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Secondary Dormancy in Cotton[1]

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ABSTRACT

This study was undertaken to evaluate the effect of low temperature and high soluble salts on the germination of cotton (*Gossypium hirsutum* L.) seeds. Stress conditions consisting of either low germination temperature (13 C) or high concentrations of soluble salts (18,000 ppm) in the germination substrate, induced a secondary dormancy in newly harvested cotton seeds. Seeds from seven cotton-producing states responded similarly, and dormancy under identical conditions decreased as the seeds aged. Three-year-old seeds showed little or no dormancy under either salt or cold germination conditions.

Additional index words: ***Gossypium hirsutum*** **L., Germination, Germination stress, Salt stress, Temperature stress.**

MANY species of plants produce seeds that will not germinate immediately after ripening but require a resting period of various lengths depending upon the species. This dormancy is known as primary dormancy (8). A second type of dormancy may be induced by environmental conditions such as temperature, aeration, or moisture, that are unfavorable for germination. Reviews of the literature pertaining to this phenomenon were presented by Bibbey (1) and Thornton (15).

The length of the dormant period in either type of dormancy varies with the species as well as with the conditions under which the seeds are stored (6). Brown et al. (2) reported that freshly harvested seeds of oats (*Avena sativa* L.), and barley (*Hordeum jubatum* L.) kept at 2 C in an atmosphere of high relative humidity maintained dormancy for a period of 3 years. Other workers (9, 15) reported dormancy periods in these crops of only 1 to 3 months when seeds were stored under more normal conditions. The structure of the seed coat, by excluding oxygen or moisture, can be a major factor in seed dormancy (7, 11, 12, 13).

In the case of cotton (*Gossypium hirsutum* L.), Simpson (12) reported that Upland cotton seeds taken from bolls immediately upon opening undergo a period of primary dormancy for a few weeks. No such dormancy was noted, however, in the Sea-Island strain tested. Hsi and Reeder (10) reported evidence that dormancy in cotton seeds existed only for short periods of time and that within 1 month after boll opening no dormancy could be detected in the Upland varieties. They also reported no dormancy in the American-Egyptian cottons. Christides (5) stated that freshly harvested Upland cotton seeds exhibited a slight primary dormancy lasting from 25 to 150 days. He also found that the American-Egyptian varieties showed little or no dormancy.

However, some cultivars of American Pima cotton — notably 'Pima S-1' and 'Pima S-3' — have been found to have a considerable number of hard seeds that require a hot water treatment to insure adequate germination (16).

The authors are unaware of any literature reporting secondary dormancy in cotton seeds, although moisture relationships certainly have an effect on hard seeds (3, 4).

The view expressed in the literature, that there was little new seed dormancy in cotton or that it was of short duration, was not consistent with grower experience in this area. Cotton seeds that were 1 to 3 years old gave better germination and stand establishment than seeds harvested the previous fall. This study was undertaken in an attempt to reconcile these divergent opinions. Two obvious conditions existing in this area and not normally encountered in all other parts of the Cotton Belt were suboptimum planting temperatures and large amounts of soluble salts in both soils and irrigation waters. The effect of these two factors in inducing a secondary dormancy of cotton seeds of various ages is reported.

MATERIALS AND METHODS

Experiment 1

In 1964, 1965, and 1966 seeds were harvested from two cultivars of Upland cotton, 'Acala 1517D' and 'Stoneville 7A.' Seeds of 'Lockett 4789' were harvested in 1965 and in 1966. All seeds were from plants grown at the Texas A&M University Research Station at El Paso under similar conditions and grown from the same lot of seeds. The seeds were hand picked, ginned, acid-delinted, and stored in paper bags in cabinets in the laboratory. Thermographs show temperature varied from a winter night-time low of 20 C to a summer day-time high of 28 C. No attempts were made to control humidity, which seldom exceeds 50%. Each seed lot was labeled as to variety and harvest date and subsamples of each were subsequently used for germination studies. Three germination tests were run on each seed lot at yearly intervals, the first at planting time of the year following harvest, with the second and third at intervals of 1 and 2 years. Seeds were germinated using the sponge technique reported by Taylor and Lankford (14). Treatments were as follows: (i) 25 C constant temperature that had previously been shown to yield germination data very similar to that produced with the standard alternating 20-30 C temperature; (ii) a cold treatment of constant 13 C; and (iii) a treatment at a constant 25 C temperature with a substrate moisture containing 18,000 ppm total salt, 50% by weight NaCl, and 50% $CaCl_2$. Germination tests were continued for 14 days with counts taken at 7, 12, and 14 days. Abnormal seedlings were deducted from the germination totals, with the exception that on the 14th day any seedling with a radicle at least ½ inch long was counted as germinated even though the cotyledons were not completely emerged from the seed coat. All treatments were replicated four times with 100 seeds per replication.

Experiment 2

In 1968, with the cooperation of researchers participating in the Regional Cotton Variety Tests, cotton seeds of Acala 1517D and Stoneville 7A were obtained from California, Nevada, Arizona, Texas, Mississippi, Georgia, and Tennessee. The cotton had been grown from seeds of known quality from single seed lots (one lot for each variety).

The seeds thus obtained from the above seven sources were acid-delinted and stored with the seeds for Experiment 1. Germination tests were run on these seed lots during the spring of 1969 and again in January 1971. Treatments were similar to those listed for Experiment 1. All treatments were replicated four times using 100 seeds per replication.

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Table 1. Percent germination of cotton seeds after 14 days at constant 25 C tested the spring following harvest and after 1 and 2 years' storage.

	Seed harvested, 1964 Seed tested			Seed harvested, 1965 Seed tested			Seed harvested, 1966 Seed tested		
Cultivar	1965	1966	1967	1966	1967	1968	1967	1968	1969
Stoneville 7A	78	95	99	75	88	98	78	90	97
Acala 1517D	80	93	98	78	90	95	80	89	95
Lockett 4789				85	92	94	81	91	96

Table 2. Percent germination of cotton seeds after 14 days at constant 13 C tested the spring following harvest and after 1 and 2 years' storage.

	Seed harvested, 1964 Seed tested			Seed harvested, 1965 Seed tested			Seed harvested, 1966 Seed tested		
Cultivar	1965	1966	1967	1966	1967	1968	1967	1968	1969
Stoneville 7A	20	68	93	16	51	94	18	70	92
Acala 1517D	10	54	94	15	73	95	3	71	93
Lockett 4789				18	63	92	11	68	91

Table 3. Percent germination of cotton seeds after 14 days at constant 25 C and with 18,000 ppm salt tested the spring following harvest and after 1 and 2 years' storage.

	Seed harvested, 1964 Seed tested			Seed harvested, 1965 Seed tested			Seed harvested, 1966 Seed tested		
Cultivar	1965	1966	1967	1966	1967	1968	1967	1968	1969
Stoneville 7a	59	82	95	54	68	92	62	78	95
Acala 1517D	52	84	97	49	53	94	55	79	95
Lockett 4789				38	62	91	20	54	89

Table 4. Percent germination of two cultivars of cotton seeds from seven states tested at two dates under three different treatments.

		Salt treatment, 18,000 ppm		Cold treatment, 13 C constant		Standard germination, alternating 20 - 30C	
State	Cultivar	1969	1971	1969	1971	1969	1971
Calif.	1517D	66	90	42	77	96	96
	St. 7A	66	81	34	73	97	96
Ariz.	1517D	86	98	22	89	99	98
	St. 7A	65	88	15	87	95	95
Nev.	1517D	16	93	2	79	99	97
	St. 7A	42	78	3	97	96	98
Texas	1517D	65	90	15	91	99	99
	St. 7A	45	86	13	84	93	94
Miss.	1517D	81	93	16	94	97	98
	St. 7A	68	71	17	84	96	96
Ga.	1517D	79	93	5	86	99	98
	St. 7A	44	89	10	84	99	99
Tenn.	1517D	69	96	30	92	97	96
	St. 7A	64	86	15	90	94	93

RESULTS AND DISCUSSION

Experiment 1

Cotton seeds tested at planting time of the year following harvest consistently showed lower germination percentages than seeds of the same lots tested in subsequent years (Table 1). Initial germinations conducted at constant 25 C temperatures usually gave values approaching 80% (a minimum for certification). Lowering the temperature to 13 C, a value similar to the average minimum soil temperature at planting time in the El Paso area, or adding 18,000 ppm salt to the substrate moisture sharply lowered the germination percentages. (Tables 2 and 3). That the effect was not due solely to the effect of the treatment *per se* but to a treatment-induced or secondary new seed dormancy became apparent as the seeds aged and the germination improved under the same treatments.

Constant 13 C was more effective in inducing dormancy in newer seeds than the salt treatment was. However, in both the cold and the salt treatments the effect was reduced or completely eliminated by using seeds that were 2½ years old.

Experiment 2

Although salt- and cold-induced dormancy had been amply demonstrated for locally grown seeds, the question arose as to whether this response was unique to the local growing conditions or was a general response. Experiment 2 was conducted in an attempt to answer this question, using seeds from cotton grown in seven states across the Cotton Belt. In February 1969 germination tests were conducted on all seed lots and were repeated in January 1971. The results are shown in Table 4. These data clearly indicate that cold- and salt-induced dormancy exists to some extent in cotton seeds regardless of their place of origin. However, a comparison of seeds from certain states indicates that the degree of dormancy can be influenced by prevailing conditions in the different areas.

Data from both tests show that the germination of new cotton seeds was reduced by either salt or low temperatures, while older seeds were essentially free from any salt- or cold-induced dormancy. This information could be of considerable value when attempting to obtain cotton stands under conditions of high salt or suboptimum temperatures (or both) that are often encountered at planting time in some western states. Planting of 1- to 3-year-old seeds, stored at moderate temperatures and low relative humidity, should markedly improve both germination and emergence under these adverse situations.

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