Seed Longevity and Seed Quality:
How Understanding Seed Longevity Can Help Us Extend the Quality of Seeds

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OUTLINE

- Seed longevity
  - Definitions
  - Research for the International Rice Genebank
- Seed quality
- Linking seed longevity and seed quality

WHAT DO WE MEAN BY SEED LONGEVITY?

- Seed longevity is the length of time (period, *p*) over which the germinability of a sample of seeds will remain above a critical level during storage.

- Usually talked about in relation to 'orthodox' seeds which tolerate drying to low moisture content - the majority of crop species.

- Controlled storage environment – moisture content of the seeds, temperature of storage, (gaseous environment).

SEED LONGEVITY AND GENEBANKS

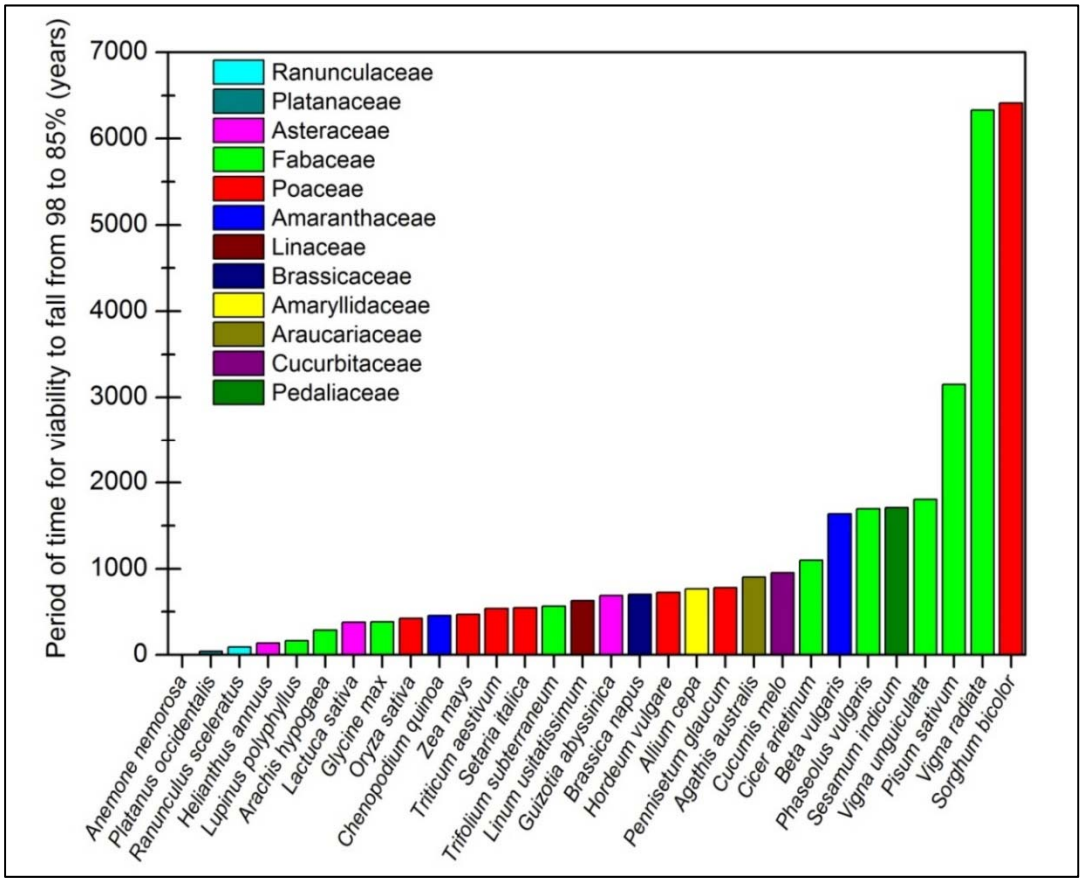
Greater understanding of seed longevity to improve genebank management:

- Optimise processing procedures;
- Know which seed lots to test and when;
- Reduce cycles of regeneration;
- Reduce the risk of genetic erosion / genetic drift.



VARIATION IN LONGEVITY: SPECIES

Predicted times for viability to fall from 98 to 85% if the seeds are stored under long-term genebank storage conditions (in moisture-proof containers at -20°C after drying to equilibrium with 15% relative humidity and 15°C)

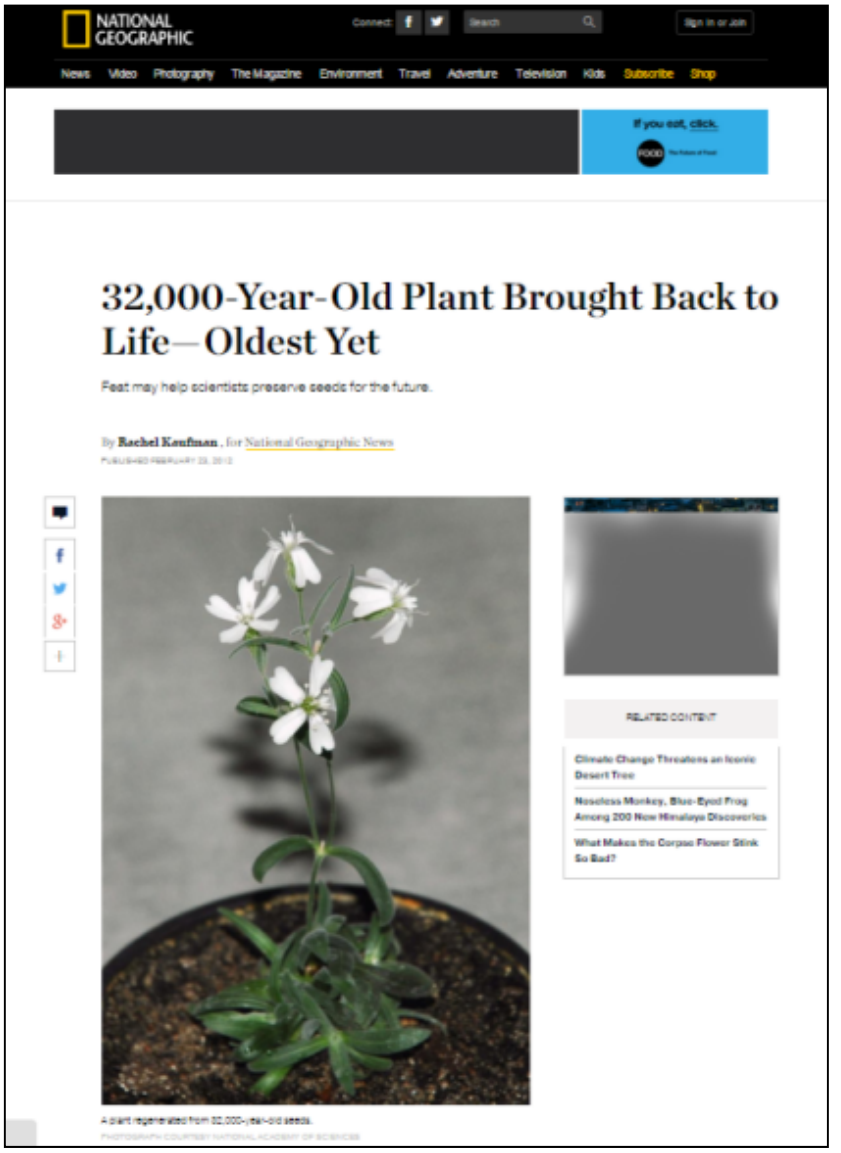


VARIATION IN LONGEVITY: SPECIES

Germination, Genetics, and Growth of an Ancient Date Seed

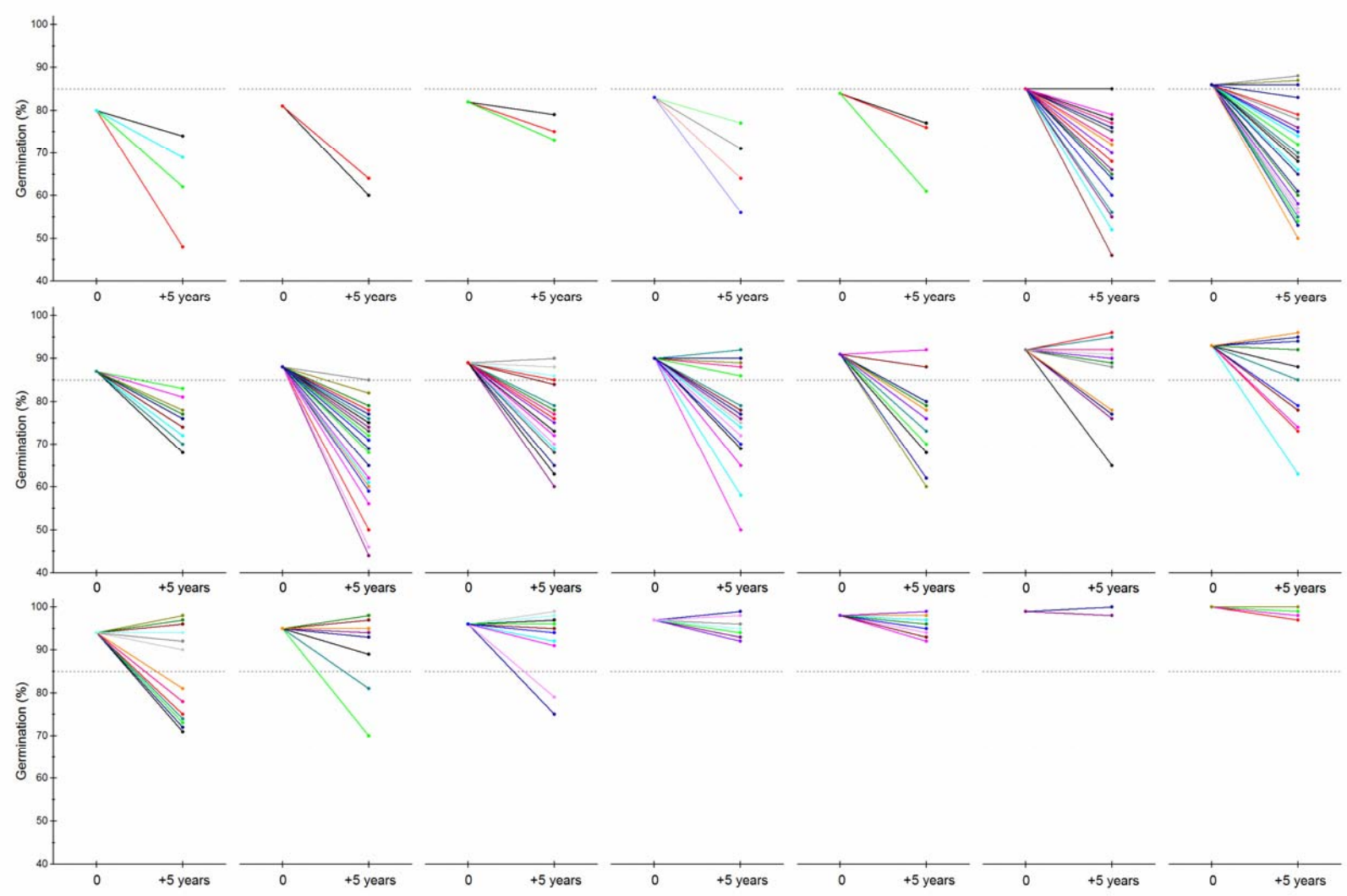
Sarah Sallon,[1] Elaine Solowey,[2] Yuval Cohen,[3] Raia Korchinsky,[3] Markus Egli,[4] Ivan Woodhatch,[4] Orit Simchoni,[5] Mordechai Kislev[5]

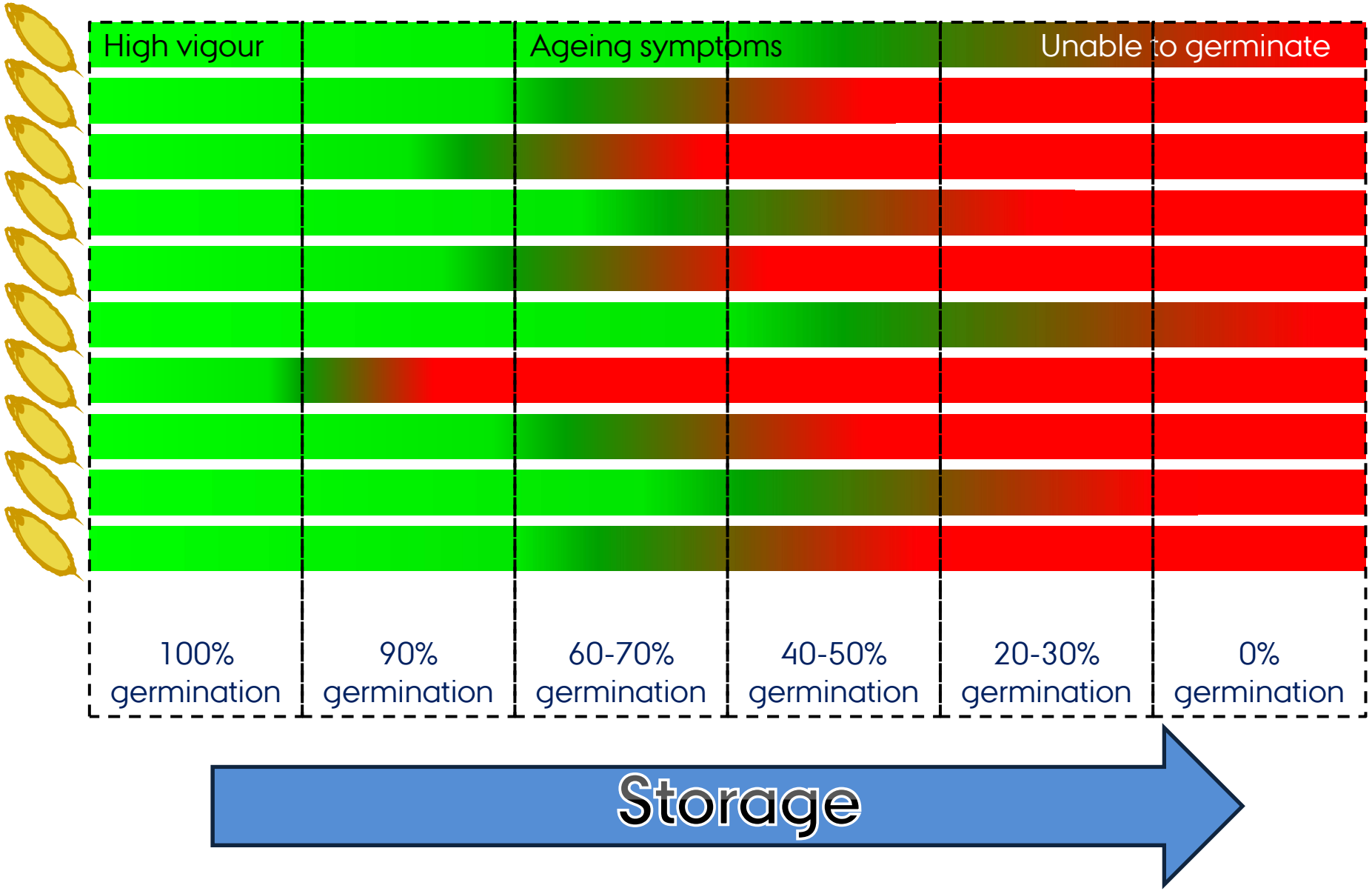
Fig. 1. (**A**) Ancient date seeds from Masada. (**B**) Germinated seedling age 3 months: normal development of simple juvenile leaves. Height = 15 cm. (**C**) Age 7.5 months: some leaves showing white patches. Height = 31 cm. (**D**) Age 26 months: normal seedling development with compound leaves. Height = 121 cm. [Photo credit: G. Elsner]



VARIATION IN LONGEVITY: SEED LOTS

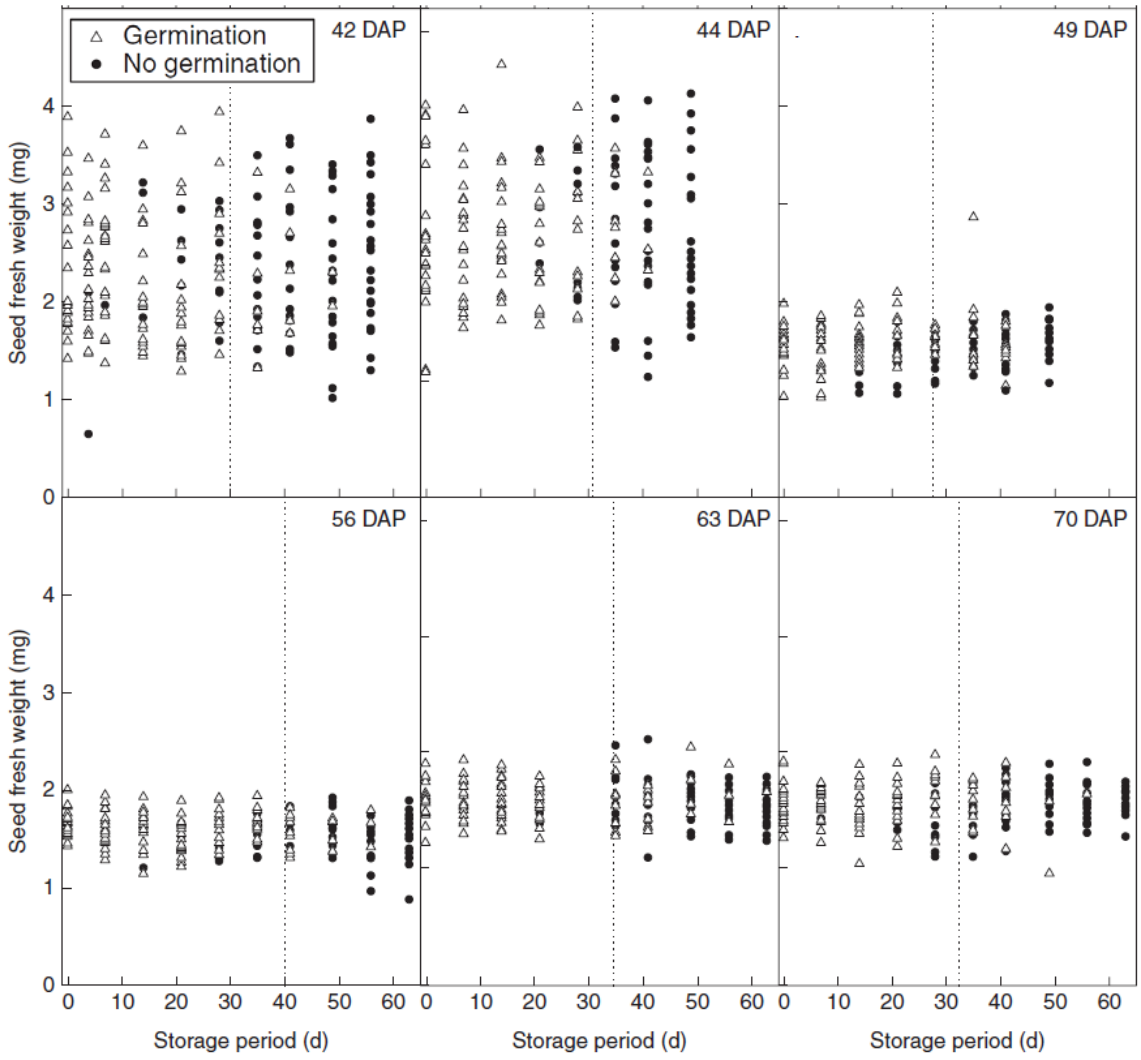
Same initial germination and storage environment → different final germination




High vigour
Ageing symptoms
Unable to germinate
100% germination
90% germination
60-70% germination
40-50% germination
20-30% germination
0% germination
Storage

VARIATION IN LONGEVITY: SEEDS

Trifolium ambiguum – each symbol represents an individual seed



From Hay *et al.* (2010)

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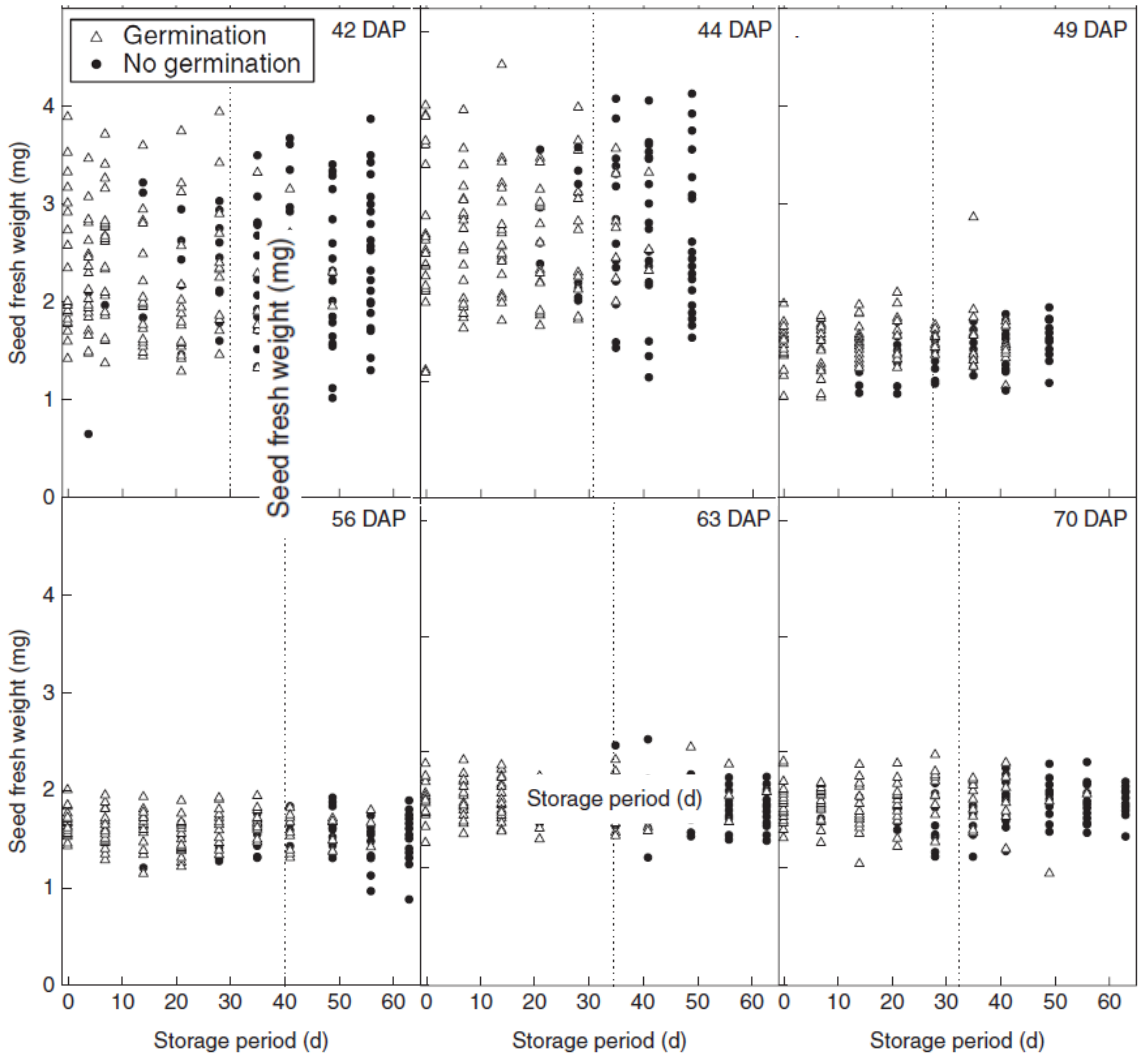

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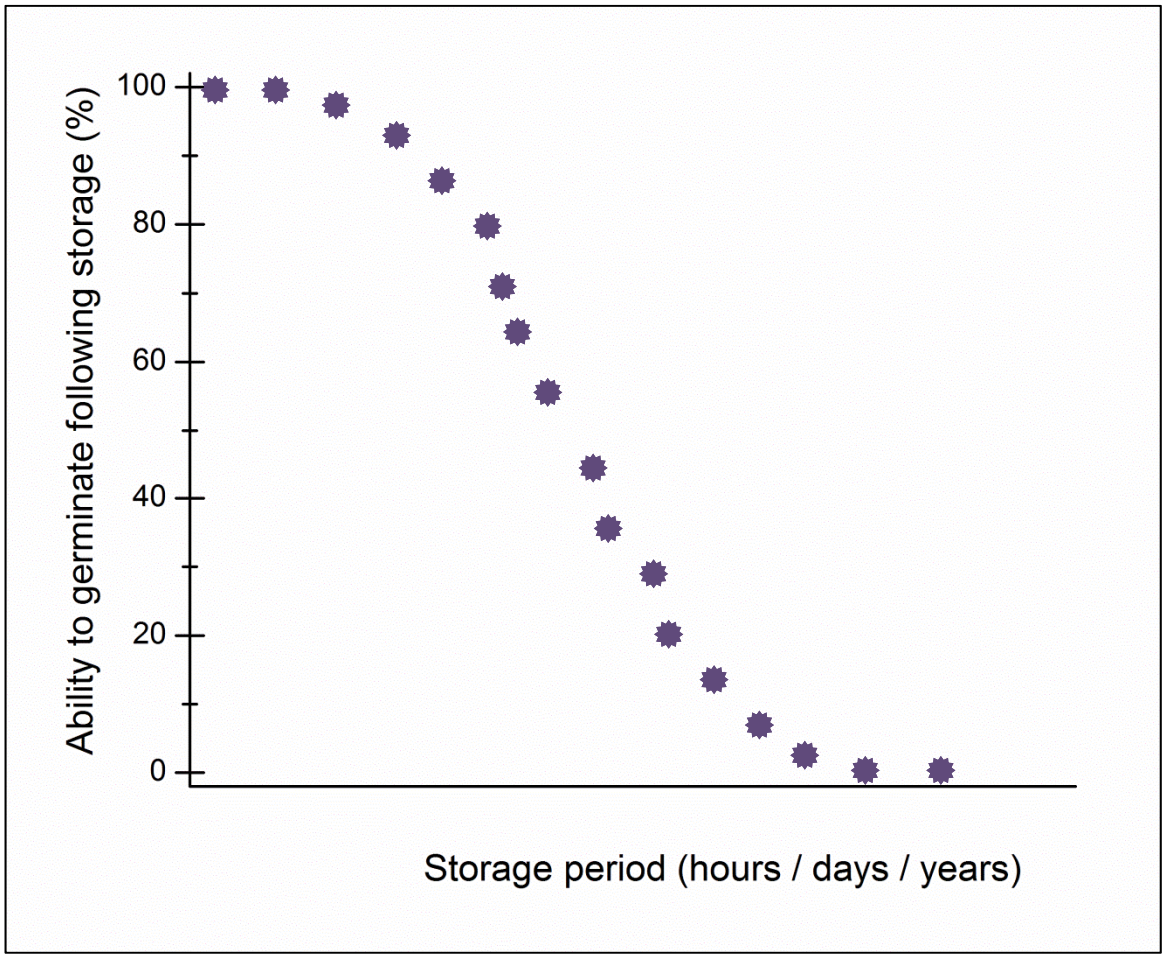
VARIATION IN LONGEVITY: SEEDS



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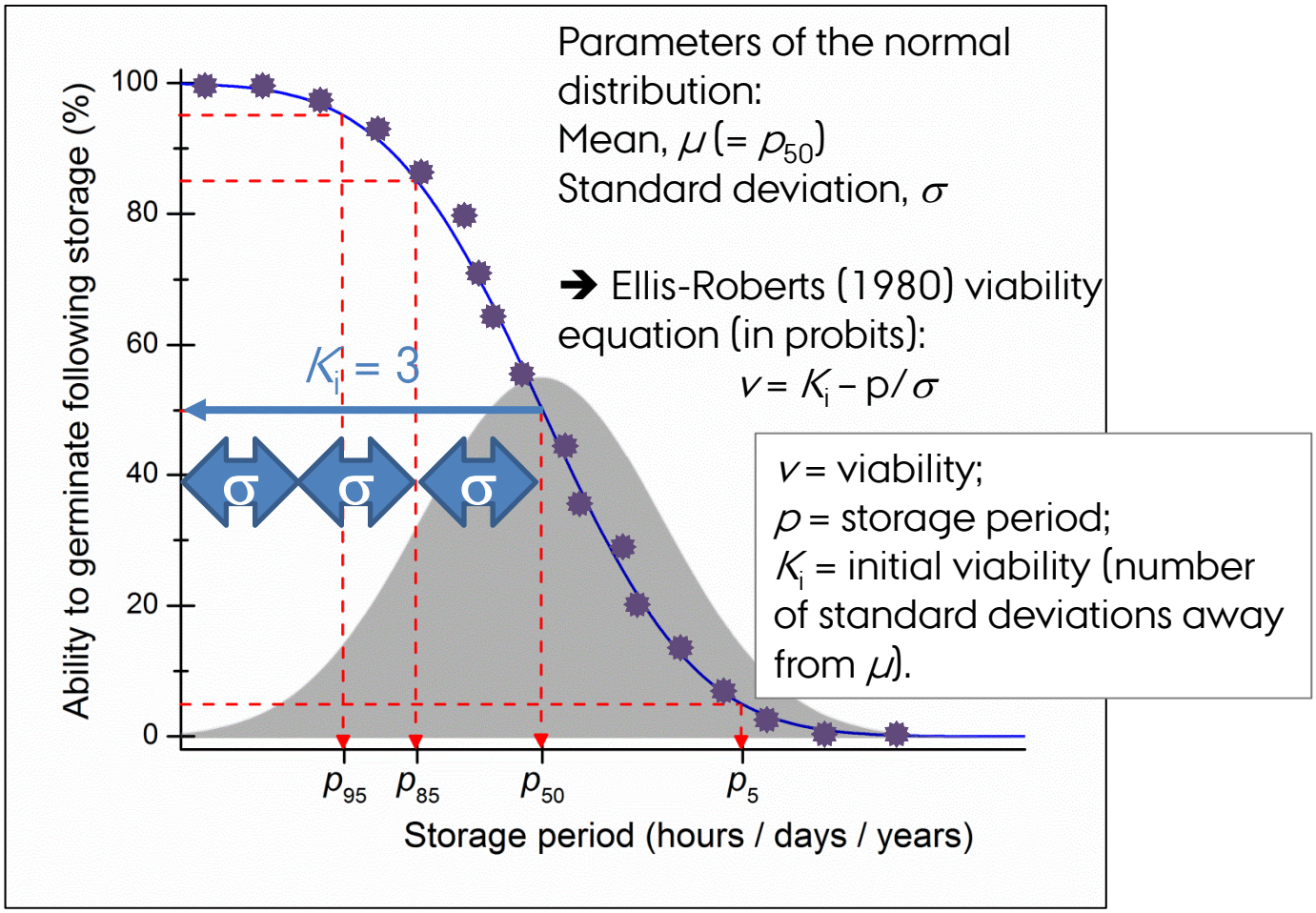

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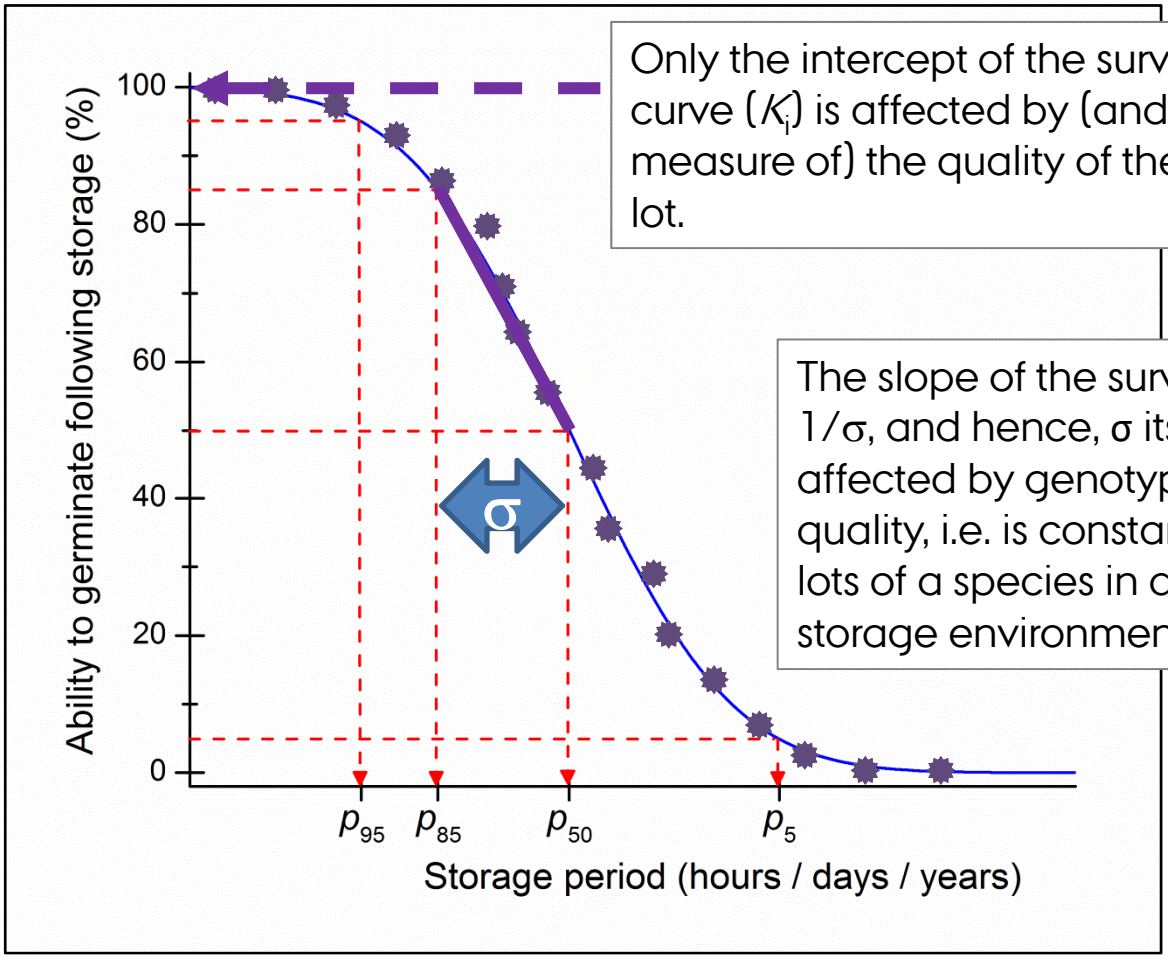
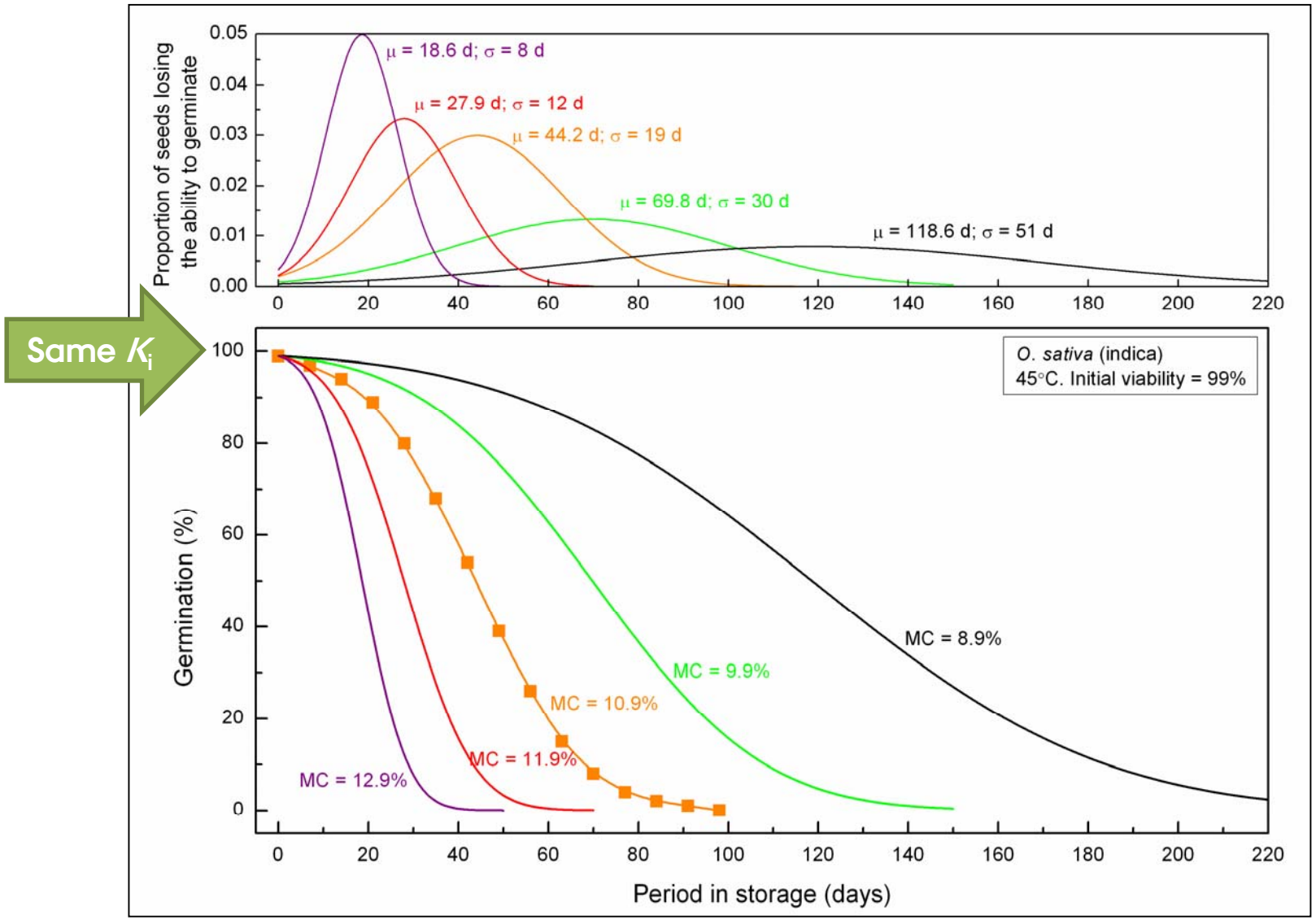


Only the intercept of the survival curve (K_i) is affected by (and is a measure of) the quality of the seed lot.

The slope of the survival curve, $1/\sigma$, and hence, σ itself, is not affected by genotype or seed quality, i.e. is constant for all seed lots of a species in a given storage environment.

VARIATION IN LONGEVITY: SEEDS × ENVMT

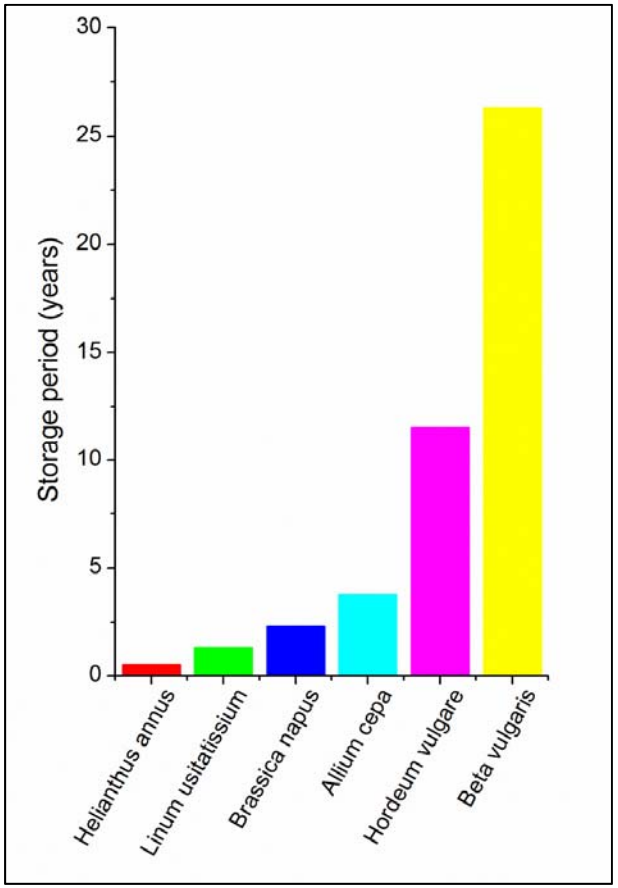


VARIATION IN LONGEVITY: SPECIES

Predicted times for viability to fall from 98 to 96% if the seeds are stored at 8% moisture content and 5°C)

Inherent differences in longevity due to differences in

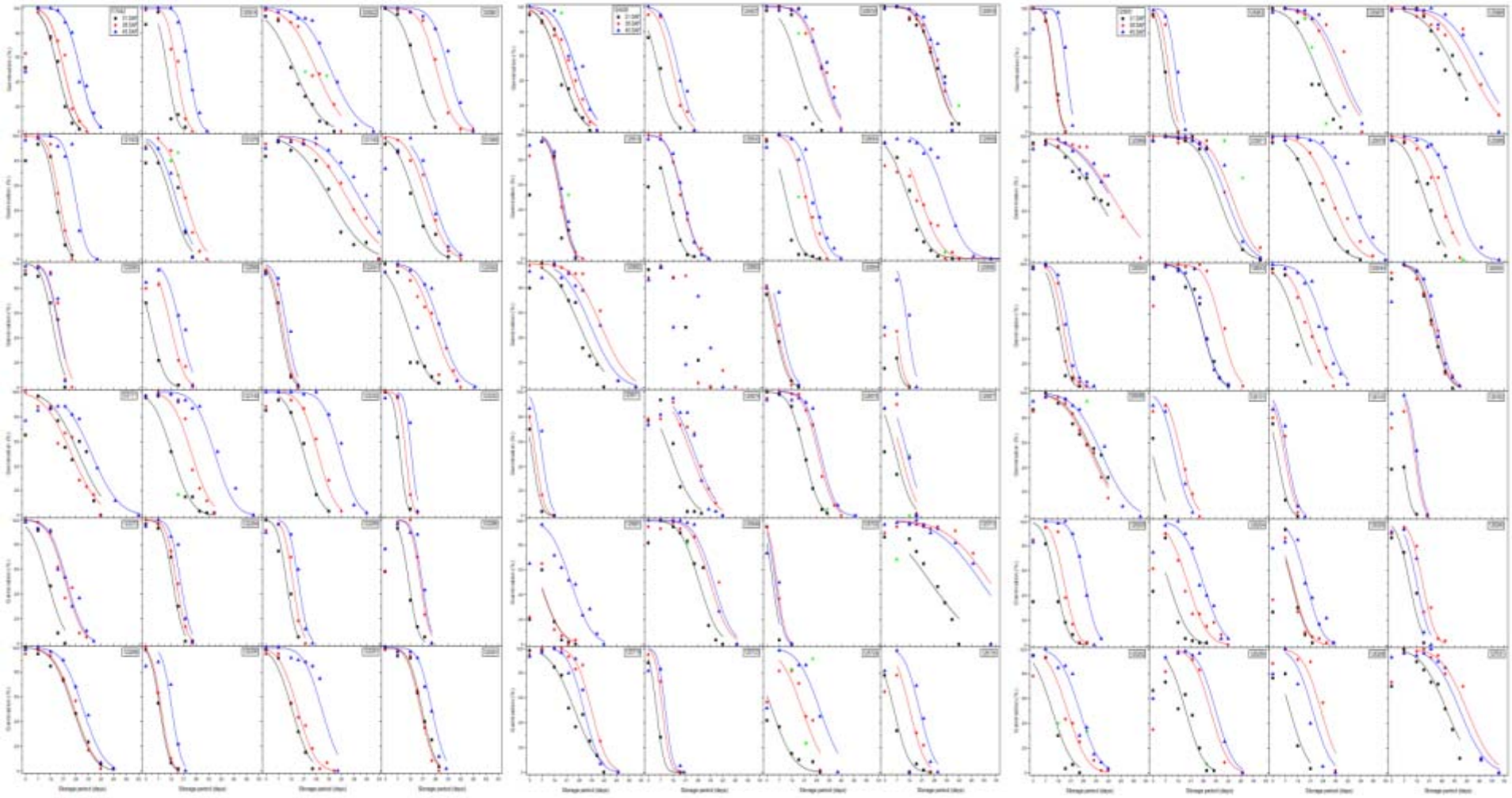
- Properties of the glassy state (sugars, proteins)?
- Antioxidant capacity?
- Ability to repair macromolecules?



VARIATION IN LONGEVITY: GENOTYPE

Use of molecular markers for K_i and σ?

Seeds aged at 10.9% moisture content and 45°C



VARIATION IN LONGEVITY: GENOTYPE

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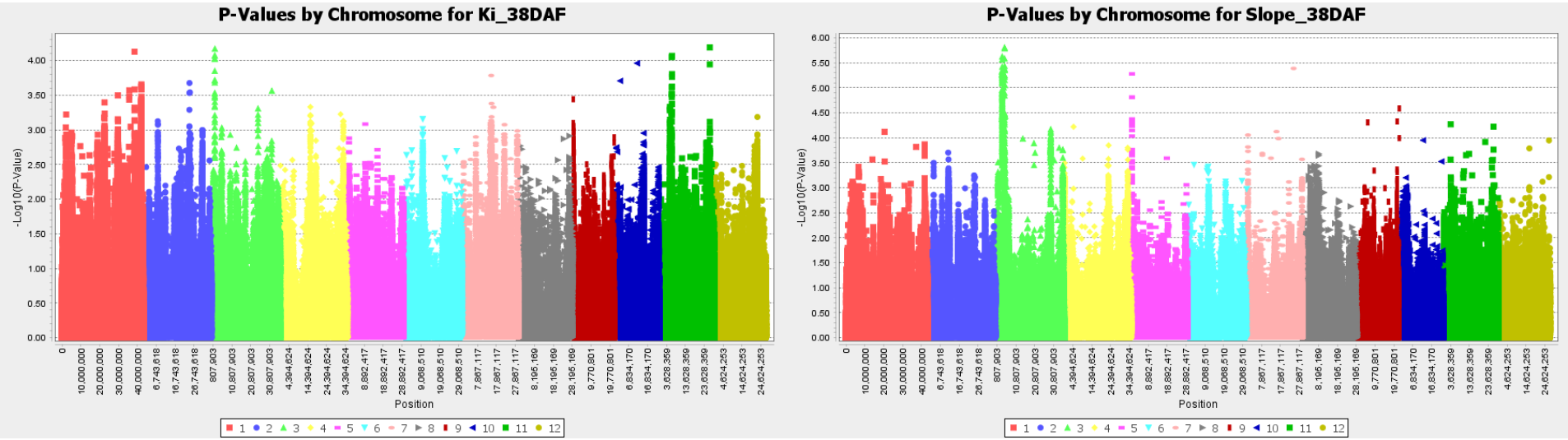


WHAT DO WE MEAN BY SEED QUALITY?

Seed quality is multi-faceted:

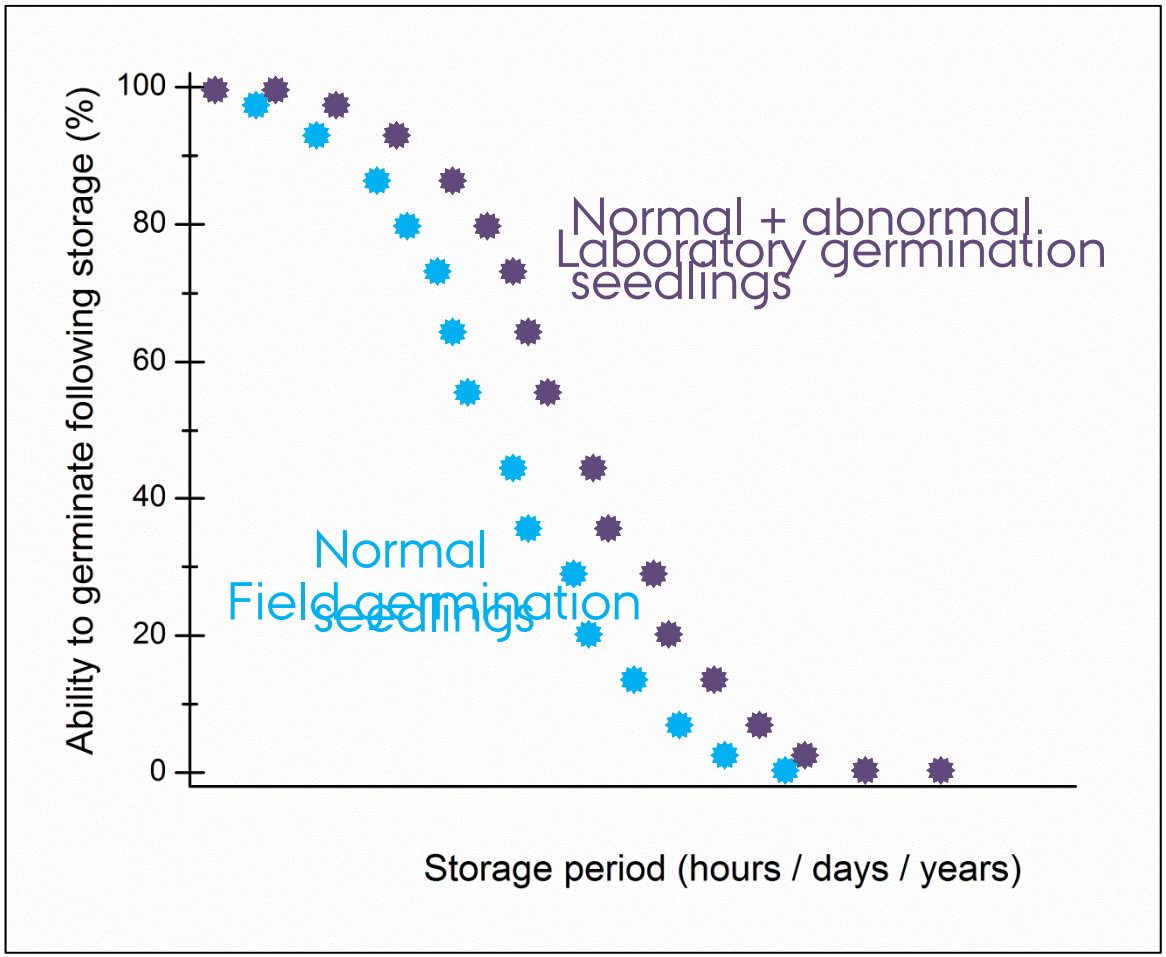
- Purity – physical
  – genetic

- Health

- Physiological quality – ability to germinate (germination %)
  – vigour, speed of germination

➡Properties of the seed lot.

VARIATION IN SEED QUALITY - SEEDS



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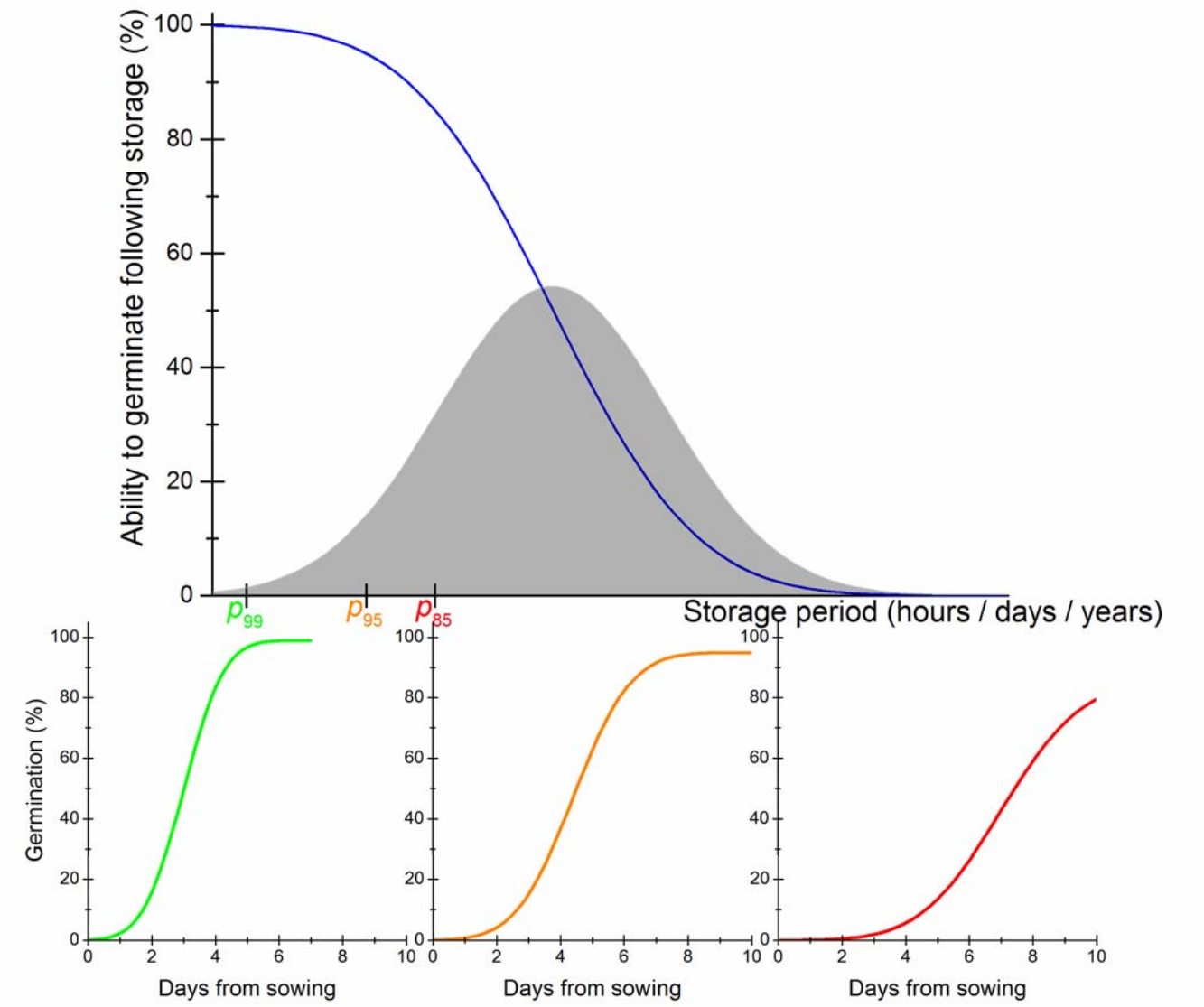

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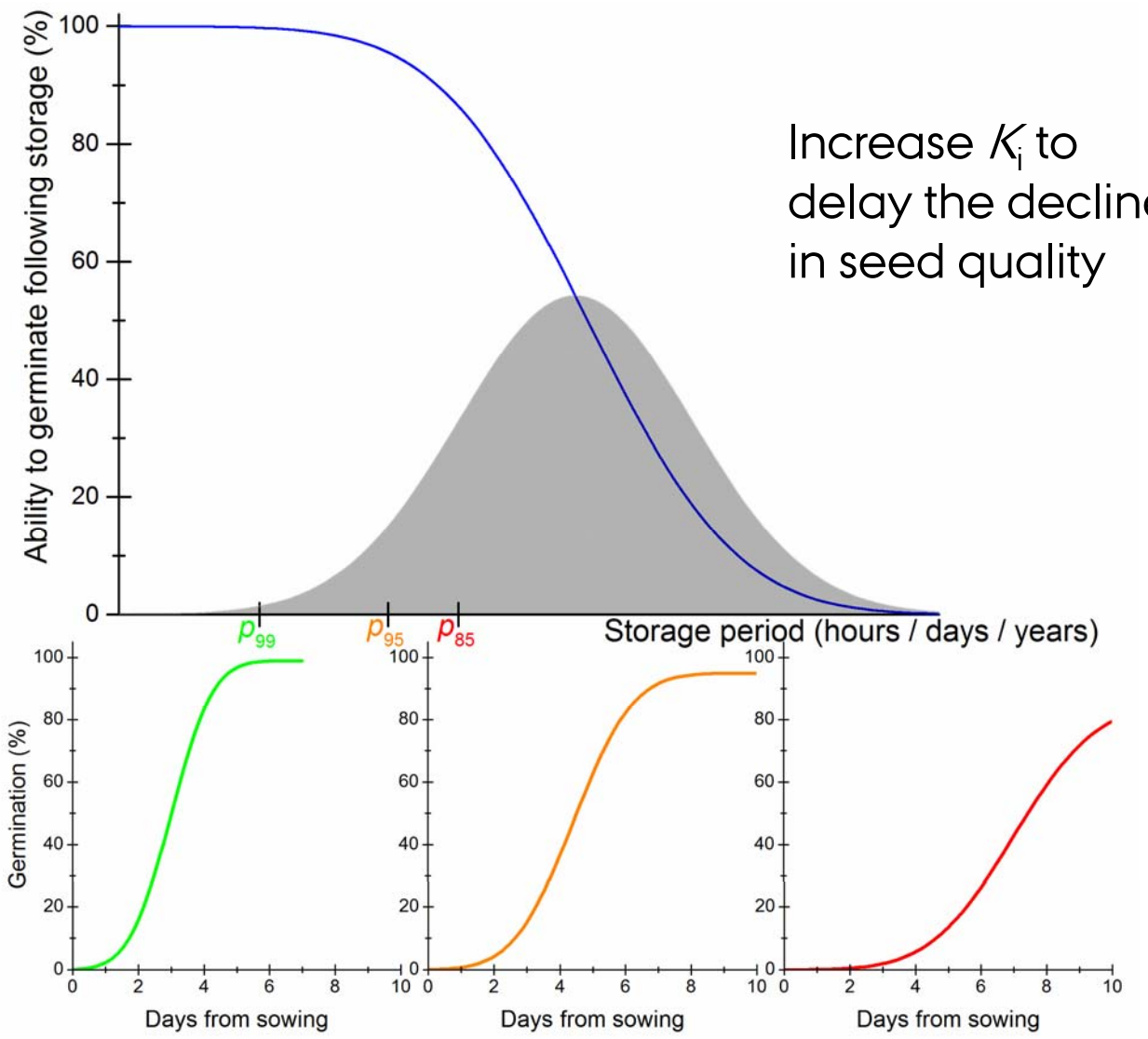
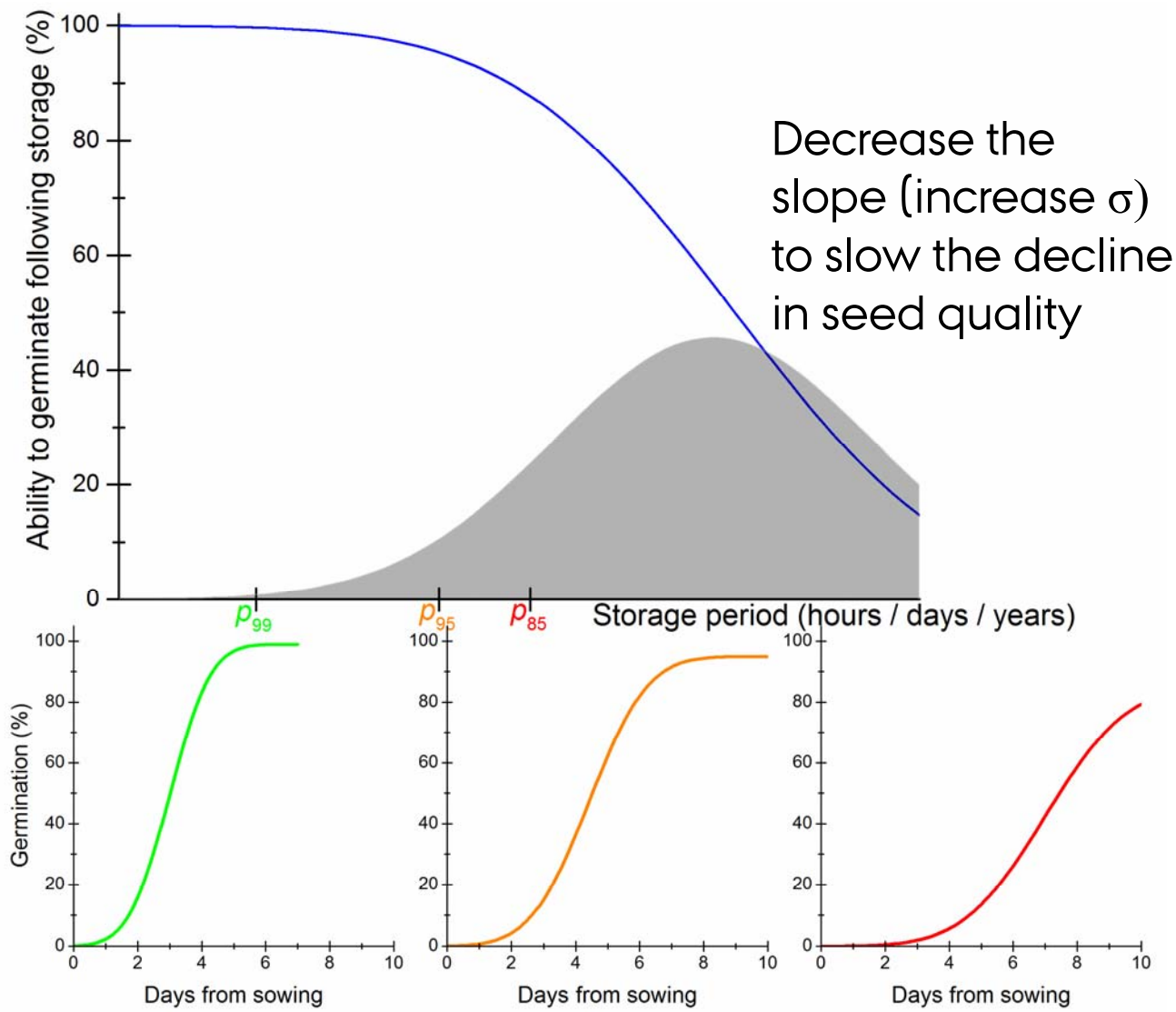


Increase K_i to delay the decline in seed quality

VARIATION IN SEED QUALITY - SEEDS



Decrease the slope (increase σ) to slow the decline in seed quality

CONCLUSIONS

- Seed longevity varies between species, between seed lots within a species and between individual seeds within a seed lot;
- Seed-to-seed variation in longevity results in a normal distribution of seeds deaths over time, described using K_i and σ;
- Seed scientists are starting to identify seed 'longevity' genes (and networks);
- Enhancing longevity should also enhance seed quality and the length of time the quality is maintained.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