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An approach to determine the optimal moisture content for controlled dormancy breakage in new tree and shrub species.

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Background

• physiological seed dormancy is released after a period of moist chilling

• chilling at slightly reduced and controlled moisture content gives:

- control of premature germination
- ability to prolong the chilling duration
- all seeds released from dormancy
- ability to germinate at high or low temperatures and fast germination
- surface dry seeds with less fungus attack
- potential of retaining desiccation tolerance during entire chilling
- ’advantage from more precise control’

Applied techniques change – from manual uncontrolled to mechanised controlled prototype to advanced controlled seed treatment

CMC chilling

Species	MC %(f.w.)	Duration
Acer palmatum	35 – 37	8-12 w
Acer platanoides	36 – 40	16-20
Acer pseudoplatanus	44 – 46	16-20
Amelanchier lamarckii	43 – 45	16-24
Berberis thunbergii	38 – 42	12-16
Fagus sylvatica	30 – 32	16-20
Fraxinus excelsior	42 – 44	16-20
Prunus avium	27 – 29	12-16
Quercus rubra	38 – 45	10-14
Sorbus aucuparia	43 – 45	16-20
Syringa vulgaris	45	8-16
Tilia cordata	40 – 43	16-24
Abies nordmanniana	32 – 34	8-10
Abies procera	30 – 34	8-10
Picea sitchensis	27 – 30	12-18
Pinus contorta	35	12-18
Pseudotsuga menziesii	32 – 35	12-18

Traditional investigation:

- 5-8 moisture contents
- 4-6 chilling durations
- full factorial experiments
- germination at 2 temperatures
- several seed lots/ provenances

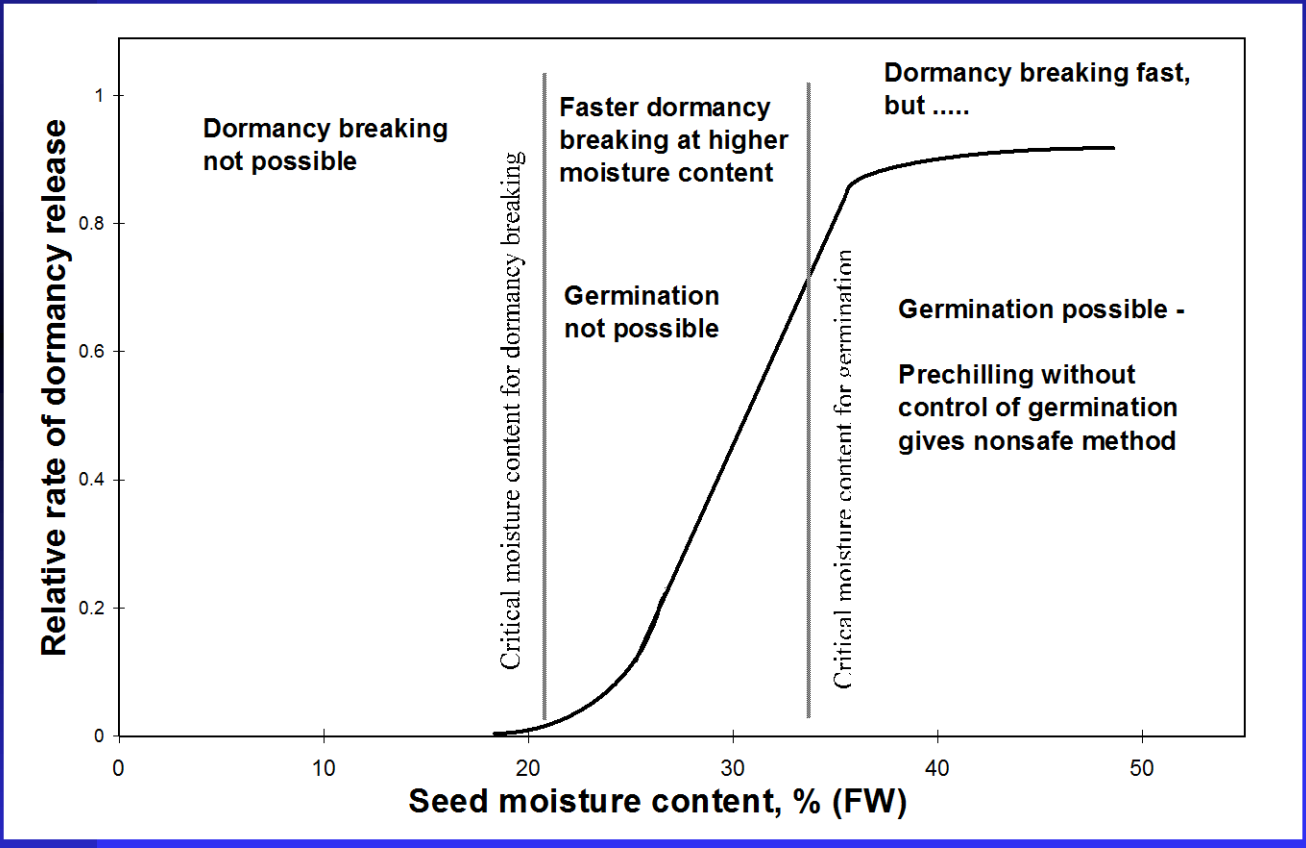
= precise results, high costs, and long time experiments

Problem in expanding the species list

- Less economical important species
- Some scientific and funding resistance of investigating a known principle on yet another species

How can we go from 15 to 100 species with less economical input?

Hypothesis: The optimal moisture content for controlled breakage of seed dormancy is always at or just below the critical moisture content for germination.



Example Abies nordmanniana, Jensen 1996)

The optimal moisture content for dormancy breakage may be predicted from knowledge on the critical moisture content for germination.

Objective:

Is it possible to predict the optimal moisture content for controlled dormancy breakage in new species by determination of the critical moisture content for germination in each new species?

Experimental approach:

1. Determination of critical mc for germination in 8 species
2. Test dormancy breakage at or just below the cmc for germination and compare to chilling of fully imbibed seeds (controls).

Materials and methods

Species: Abies alba, Abies procera
Crataegus monogyna, Malus sylvestris
Prunus spinosa, Rosa multiflora
Sorbus mougeotii, Tilia platyphyllos

1. Determine crit. m.c. for germination

Chilled, non-dormant and fully imbibed seeds were:

A. Placed in solutions of 13 different PEG concentrations + water (0 to -4MPa)
B. Dried to 10 different mcs and kept in small glass jars (+aeration, -evaporation)

Seed moisture content tested and germination (radicle protrusion) at 4C recorded after 4 and 8 weeks.

Materials and methods

2. Test of dormancy breakage at selected mcs and durations (chilling only):

Species	mc % (fw)	duration, weeks
Abies alba	29,31,32,34,45	3,6,8,10,12
Abies procera	30,33,43	3,6,8,10,12
Crataegus monogyna	23,26,28,30,43	14,16,18,20,22,24
Malus sylvestris	28,32,33	8,10,12,14,16,20
Prunus spinosa	23,26,33	14,16,18,20,22,24
Rosa multiflora	33,37,44	8,10,12,14,16,20
Sorbus mougeotii	33,36,38,40,50	8,10,12,14,16,20
Tilia platyphyllos	36,38,66	14,16,18,20,22,24

Recording:

- moisture content
- premature germination

Germination test at 10°C (4 x 100 seeds)

- germination % (after 8 weeks)
- MGT (speed of germination)

Results

Species	critical mc germ % (fw)	optimal mc cmc chilling % (fw)	optimal duration weeks
Abies alba	32-34	32-34	12-14
Abies procera	32-33	32-34	12-14
Crataegus mono.	28-29	29-30	20-24
Malus sylvestris	33-34*	34-35*	16-20
Prunus spinosa	24-26	25-26	18-22
Rosa multiflora	36-38	36-37	16-20
Sorbus mougeotii	42-43	38-40	14-20
Tilia platyphyllos	38-40*	38	20-24

* Most likely interval

Germination of moist seed in PEG not reliable method – germination before equilibrium is met.

Glass jar method preferred (ensure oxygen supply)

Hypothesis confirmed: Optimal moisture content for controlled breakage of dormancy is at or just below the critical mc for germination.

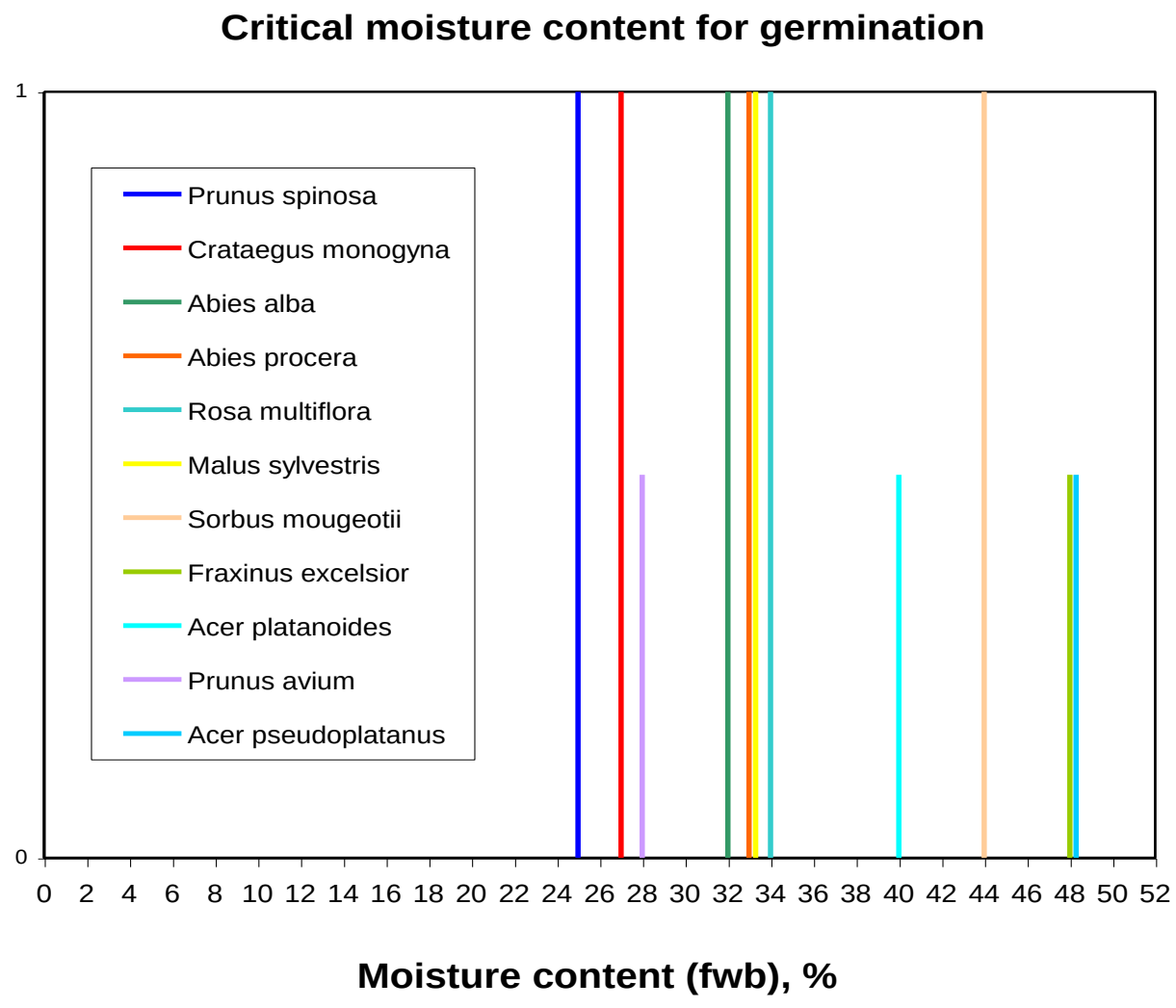
Conclusion

Determination of optimal controlled moisture content during chilling in a new species: (much less expensive method)

1. Obtain non-dormant seed from nursery or seed company in spring.
2. Dry to 10 different mc levels and germinate at 4°C in closed glass jars opened daily for few seconds for oxygen supply.
3. Record actual mc and germination percentage of each level of hydration after ca. 4 - 6 weeks.
4. Plot and estimate critical mc for germination = predicted estimate of the optimal mc during chilling.
5. Adjust mc according to applied experience.

Future research

Understanding the variation between species.



Is it the same type of dormancy breakage?

How can we predict mc in a new species?

A model to predict optimal/efficient mc for controlled breakage of dormancy should be based on:

1. Measurement of water potential instead of moisture content

2. Measure on physiological active seed tissue (embryo /endosperm)

3. Biochemical composition of seed tissue: lipids, carbohydrates and protein (water sorption properties)

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