be below 60%, preferably around 30%
    b. Check frequently if the eRH remains at desired level (data logger, moisture box)
3. A low storage temperature is less important compared with a low eRH
4. Store seeds at a low oxygen level (under vacuum, flushing with nitrogen gas and in a container with low oxygen permeability)
5. Weigh costs against seed value and consumer/client satisfaction

Related Training Units & Modules

12.1 – Seed vigour, maturation and protection

12.2 – When to harvest

13.1 – Why and how to dry seeds

Other LiveSeeding training modules https://liveseeding.eu/trainings-summer-school/

For more information:

- LiveSeeding web page: https://liveseeding.eu/
- Steven P.C. Groot: https://www.researchgate.net/profile/Steven-Groot

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Thank you!