# Seeds, Vegetable

**Revised 2018**

## Storage Conditions

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| **Temperature** | Most vegetable seeds can be stored at 41°F (5°C) or lower for up to 12 months. When storing seed for extended periods of time at 0°F (-18°C), equilibrate the seed for 4 weeks at 41°F (5°C) and 25% relative humidity (RH). After equilibration is completed, store seed in a moisture-proof container. Lettuce and onion seeds do not store well and should be kept at temperatures below 0°F (-18°C) for short- and long-term storage. Wild rice seed is held near 32°F (0°C) to prevent premature germination. Seeds should not be re-frozen. |
| **Relative Humidity** | 20 to 25% RH preferable for most kinds; hard-seededness is induced in many legume below 45-50% RH; dormancy has been induced in sorghum with 7 and 10% moisture contents (35-45% RH). For peanuts and tree nut seeds, 50-60% RH is best and 65% RH should not be exceeded. Wild rice seed is held at practically 100% RH. |
| **Storage Period** | Differs for different kinds or species and, in some cases, with varieties (cultivars) within a species. Onion seed is the most sensitive to storage conditions, and tomato seed the least sensitive. In storage experiments at 50°F (10°C) and 50% RH, seeds of bean, cucumber, pea, sweet corn, tomato, and watermelon did not decrease significantly in germination over a 9-year period. Under similar conditions, seed stocks of cabbage, carrot, celery, lettuce, okra, onion, pepper, spinach, and turnip did not decrease significantly in germination during 36 weeks. The viability of seeds of most vegetable species will be maintained at a satisfactory level for 10-12 months when stored under conditions where the sum of the percent RH and the temperature (F) does not exceed 100. |

Refrigeration is necessary for holding peanuts and tree nut seeds for more than 3 months, but under refrigerated conditions germination may be extended for more than 3 years.

The mean moisture content (MC) of seeds, which is important from a standpoint of percent germination and vigor, varies directly with air humidity and composition of the seed. Different seeds vary considerably in both the moisture equilibrium at a given humidity and the rate of change of moisture content, but a 20-25% relative humidity which gives moisture content of approximately 4-8% is ideal. Lower RHs may remove too much seed moisture and cause dormancy, increase the rate of deterioration in some kinds, or induce hard-seededness in susceptible kinds. Harrington's rule indicates that moisture is more critical than temperature for seed storage. He suggests that a 1% reduction in moisture content doubles shelf life, but not below 4%. A 10°F (5.6°C) reduction in temperature also doubles the life of the seed. However, as temperature is reduced, seed moisture increases, unless the seed is stored in a moisture-proof container. Bulk seed should be monitored for so-called "hot spots," which usually have only a slight effect on average moisture content but can be devastating infection centers.

The original condition of seed influences the rate of deterioration during storage. Low temperatures must be used to maintain germinability of seeds stored at high (65-70%) RH or those seeds containing more than about 12% moisture. The low temperatures are needed to reduce the deterioration processes of the high-moisture seed as well as to reduce the growth of storage fungi, which accelerate deterioration. Thus, it is important to store high vigor seed at 41°F (5°C) or lower. Mold spores and insects are inactive at approximately 41°F (5°C) and 8% MC or lower.

If the seed moisture is below 10%, freezer temperatures of 0-10°F (-18 to -12°C) can be used effectively for vegetable seeds in vapor-proof containers, especially for long-term storage. Research suggests that dry soybean seed, which is about 5.3% moisture content, should be slowly increased in moisture during germination, or internal cracks and breaks will occur. Seeds held in moisture vapor-proof containers, when packed at optimum moisture content for the kind or type, store better than seeds exposed to the atmosphere.

Seeds held in refrigerated storage should be kept in moisture-resistant containers. If moisture-resistant containers cannot be used, the refrigerated storage space for most seeds should be conditioned to 25% RH. Upon removing such seeds from cold storage, the condensate should be removed by forced circulation of dry air among the seed stacks. If necessary, the temperature of the free-moving air can be increased up to 115°F (46°C), but never above 120°F (49°C). High temperature forced air circulation should only be used for short periods of time, as it will cause seed deterioration.

Insect infestation and damage is significantly retarded at temperatures below 41°F (5°C). Some insects and their eggs are not killed, however, until freezing temperatures are employed. Insects cannot reproduce when the seed moisture is below 8%, and most insects will die at 4-6% MC.

Color changes in seeds are due to auto-oxidation and the browning reaction. Both reactions are accelerated by exposure to light and high temperatures. Color changes are retarded by low oxygen and high carbon dioxide atmospheres that are quickly reached in sealed, vapor-resistant containers.

The most practical method for predicting potential storability of seed lots is the accelerated aging test as suggested by the Association of Official Seed Analysts Handbook #32. The test consists of subjecting the seeds to specific stress conditions before performing a standard germination test. Seeds are placed in chambers at 100% RH and temperatures of 105-115°F (41-46°C) for predetermined time periods.

Seed of several field, vegetable, and flower species have been successfully stored in liquid nitrogen vapor (-320°F or -160°C) for many years. The National Center for Genetic Resources Preservation is preserving certain germplasm in liquid nitrogen vapor to prolong seed storage life. Liquid nitrogen is not a medium that would be recommended for short-term storage.

## Effects of Ammonia on Seeds

In 1985, WFLO funded a Research Project to determine the risks that might be involved in storing seed stock in refrigerated warehouses where an ammonia leak could occur. For complete details of the research results, refer to WFLO Research Summary #85-1, June 1985, entitled "The Toxicity Effects of

Ammonia on the Germination and Growth (Vigor) of Seed Stock Stored in Refrigerated Warehouses." Following is a summary of these results:

Exposure of dry soybean, corn, or peanut seeds to ammonia concentrations of 20 and 200 ppm did not reduce seed quality as determined by germination and growth tests. Ammonia concentrations of 2,000 ppm or higher had an adverse effect on seed quality. Such levels of ammonia are substantially higher than would ordinarily be encountered in a warehouse, except with a severe leak or spillage.

1. Crop seeds differ in sensitivity to ammonia. Corn was more sensitive than peanut. Peanut was more sensitive than soybean.
2. Toxic effects of ammonia became more severe with exposure duration. For example, in soybean 20,000 ppm ammonia is not injurious after 2 hours but is lethal after 24 hours exposure, and in corn 2,000 ppm ammonia is not injurious after 2, but is after 24 hours exposure. Thus, prompt action in removing seeds from high levels of ammonia is recommended.
3. Cold temperatures (41°F or 5°C) protected corn and soybean seeds from NH3 toxicity at 2,000 and 20,000 ppm.
4. The ASAC-1000, which measures seed quality by determining leachate conductivity, was able to detect the injurious effects of 2,000 ppm ammonia on corn seeds. However, leachate conductivity also increased in the case of soybean seeds which were only marginally weakened by 2,000 ppm $NH_3$.
5. Imbibed soybean seeds were approximately 10 times more sensitive to NH3 than were dry seeds.

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