

Survival of groundnut seeds under different storage conditions

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Longevity of stored seed is affected by a number of environmental factors. The three major factors are seed moisture content (*mc*), temperature and oxygen concentration in the storage environment (Roberts 1972). Conservation of germplasm in seed storage facilities necessitates techniques that prolong seed longevity. The orthodox seeds tolerate considerable amount of desiccation, and over a wide range of conditions, longevity of seeds increases in a quantifiable way with decrease in *mc* (Roberts 1973). Lower levels of *mc* can be achieved in oily seeds rather than in starchy seeds; and oily seeds show much poorer longevity than starchy seeds at the same storage temperature and *mc* (Ellis et al. 1989). Seed deterioration is a continuous process, but for orthodox seeds a combination of 3–7% seed moisture and storage temperature below 0°C permits long-term seed preservation (FAO/IPGRI 1994). The concept of ultra-dry technology is to reduce or avoid the requirement for refrigeration in germplasm facilities with economic constraints (IBPGR 1985, Ellis et al. 1986). Ellis et al (1989) found a 12-fold increase in the half-viability period (longevity) in rape (*Brassica napus*) seeds when stored at 3% *mc* instead of 5%, and also reported that a reduction in seed storage *mc* from 5 to 2% resulted in approximately the same increase in longevity as a reduction in seed storage temperature from +20°C to –10°C. Seed drying involves reduction of *mc* using techniques which will not be detrimental to seed viability. Orthodox seed can be safely dried to very low levels of *mc*, 2–6%, equivalent to a water potential of –350 Mpa (Roberts and Ellis 1989). Groundnut (*Arachis hypogaea*) seed lots of about 9% *mc* can be safely dried to about 3% *mc* at 15°C and 15% relative humidity (RH) using sorption type drier with secondary refrigeration (Sastry et al. 2003). The capacity to dry seeds to even lower water contents with silica gel is efficient, cost-effective and such drying did not have any detectable effects on germination percentage (Hu et al. 1998). The objective of this study was to determine the viability of groundnut seeds under a range of storage conditions.

Materials and methods

Seeds of groundnut cultivar ICGS 11 from the 2000 post-rainy season at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India with 5.0% initial *mc* and 100% germination were used for the study. The effect of air and vacuum on seed longevity was studied at five seed moisture levels: 1.7%, 3.4%, 4.4%, 7.1% and 10.1%; and two storage temperatures: 35°C and 50°C in incubators. The *mc* levels were achieved by holding the seeds in desiccators on saturated salt solutions of LiCl (13% RH), MgCl₂ (33% RH), NH₄NO₃ (62% RH) and NaCl (72% RH) for about two weeks at 25°C and one sample in a desiccator under vacuum for 60 days using dry silica gel. Seed *mc* was estimated using oven-drying method and the values expressed on the fresh weight basis (ISTA 1985). Each seed lot was subdivided into samples of about 100 seeds and sealed in laminated aluminum foil pouches with air or vacuum using an Audionvac VM101H[®] vacuum-sealer programmed to a pressure of –0.95 bar. Ellis (1998) reported investigations on longevity of ultra-dry seed storage at high temperatures of 50°C and 65°C. Seeds were sampled at regular intervals ranging from once in two days (50°C and 10.1% *mc*) to once in 48 weeks (35°C; 1.7% and 3.4% *mc*) for testing seed viability. To avoid imbibition injury during germination, especially for seed with <7.1% *mc*, seeds were humidified for 24 h over water in a desiccator at 25°C. Four replications of 25 seeds each were used for testing seed germination before storage and during subsequent sampling. Germination was expressed as the percentage of normal seedlings produced after 10 days of incubation at 20°C. Observations on seed viability under different storage conditions were recorded and data were analyzed using Genstat 9.1.

Results and discussion

The initial seed viability of test samples is generally high and ranged between 98 and 100%. Upon storage, there

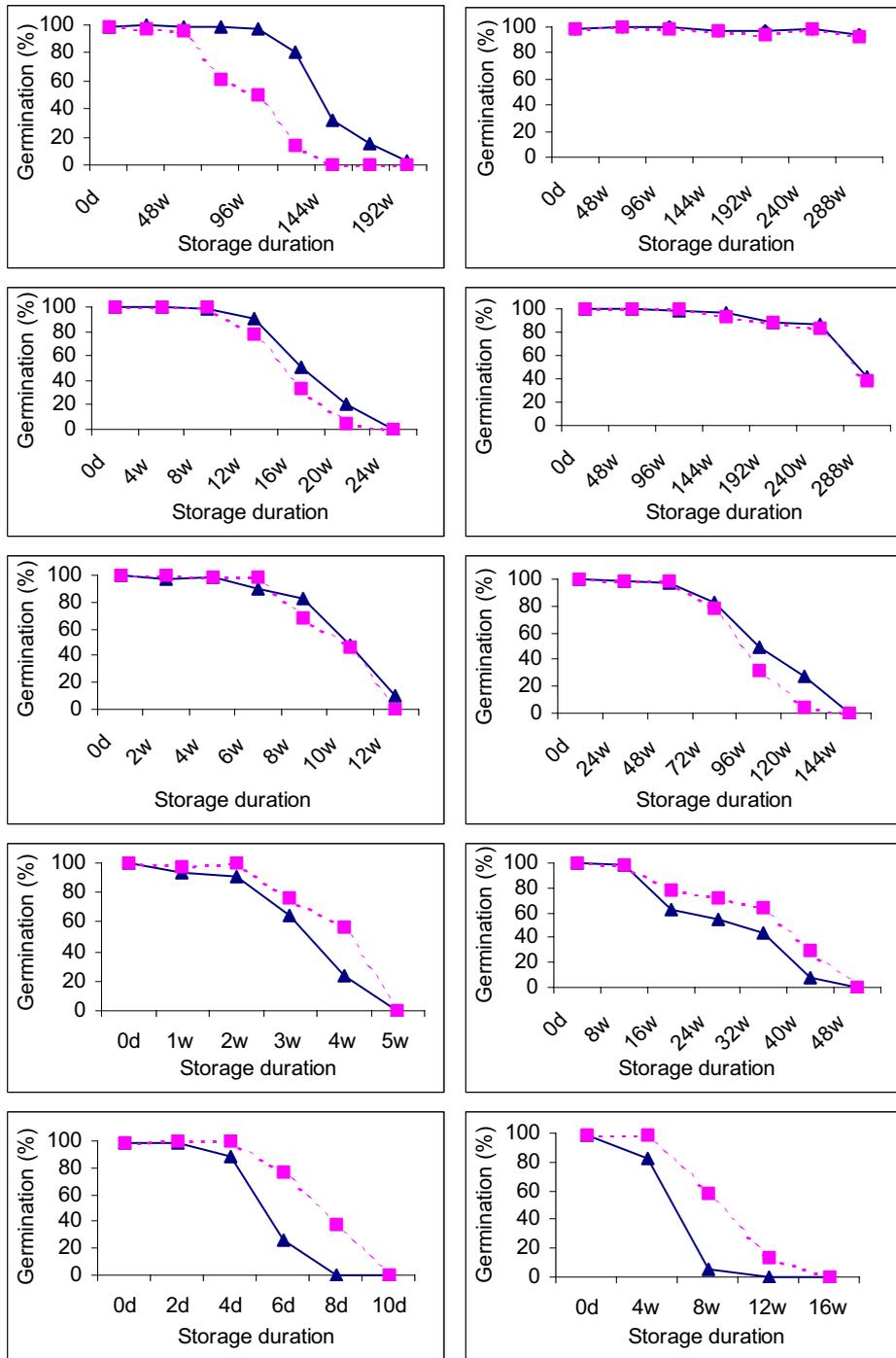


Figure 1. Effect of seed moisture content on groundnut seed viability during storage. Graphs on left refer to storage at 50°C and on right to 35°C and moisture contents 1.7, 3.4, 4.4, 7.1 and 10.1% (top to bottom). Dotted line indicates air-sealed and solid line is vacuum-sealed storage.

was a gradual loss in the germinability of seeds in all the treatments. Seeds stored at higher temperatures (50°C) and *mc* (10.1%) deteriorated faster compared to other treatments and complete loss of viability occurred within 10 days in both air- and vacuum-sealed conditions. However, seed survived for up to 20 weeks when seed *mc* decreased from 10.1 to 3.4% under both conditions of storage under 50°C. There was a significant improvement in the survival of seeds, especially when the seed *mc* was reduced from 3.4% to 1.7%. The initial viability levels remained up to 48 weeks in both types of storage and the viability remained as high as 80% up to 120 weeks in vacuum-sealed samples at 50°C. This indicates potential survival of groundnut seeds at higher temperatures when sufficiently dried to *mc* around 3% and stored under vacuum.

At 35°C, groundnut seed with 10.1% *mc* survived for 12 weeks and up to 120 weeks when the *mc* reduced to 4.4% (Fig. 1). Viability at 3.4% seed *mc* was significantly high up to 240 weeks for both air-sealed and vacuum-sealed samples and signs of deterioration occurred in subsequent samplings. Seed samples with 1.7% *mc* almost retained initial levels of viability even after 288 weeks storage in both air- and vacuum-sealed aluminum pouches. However, we continue recording observations on surviving treatments at this temperature.

The results on seed viability among treatments showed significant interactions between storage temperature, seed *mc* and method of storage (Fig. 1). Irrespective of storage temperatures, seed samples with higher *mc* (7.1 and 10.1%) and stored under vacuum deteriorated faster than seeds sealed with air. There is no significant effect of air and vacuum sealing when the seed *mc* was between 3.4 and 4.4%. However, when seeds with 1.7% *mc* were stored at 50°C, seeds retained viability up to 192 weeks under vacuum compared to 144 weeks when sealed in air. Storage at 35°C at lower seed *mc* (1.7 and 3.4%) both in air and vacuum enabled seeds to retain viability even after 288 weeks.

The results presented here demonstrate the potential benefit of storing groundnut seeds with very low moisture levels (ultra-dry storage).

Conclusions

- Groundnut seeds dried up to 4% *mc* using sorption type drier with secondary refrigeration (15°C and 15% RH) retain viability considerably for longer periods and replacing air with vacuum further enhanced seed longevity.

- Seeds dried to very low *mc* (1.7%) retained higher viability levels for over two years of storage at 50°C.
- Ultra-dry storage of groundnut seed improves longevity and valuable germplasm or breeding samples can be safely dried and stored for longer periods even under ambient conditions saving on refrigerated storage and frequent regeneration.

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