A Global Experiment to Explore Ultra Dry Seed Storage Technology and Optimum Conditions for Seed Storage

Perspectives after 14 years

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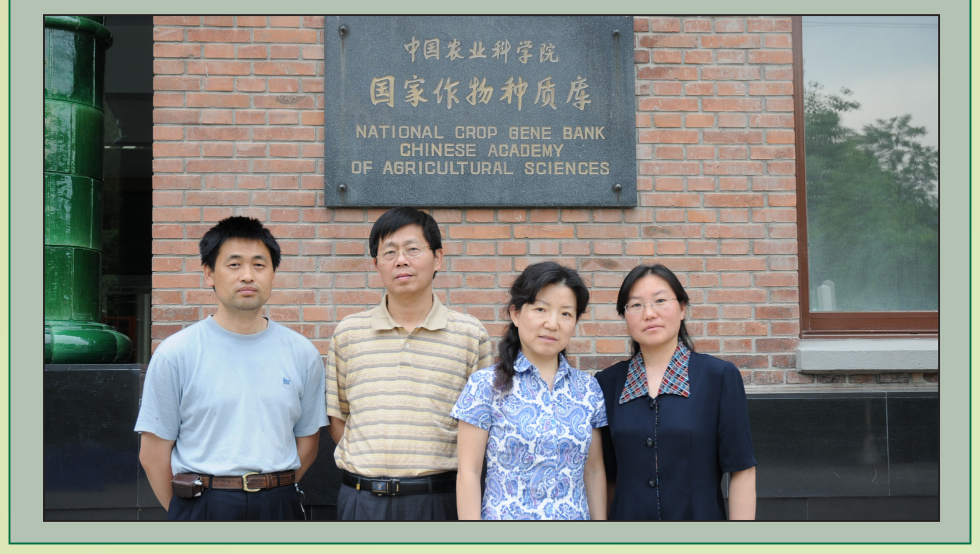

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Introduction

Ultradry seed storage might extend the viability of seeds conserved in genebanks without incurring the expense of refrigeration. It remains unclear whether drying seeds to very low water contents can achieve the same longevity as freezer storage. Also, excessive drying might hasten seed aging. The debate about ultradry storage is really a question about whether temperature and water content are interacting factors affecting seed aging rates.

In 1994, Bioversity International (previously IPGRI) sponsored a global experiment with a complete factorial design to resolve the debate. This model approach for settling complex and controversial issues with global relevance will guide better storage practices for seed banks.

The Global Experiment assumes that seed longevity increases logarithmically with decreasing water content until seeds are dried to a "critical" water content at which no further benefit to drying is observed. The Global Experiment addresses:

- the value(s) of the critical water content and relative humidity at different temperatures
- whether a detrimental effect of excessive drying is observed
- whether different aging assays measure different responses.

Methods

Water content of lettuce seeds was adjusted at RH ranging from 0.5 to 75% and then seeds were aliquoted for storage in three different labs at three storage temperatures (50, 35 and 20oC). Water content and viability was monitored using standard protocols to measure % germination, radicle length and incubation time required to achieve 50% of maximum germination (T50). The time required to reduce germination parameters to half the original value (P50) was calculated by fitting viability time courses to a sigmoidal function.

What was the RH within the sealed bags?

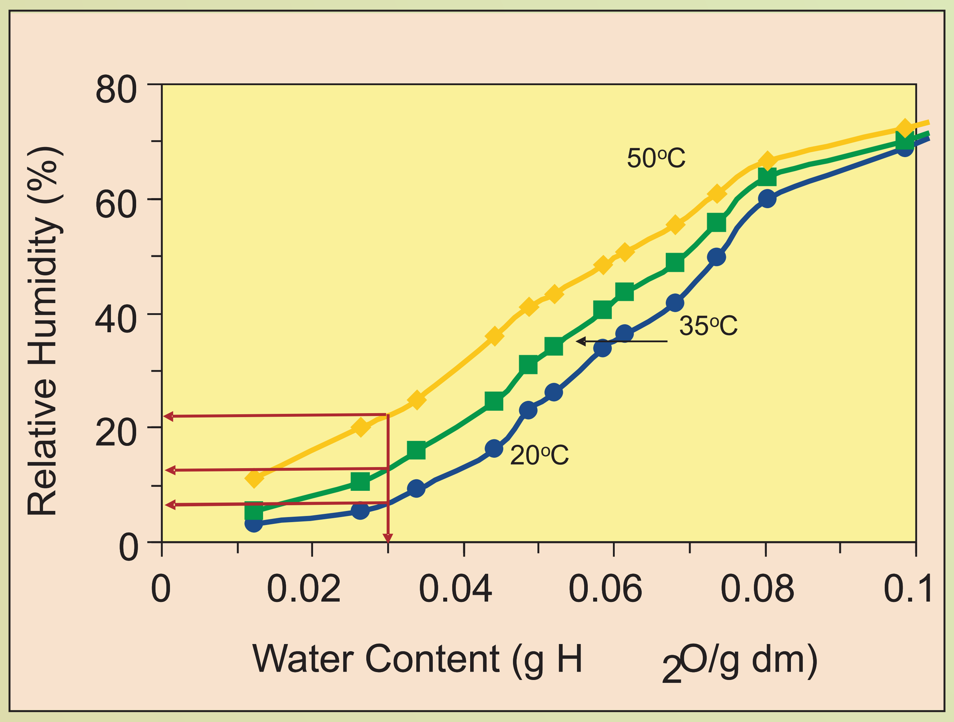

Figure 1. The relative humidity for each water content-temperature combination was measured using data loggers included in the bags. RH increased within the bag with increasing temperature. Hence, a seed containing 0.03 g/g was held at an RH of 8, 14 and 22% RH at 20, 35 and 50oC, respectively.

Did the sealed bags leak moisture?

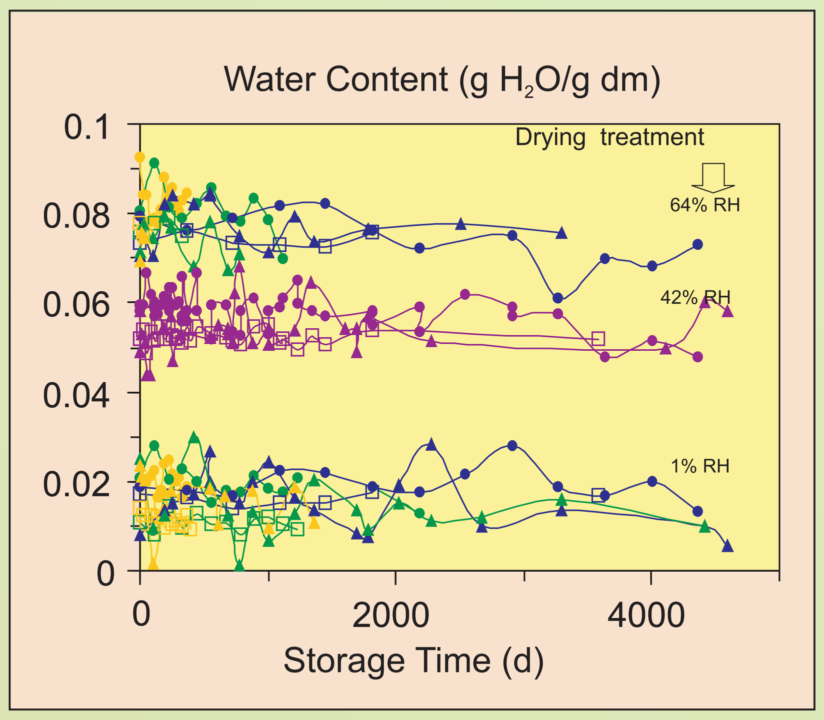

Figure 2. Representative data for water content measurements are given for all labs [China (closed circles), India (open squares) and USA (closed triangles)] and temperatures [20oC (blue), 35oC (green), 50oC (gold), and -18oC (purple)]. Changes in water content were not detected throughout the > 4000 days of the experiment. The foil-laminate pouches (Barrier Foils) used were of sufficient quality to eliminate concerns of moisture flow.

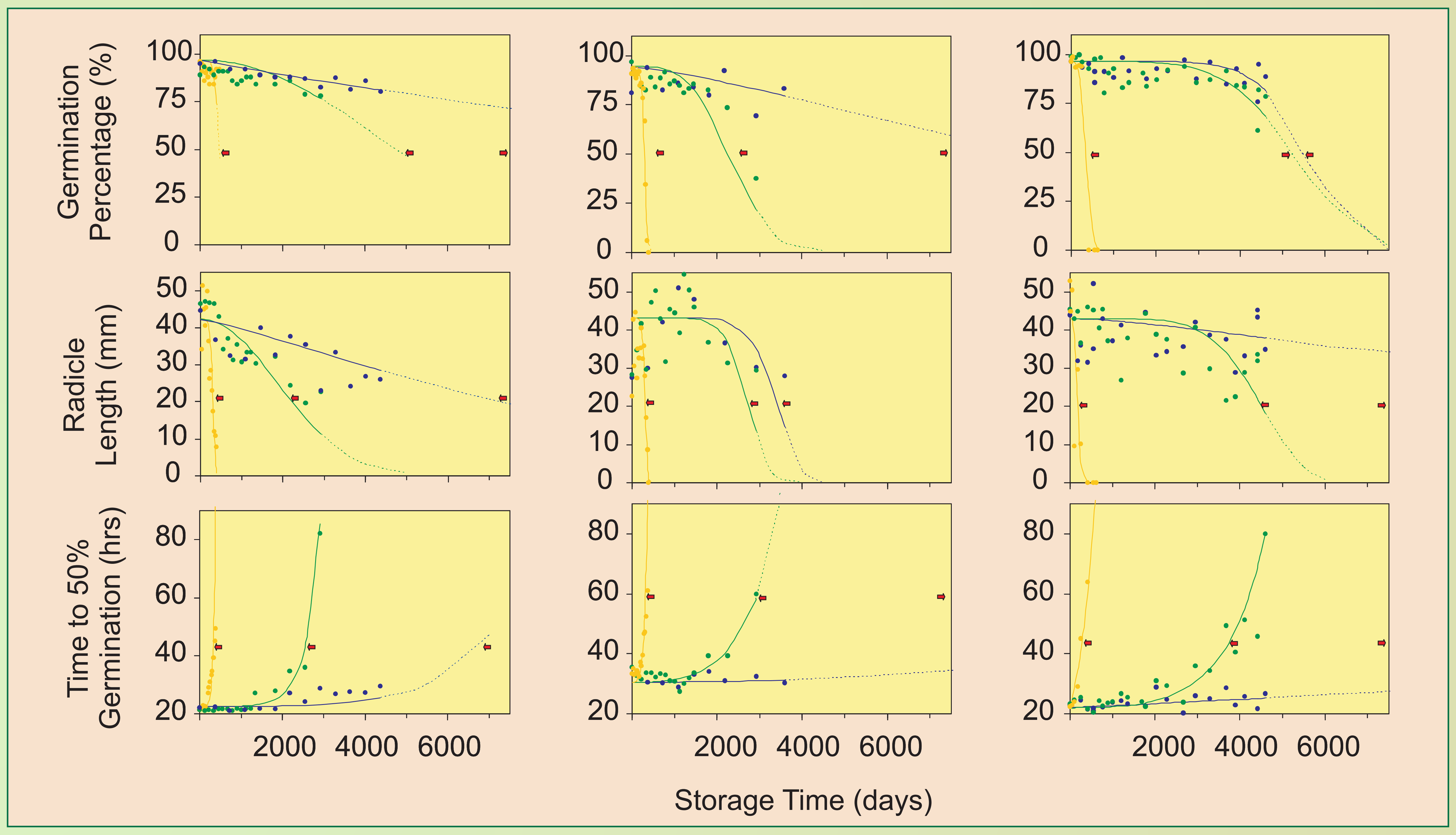

Figure 3. These data describe deterioration of seeds containing 0.035 g H2O/g dm for each lab, at indicated temperatures using different viability assays. When necessary, sigmoidal curve was extrapolated to predict P50. Longevity for this seed lot is substantial for seeds stored at low water contents. Longevity increased with decreasing storage temperature. Results among labs were similar.

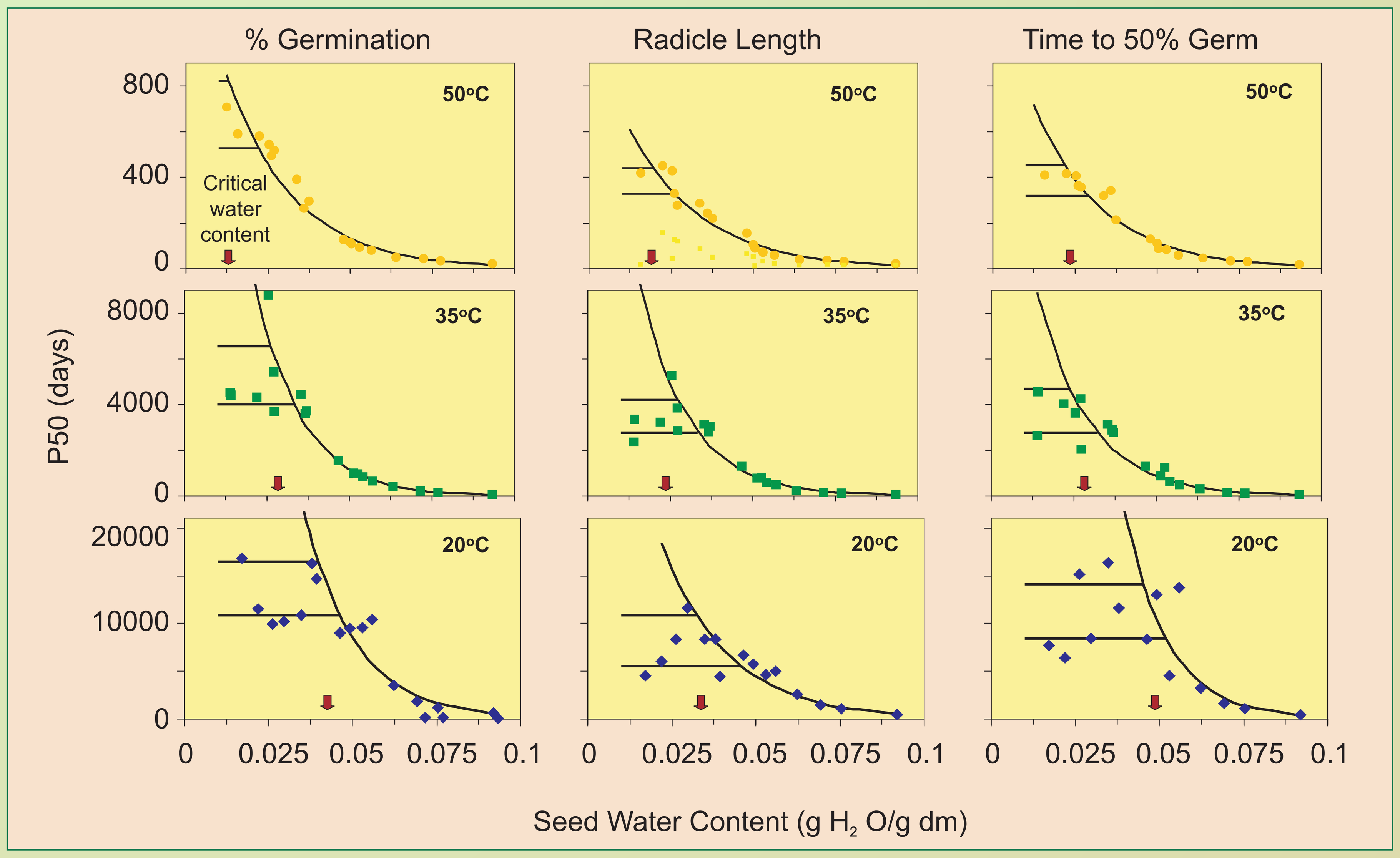

Figure 4. P50 values for each water content- temperature combination are averaged among labs. Curves describe the logarithmic relationship between water content and P50-1. Horizontal lines bracket the 95% CI for maximum P50. Critical water content ranges occur where horizontal lines and curves intersect (red arrows are midpoint of range) Maximum P50s range from about 1,10 and 20 years for seeds stored at 50, 35, and 20oC. Critical water contents are similar among seed quality assays. Greater uncertainty is noted for radicle length assays. Critical water contents are different among storage temperature, and increase as temperature decreases.

Conclusions

A finite longevity is achieved at each storage temperature (Fig 4). Seeds stored at lower temperatures survive longer (Figs 3,4). Radicle length and T50 measurements tend to detect aging sooner than % germination assays but within-assay variability can make these measurements less reliable (Figs 3, 4). Significant benefit or damage by drying below the critical water content was not detected (Fig 4).

A temperature x water content interaction affecting longevity was detected (Fig 4). The critical water content increased from about 0.012 to about 0.04 g/g when storage temperature decreased from 50 to 20oC. These critical water contents correspond to a similar RH range of 15-25% for all storage temperatures (Fig 1) but a different drying RH (<1%, 10% and 20-30% RH for storage at 50, 35 and 20oC).