Properly Drying Seed Collections Prior to Storage

Harold L. Lyon Arboretum-Seed Conservation Laboratory

Technician- Tim Kroessig

Old Seed Storage Classification

ORTHODOX (tolerate extreme drying)	INTERMEDIATE (tolerate some drying)	RECALCITRANT (do not tolerate drying)
-Tolerate drying to low moisture levels (2-5% of wet weight)	-Tolerate drying but only down to a critical moisture level	-Intolerant of drying
-Longevity increases as moisture level decreases	-Tolerate some low temperatures, but not freezing	-Seeds die if moisture level reduced to less than 12-31% of wet weight
-Tolerate low temperatures, can be frozen (-18C)	-Represent a wide range of characteristics that don't fit orthodox or recalcitrant categories	-Intolerant of low temperatures
-Longevity increases as temperature decreases	-Short to medium term storage is practical	-Lose viability rapidly after ripening
-Good candidates for seed storage, often long-lived	-Mediocre candidates for seed storage	-Poor candidates for seed storage, usually short-lived

Seed Storage Behavior

Desiccation Tolerant

- ‘Orthodox’; conventional seed storage
- Sensitive to freezing
- Short lived

Desiccation Sensitive

- ‘Recalcitrant’
- Do not withstand drying for frozen storage

Seed Storage Behavior

Desiccation Tolerant

- 'Orthodox'; conventional seed storage
- Sensitive to freezing
- Short lived

Target collections for medium to long term storage

Desiccation Sensitive

- 'Recalcitrant'
- Do not withstand drying for frozen storage

Seed Storage Behavior

Desiccation Tolerant

- 'Orthodox'; conventional seed storage
- Sensitive to freezing
- Short lived

Require Alternative *Ex situ* Methods

Desiccation Sensitive

- 'Recalcitrant'
- Do not withstand drying for frozen storage

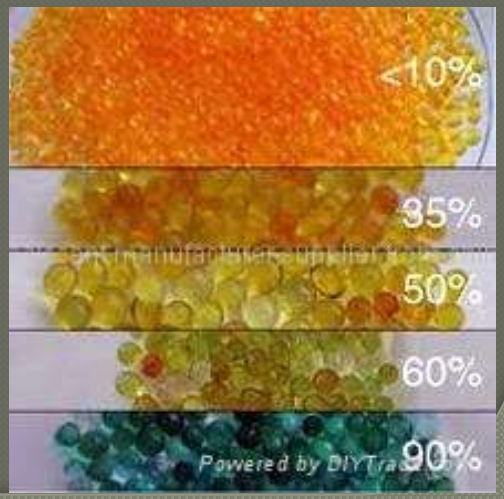
What is desiccation?

- To preserve by removing moisture
- Drying necessary to achieve optimal seed storage longevity
- Types of desiccants:

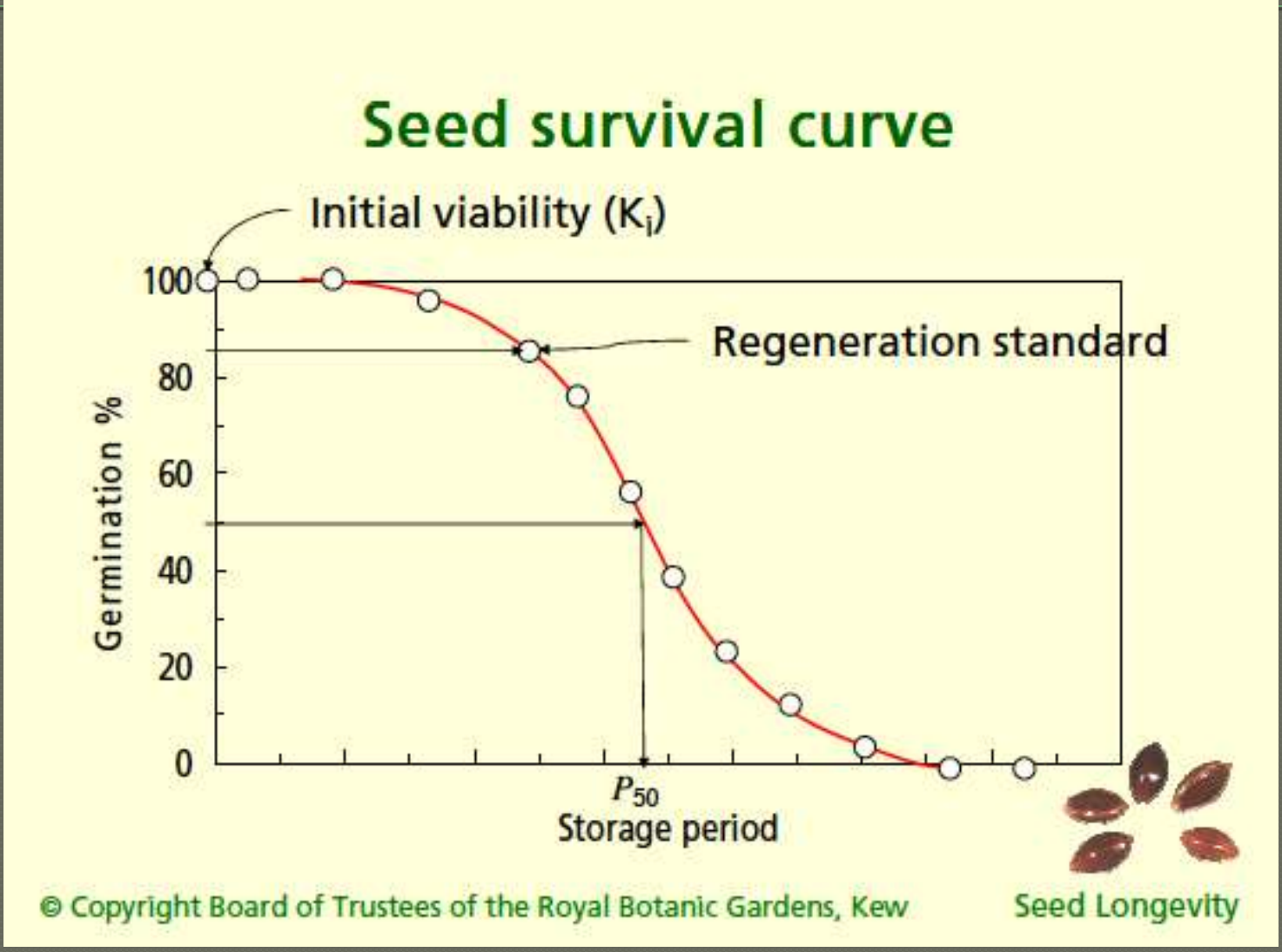
Table 9. Equilibrium relative humidities generated over saturated solutions of a selection of salts.

Saturated salt solution	*Temperature °C*										
	0	5	10	15	20	25	30	35	40	50	60
	Relative humidity (%)										
Potassium sulphate	99	98	98	98	98	97	97	97	96	96	--
Potassium nitrate	96	96	96	95	95	94	92	91	89	85	--
Potassium chloride	89	88	87	86	85	84	84	83	82	81	80
Ammonium sulphate	82	82	82	82	81	81	81	80	80	79	--
Sodium chloride	76	76	76	76	75	75	75	75	75	74	75
Sodium nitrite	--	--	--	--	65	64	63	62	61	--	--
Ammonium nitrate	--	--	75	70	67	64	60	53	--	--	--
Sodium dichromate	61	59	57	57	55	54	53	51	50	49	47
Magnesium nitrate	60	59	57	56	54	53	51	50	48	45	--
Potassium carbonate	43	43	43	43	43	43	43	--	--	--	--
Magnesium chloride	34	34	33	33	33	33	32	32	32	31	29
Potassium acetate	--	--	23	23	23	23	22	--	--	--	--
Lithium chloride	11	11	11	11	11	11	11	11	11	11	11
Potassium hydroxide	--	14	12	11	9	8	7	7	6	6	5

The values listed in the table are taken from papers by Greenspan (1976), O'Brien (1948), Wexler (1954) and Young (1967). Where gaps are shown in the table, no reliable data are available.



Regeneration and Seed Viability



Seed Moisture Content

Table 1. Factors by which longevity is altered by a difference of 1% moisture content in barley (Hordeum distichum L.) and onion (Allium cepa L.) seeds.

Moisture content range in % fr.wt.	Factor by which longevity is altered*	
	Barley	Onion
4-5	3.70	2.17
5-6	2.92	1.88
6-7	2.47	1.71
7-8	2.19	1.59
8-9	2.00	1.50
9-10	1.86	1.44
10-11	1.75	1.39
11-12	1.67	1.35
12-13	1.60	1.32
13-14	1.56	1.29

* For a decrease in moisture content over the ranges indicated, longevity is increased by the factor indicated; for an increase in moisture content over the ranges indicated, longevity is decreased by the reciprocal of the factor indicated. E.g. when drying a seed lot of non oily seed in store from 10 to 6 %, moisture content will approximately increase the longevity by 1.86 × 2.00 × 2.19 × 2.47 = 20 times.
E.g. if it took the seed lot at 10% moisture content 2 years before the germination percentage fell to 70%, it would stay approx. 40 years in the same store before the germination percentage fell to 70% if the seed lot had been dried to 6% moisture content.

Optimal Storage Conditions

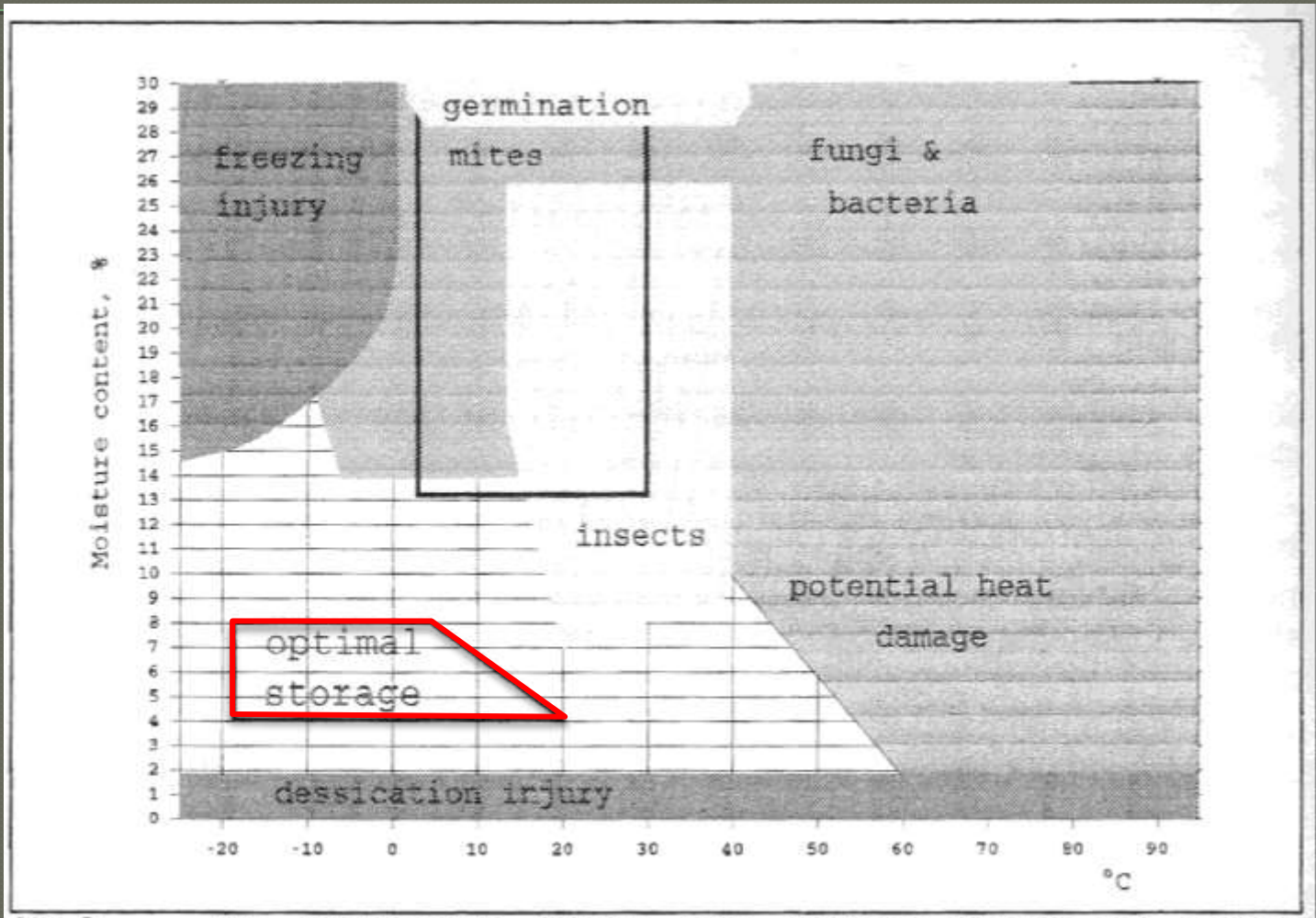


fig 3. The relationship between seed moisture content and storage problems at different temperatures.

Factors to Consider

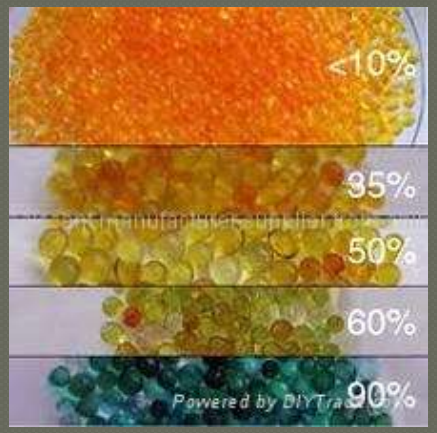
- Are your seeds desiccation tolerant?
- Volume of seeds
  - Spread seeds out in thin layer for even drying
- Time frame for storage
  - Long-term germplasm vs. short-term working
- Materials available
  - Facilities, drying cabinets, drying racks, desiccants, etc.

Processing seeds prior to drying

- Extract seeds from fleshy fruits
  - Let seeds air-dry before putting into drying unit
- Separate seeds from dry chaff, seed pods, or capsules
- Remove insect pests or fungal pathogens
  - Manually
  - Fumigation- CO2, No-Pest strips
  - 10% clorox rinse
- Inventory
  - Weigh known portion of seed lot (25-200), then weigh the entire lot

Seed Drying for Small Volumes

- Electronic drying cabinets
  - Saturated salts to buffer
- Likely to dry faster than large volumes
- Generally germplasm storage of rare or endangered species
- Always monitor temp and RH% of drying environment
  - Hygrometer



Seed Drying for Large Volumes

How long to dry your seeds?

- Depends several factors:
  - Volume, seed coat, drying conditions
  - Approximately 3 weeks to +2 months
  - Our rule of thumb- 1 month

- Monitoring Drying
  - Pen Hygrometer or Hygropalm
  - Both measure RH% and temp of air surrounding seeds (equilibrium relative humidity)

Target relative humidity levels for storage at different temperatures

- Target moisture content= 4-8% by seed weight
  - Not easy to directly measure this without destroying seeds
- Target RH% @ drying temp. = 15-20% eRH @ storage temp.
  - Adjusted for drying temperature

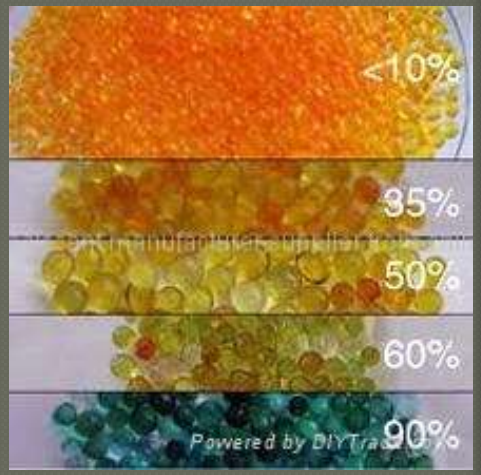
Recommended drying conditions for seeds stored in moisture-proof containers at various temperatures. The given drying temperature and RH combinations give a storage RH of 20% at the indicated storage temperature.

Drying Temperature (°C)	Drying RH for Storage at 15°C	Drying RH for Storage at 5°C	Drying RH for Storage at −18°C
25	28	33	46
15	20	26	38
5	14[a]	20	32

[a]Drying seeds at temperatures less than the storage temperature is not cost-effective and therefore strongly discouraged: dehumidification is more difficult at lower temperatures, and the refrigeration costs used during drying might be more effectively spent during storage.

Recap-How to dry your seeds to achieve desired storage life

- Moisture content
  - 4-8% by seed weight =
  - 15-20% equilibrium RH @ storage temp
- If drying @ 25C
  - 33% eRH- refrigerated storage
  - 46% eRH- frozen storage
- Saturated Salts
  - MgCl2- 33%RH @25C
  - CaCl2- 32%RH @25C
  - K2CO3- 43%RH @25C



Recommended drying conditions for seeds stored in moisture-proof containers at various temperatures. The given drying temperature and RH combinations give a storage RH of 20% at the indicated storage temperature.

Drying Temperature (°C)	Drying RH for Storage at 15°C	Drying RH for Storage at 5°C	Drying RH for Storage at −18°C
25	28	33	46
15	20	26	38
5	14[a]	20	32

[a]Drying seeds at temperatures less than the storage temperature is not cost-effective and therefore strongly discouraged: dehumidification is more difficult at lower temperatures, and the refrigeration costs used during drying might be more effectively spent during storage.

Bringing dry seeds out of storage

- Let container come up to room temp. before opening
- Re-humidify dry seeds before coming into contact w/liquid water to avoid imbibition damage
  - 24-48 hours in humid environment

Questions about drying seeds for storage?