

The damaging effects of oxygen on seed viability are underestimated

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Introduction

The emphasis in maintenance of seed longevity is on storage at low temperatures and moisture levels. To predict shelf life in relation to their physiological condition or after seed treatments artificial ageing or controlled deterioration treatments are used. But these tests at high moisture and/or temperature are highly debated. Despite multiple observations showing that the main damage occurring during natural seed ageing is oxidation, relative little attention is paid to the role of oxygen in the storage environment.

Method

To analyse the role of oxygen on seed ageing in a relative short time frame, we stored seeds under Elevated Partial Pressure of Oxygen (EPPO) up to 18 MPa (180 bar) oxygen (Figure 1). Control seeds were stored either at 0.1 MPa (1 bar air pressure) or 18 MPa nitrogen gas.

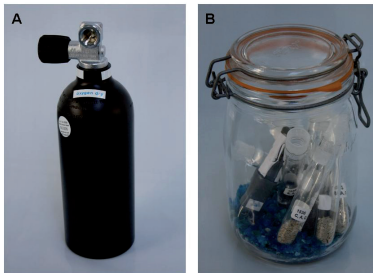


Figure 1. Storage containers: A: Steel tank which can be filled with gas till 20 MPa. B: Glass jar containing air at ambient pressure.

Results

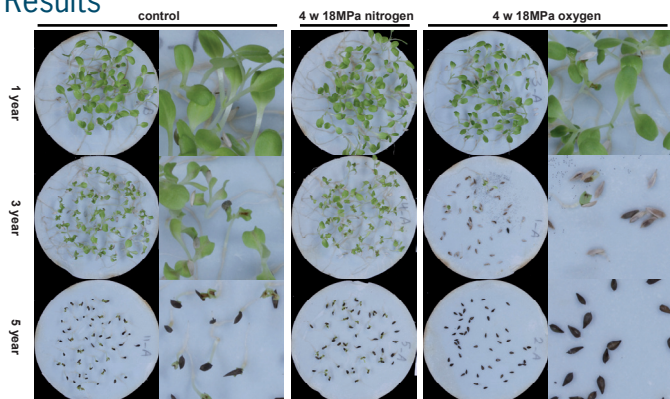


Figure 2. Lettuce seedling quality after natural ageing and subsequent storage under high pressure nitrogen or oxygen.

With the EPPO method we observed within a few weeks clear ageing of lettuce seeds at 20 °C and 32% RH. The morphological symptoms are very similar to natural ageing: retardation of radicle protrusion, reduction of normal seedlings and the occurrence of midvein necrosis on the cotyledons (Figure 2). Control seeds stored during the same period under 18 MPa nitrogen or in air at atmospheric pressure (0.1 MPa) showed no symptoms of ageing. EPPO storage of primed lettuce seeds gave symptoms typical for ageing of primed seeds: retardation of radicle protrusion and necrosis at the radicle tip (Figure 3).

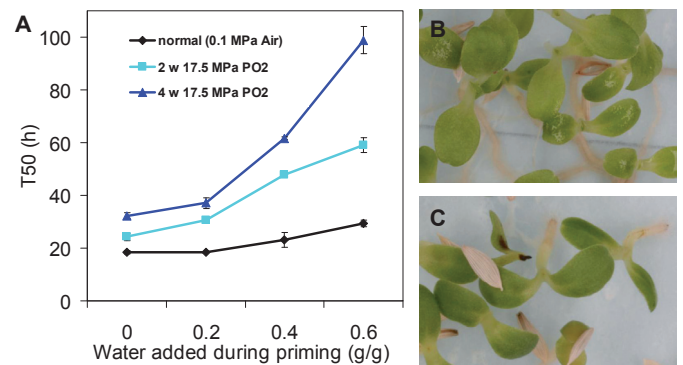


Figure 3. Sensitivity of primed seeds for EPPO storage. Lettuce seeds had been primed for one week at different levels of moisture. The re-dried and control seeds were stored either at ambient or EPPO conditions at 32% RH for 2 or 4 weeks. A: Time needed for 50% of the seeds to germinate. B: Primed seeds after ambient storage. C: Seedling morphology after priming with 60% water and 2 weeks storage at 18 MPa EPPO.

Experiments with soybean, cabbage, barley and tomato also revealed acceleration of ageing under EPPO conditions.

Conclusions

- EPPO storage shows the damaging effect of oxygen during storage.
- EPPO storage is a new method to study seed ageing processes and for instance genetic variation.
- Likely reduction of oxygen levels during seed storage can prolong their shelf life.