Vacuum and Inert-Gas Storage of Safflower and Sesame Seeds

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CAREFUL control of the environment is required for safe long-term storage of seeds. Loss of viability of stored seeds is generally believed to be associated with the rate of respiration during storage. Respiration rate can be controlled by either reducing seed moisture content, decreasing the storage temperature, or reducing available oxygen (O₂). Seed moisture content can be reduced by drying and maintained at the desired level by controlling the relative humidity of the storage area or by using moisture-proof containers. Satisfactory temperatures for long-term storage of seeds can be obtained by refrigeration. However, refrigeration of large storage rooms is expensive. Therefore, satisfactory methods of storing seeds for long periods without refrigeration would be of great monetary value.

The amount of available O₂ can be reduced by airtight storage which restricts the movement of air among the seeds. The O₂ supply can be further reduced by evacuating the container prior to sealing or by injecting an O₂-free gas into the container in place of air before sealing.

A long-term study is being conducted on the effects of a partial vacuum and various inert gases on the viability of safflower (Carthamus tinctorius L.), Pacific No. 1 variety, and sesame (Sesamum indicum L.), Margo variety, seeds packaged at three seed moisture levels and stored at a wide range of temperatures in sealed metal cans. This report is presented to make our early findings available to research workers and seedsmen.

LITERATURE REVIEW

The effects of seed moisture contents and storage temperatures on the viability of seeds stored for various periods in sealed containers has received considerable attention. The effects of various atmospheres, such as O₂, carbon dioxide (CO₂), nitrogen (N₂), and vacuum, have also received some attention.

Only a few of the more salient papers are reviewed here. See James (10) for a comprehensive review of the 20th Century English language literature on seed storage.

Carter and Young (5) found that low temperatures and low moisture delayed the development of “sick” kernels when wheat was held in sealed containers. Higher temperatures, higher moisture, and longer periods resulted in 100% “sick” kernels. Toole and Toole (19) found that the viability of Mammoth Yellow and Otootan soybeans with 18 and 13% moisture could not be maintained beyond 1 year when stored at 20 to 30°C. The viability of soybeans with 13% moisture was extended to 3 years by storage at 10°C. Reducing the moisture content of soybeans to 8 to 9% permitted storage for 10 years at 10, 2, and −10°C, with no loss of viability. Similar seeds stored at 30°C lost viability very rapidly after 1 year.

Kincaid (12, 15) reported that tobacco seeds deteriorated rapidly under room conditions unless held at a low moisture level in sealed containers. Unsealed seeds remained viable for 15 years under refrigeration, while sealed seeds remained viable for 24 years.

According to Bass (1), Kentucky bluegrass seeds containing 8.7% moisture or less when sealed in metal cans and 10-mil polyethylene bags maintained essentially their original viability during 50- and 24-month storage, respectively, at temperatures up to 70°F. Seeds in sealed or unsealed containers showed a decline in viability after 18 months at room temperature, 6 months at 90°F, and 3 months at 110°F. Seeds in 10-mil polyethylene bags showed a slight decline in viability after 24 months at 90 and 110°F. Creeping red fescue seeds containing 3.2 and 11.4% moisture when packaged maintained high germination longer in 10-mil polyethylene bags than in metal cans at most temperatures tested.

Guillaumin (8) reported that soybeans lost their viability in temperatures of 6 years in open storage, but germinated 92% after storage in an O₂-free atmosphere, and 100% after storage in a partial vacuum.

Simpson (18) found that cotontwines containing less than 13% moisture did not deteriorate in 15 years when stored at 33°F in sealed containers. He also found (17) that cottonseeds containing 7% moisture in sealed containers with air, O₂, CO₂, or N₂ were maintained with no decline in germination for 10 years at 70°F; at 90°F, no deterioration occurred in 3½ years. Seed containing 13% moisture had slightly over half of its initial germination after 1 year of storage at 70°F; at 90°F, only an occasional seed was viable after 6 months. No differential effects of gases was noted.

Glass et al. (6) found that an atmosphere of N₂ delayed the start of deterioration of wheat containing 16 to 18% moisture for 2 to 4 weeks when stored at 30°C and for 10 to 12 weeks at 20°C. Gane (5) reported that the effect of N₂ on chewing fescue seed was negligible, and Evans et al. (4) found that storage in N₂ had no advantage for meadow fescue and timothy seeds.

According to Goodsell et al. (7), cold test germinations for corn seeds were, in general, no higher for CO₂- or N₂-stored seeds than for air-stored seeds except the seeds with 12% moisture at 60°F, where germination was noted.

Struve (9) reported that O₂ may become an important factor in the deterioration, within 10 months, of corn seeds stored in air at temperatures as low as 33°F. The O₂ effect was magnified by increased O₂ concentration, higher temperature, or longer storage. Seeds stored in pure N₂ maintained viability and vigor longer than seeds stored in O₂. Sayre (16) obtained no advantage by storing corn seeds with gases other than air.

Kalyvoreas (11) kept 20.8%-moisture rice in good condition for 6 months at room temperature in an atmosphere of 30% CO₂ plus 1,000 ppm ethylene bromide. Kondo and Okamura (14, 15) obtained no important difference between airtight and CO₂ storage of hulled rice, but thought that CO₂ storage might be better in some respects.

Isely and Bass (9) and Grabe and Isely (4) reported that a study conducted at Iowa State University failed to demonstrate any advantage in storage of creeping red fescue and Kentucky bluegrass seeds in N₂ or a partial vacuum rather than air in sealed metal cans.
