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Effects of Various Storage Conditions on Longevity of Cotton, Corn, and Sorghum Seeds[1]

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ABSTRACT

Seed of 'Acala' cotton (*Gossypium hirsutum* L.), 'White Surcropper' corn (*Zea mays* L.), and 'Dwarf Yellow Milo' sorghum (*Sorghum bicolor* (L.) Moench) were sealed in bottles and stored in refrigerated storage (10C) and at room temperature. Treatments used were vacuum, dehydrated, vacuum-dehydrated, and control.

Storage at 10C had the greatest influence on maintaining viability. After 26 years the sorghum, cotton, and corn germinated 91, 41, and 0%, respectively. The corn seed germinated 34% at the end of 22 years of refrigerated storage. Seed sealed in bottles and stored at room temperature remained viable at least 2 years longer than seed stored in paper envelopes.

Dehydration was ineffective in maintaining the viability of both cotton and corn seed. The germination percentage of cotton and grain sorghum was maintained at a higher level by storage in a partial vacuum.

Additional index words: Gossypium hirsutum L., *Zea mays* L., *Sorghum bicolor* (L.) Moench, Germination, Vacuum, Dehydration.

SEED of *Angiosperms,* with few exceptions, lose germinability and vigor during long exposure to warm, humid conditions. Germinability and longevity are prime considerations in programs that involve the development, multiplication, storage, and distribution of planting seed. Germinability is a requirement of seed in all phases of the seed industry, but in the developmental (genetic and breeding) phases, both germinability and longevity play important roles.

Plant breeders need to be able to store seed for several years pending the results of tests and other experimental determinations. Having experienced difficulty in obtaining satisfactory stands from certain stocks of field seed stored under room conditions for more than 1 year, an experiment was initiated in 1937 to study various storage methods and to determine the viability, longevity, and germinability of cotton (*Gossypium hirsutum* L.), corn (*Zea mays* L.), and sorghum (*Sorghum bicolor* (L.) Moench) seed subjected to various storage treatments. The results of that experiment are reported here.

REVIEW OF LITERATURE

Under conditions prevailing in Ohio, Welton (13) found that the germinability of corn seed began to decrease after 4 years of storage in ordinary containers. In Colorado, Robertson, Lute and Krueger (8) found that 'Black Amber' Sorgo maintained its germinability for a 17-year period, while the germination of 'Yellow Dent' corn gradually declined from the 1st to the 21st year. The corn germinated 32% at the end of the period when it had been stored in cloth sacks in a dry unheated room.

Simpson (10) reported that cotton seed containing less than 13% moisture did not deteriorate in 15 years when stored at 0C in sealed containers. Cotton seed with 7% moisture in sealed containers with air, 0_2, CO_2, or N_2 were maintained with no decline in germination for 10 years at 21C; at 32C no deterioration occurred in 3½ years. No differential effects of gases were noted (11).

Bass, Clark, and James (3) found that at the end of the 2nd year of storage, sorghum seed held in a partial vacuum germinated significantly higher than those held in CO_2, N_2, helium, and argon in sealed cans, but the rate was not significantly different from the air checks.

Temperatures of 21C or higher were detrimental to longevity of corn seed, whereas those of freezing or below were all about equally favorable to longevity. Seed dried to 5 to 8% moisture, sealed in air, and stored at temperatures of 21C or lower retained its viability for 13 years (9).

Other workers found that low temperature and humidity were necessary to maintain seed viability (2, 5, 6, 10, 12). According to Kincaid (7), Evans (5), and Duvel (4), seed stored in sealed containers maintained its viability longer than in open containers.

MATERIALS AND METHODS

Seed used consisted of 'Acala' cotton, 'White Surcropper' corn, and 'Dwarf Yellow Milo' sorghum produced on the Agronomy Farm at College Station in 1937, the year the experiment was initiated. The cotton seed was cleaned and culled (but not delinted) following ginning, and the corn and sorghum seed were graded after threshing. No fungicide or other chemical treatment was applied to any of the seed lots. The experiment was planned to control temperature, oxygen supply, and amount of moisture in the stored seed.

There were three main treatments: (*1*) refrigerated storage (10C) — sealed containers; (*2*) room temperature — sealed containers; and (*3*) room temperature — paper envelopes. Subtreatments under the first two main treatments were: (*a*) dehydrated, (*b*) vacuum, (*c*) vacuum-dehydrated, and (*d*) control. The controls were made up of undehydrated seed sealed in the containers at atmospheric pressure. There were no subtreatments under main treatment (*3*) — storage at room temperatures in paper envelopes.

The seed were stored in 236-ml glass containers, using 200 samples of each variety. The samples of corn and sorghum contained 114 g in each glass, while the glasses of cotton samples each contained 68 g. Half of the samples of each variety were dehydrated. The corn was dehydrated at 52-57C for 9 hours. Cotton and sorghum were dehydrated at 46-49C for 10 hours.

The moisture contents of the seed lots before and after dehydration prior to further treatment and storage were as follows:

	Before, %	*After, %*	*Reduction, %*
Cotton	6.49	6.22	0.27
Corn	10.94	9.53	1.41
Sorghum	9.41	7.61	1.80

Half of both the dehydrated and nondehydrated samples were sealed under a partial vacuum of 0.226 kg/cm² and the remaining half were sealed under normal pressure. Half of the samples

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were stored in a refrigerated room at approximately 10C, the other half under room temperature conditions. Actual temperatures in the refrigerated storage room ranged from 8C to 12C. The room temperature storage conditions varied from below −5C to above 38C, while the relative humidity varied from 100% to less than 40%.

Samples were germinated in rolled towels at alternating night (20C for 15 hours) and day (30C for 9 hours) temperatures according to the method described in *The Association of Official Seed Analysts Rules for Testing Seeds* (1).

RESULTS AND DISCUSSION

Germination results are summarized for the cotton, corn, and sorghum seed in Tables 1, 2, and 3, respectively. Data is presented only for those years in which significant changes occurred. The results were statistically analyzed for the last year of the refrigerated storage tests (1959 for corn and 1963 for cotton and sorghum).

Data presented in the tables show differences in germination percentages among the crops, the main treatments, and certain of the subtreatments. They also show a tendency to decrease with time although there was considerable year-to-year variation within subtreatments.

The differences among the three crops in respect to viability in refrigerated storage are noteworthy. After 26 years, sorghum seed had lost only 5% in germination compared to 49% for cotton; corn had completely lost its germinability. Acceptable levels of germination depend on the use to be made of the stored seed stocks. Germination as low as 10% might be tolerated in the case of certain parental breeding stocks, while much higher percentages would be desired in certain segregating materials. In most areas of Texas where cotton, corn, and sorghum are grown, 85% is an acceptable level of germination for commercial seed. In our experiment, sorghum seed held in commercial-type refrigerated storage exceeded this level of germination throughout the 26-year period, cotton through 22 years, and corn through 3 or 4 years. Though corn seed lost high germinability rapidly as compared to the other two crops, it germinated acceptably (60%) after 16 years, and showed useful germinating capacity (34%) after 22 years. Relatively small but significant differences were found among the subtreatments. However, if seed is to be held in refrigerated storage, vacuum treatment does not appear to be warranted and neither does dehydration if the moisture content of the seed entering storage is 10% or less.

It is evident that the initial moisture contents of the cotton and sorghum seed were low enough so that dehydration had no effect on the variability of these seed stored in sealed containers (Bass et al., 3). Cotton seed may be stored safely if their initial moisture content is below 11% (J. W. Sorenson, Jr., personal communication). But corn seed which had an initial moisture content higher than either the cotton or sorghum seed tended to remain viable longer if dehydrated.

Compared with room storage in paper envelopes (treatment 3), storage in sealed containers at room temperature (treatment 2) extended the viability period of cotton, corn, and sorghum seed for approximately 2 years in each case. This suggests that controlling the humidity and atmospheric air, while not nearly so effective as a constant low temperature, is effective in maintaining the viability of seed on a short-term basis. Instances of beneficial effects of one or more of the subtreatments of the room temperature treatment also can be cited. The combination vacuum-dehydration treatment was particularly effective on corn seed, and since corn seed lost viability sooner in storage at room temperature in paper envelopes than did cotton or sorghum, such a treatment might prove to be useful.

Table 1. Percent germination of cotton seed stored under different conditions for up to 26 years.

Treatment	Years of storage 0	4	5	6	7	11	16	22	26
	Germination, %								
1. Refrigerated (10C)–sealed bottles									
Dehydrated	86	96	86	63	82	81	91	86	37b*
Vacuum	89	98	97	99	99	89	92	90	47a
Vacuum-dehydrated	88	90	84	80	92	85	92	89	54a
Control	92	96	82	78	88	87	92	84	25c
Avg	89	95	87	80	90	86	92	87	41
2. Room temperature–sealed bottles									
Dehydrated	86	94	80	62	68	2	0		
Vacuum	89	92	75	82	77	0	0		
Vacuum-dehydrated	88	92	84	84	84	2	0		
Control	92	95	71	66	31	0	0		
Avg	89	93	78	74	65	1	0		
3. Room temperature–paper envelopes	91	88	28	8	0				

* Duncan's multiple range test. Averages with the same letters do not differ significantly at the 5% level.

Table 2. Percent germination of corn seed stored under different conditions for up to 26 years.

Treatment	Years of storage 0	2	3	4	5	6	7	11	16	22	26
	Germination %										
1. Refrigerated (10C)–sealed bottles											
Dehydrated	93	92	92	84	85	79	66	58	68	42b*	0
Vacuum	95	92	90	79	84	78	78	60	52	16c	0
Vacuum-dehydrated	95	94	94	78	84	77	68	57	64	58a	0
Control	94	94	92	88	81	80	65	64	58	20c	0
Avg	94	93	92	82	84	78	69	60	60	34	0
2. Room temperature–sealed bottles											
Dehydrated	93	86	41	21	16	0	0	0			
Vacuum	95	68	14	0	0	0	0	0			
Vacuum-dehydrated	95	84	73	64	60	18	18	0			
Control	94	49	2	0	0	0	0	0			
Avg	94	72	32	21	19	4	4	0			
3. Room temperature–paper envelopes	94	80	17	2	0						

* Duncan's multiple range test. Averages with the same letters do not differ significantly at the 5% level.

Table 3. Percent germination of sorghum seed stored under different conditions for up to 26 years.

Treatment	Years of storage 0	3	4	5	6	7	11	16	22	26
	Germination, %									
1. Refrigerated (10C)–sealed bottles										
Dehydrated	97	96	94	98	93	95	90	94	93	88a*
Vacuum	97	98	94	97	95	94	91	95	89	92a
Vacuum-dehydrated	96	96	93	98	96	96	93	95	95	92a
Control	95	98	92	97	91	96	89	93	90	92a
Avg	96	97	93	98	94	95	91	94	92	91
2. Room temperature–sealed bottles										
Dehydrated	97	96	93	92	38	16	0			
Vacuum	97	97	89	80	35	40	0			
Vacuum-dehydrated	96	97	94	94	94	91	32			
Control	96	92	89	81	36	8	0			
Avg	96	96	91	87	76	39	8			
3. Room temperature–paper envelopes	96	84	67	8	0					

* Duncan's multiple range test. Averages with the same letters do not differ significantly at the 5% level.

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