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Effect of Chilling Duration on Germination of Cottonseed[1]

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ABSTRACT

Seed of genetic selection M-8 (*Gossypium hirsutum* L.) and 'Pima S-4' (*G. barbadense* L.) were subjected to various levels of chilling (0, 1, 2, 4, 8, 16, and 32 days at 5 C in water) after the seed were preconditioned by inbibition for 6 hours at 30 C in water. Seed for evaluation of chilling injury were germinated over a temperature range of 15 to 30 C on a thermogradient plate and in rolled towels at 30 C. Percent emergence and stand survival were determined for both cultivars.

Higher percent germination over the same range of temperatures on the thermogradient plate was obtained with M-8 than with Pima S-4. Seed chilled for 16 and 32 days was very low in viability and germinated over a narrower range of temperatures than seed chilled for shorter periods. Preconditioning increased germination of both selections and improved emergence of M-8. Seed of Pima S-4 inbibed water at a faster rate than M-8. Selections differed in their responses to different durations of chilling.

Additional index words: **Thermogradient plate, Emergence, Seedlings, *Gossypium hirsutum* L., *G. barbadense*.**

RESEARCH with cotton (*Gossypium hirsutum* L.), soybean (*Glycine max* L.), and bean *Phaseolus vulgaris* L.) seed indicated that effects due to short intervals of chilling (24 hours) were reduced if the moisture content of the seed was above 12% (3, 6, 7). Chilling effects are expressed as reduced vigor, abnormal development, or death of seedling (1).

Adjustment of internal moisture of cottonseed to levels above 12% protected them from chilling injury when germinated at optimum temperatures (2). Field research has shown benefits from combinations of cottonseed preconditioning (water soaking) followed by chilling treatments. Yield increases were attributed to increases in the total fruitful plants in the plant stand (8). Recent data indicated that preconditioning cottonseed by water soaking, protected them from chilling injury when germinated at suboptimal temperatures (5). Information is lacking as to how long cottonseed can be subjected to low temperatures (5 C) after preconditioning without reduction in performance.

Our objectives were to determine the effects of chilling time after preconditioning cottonseed of two species, genetic selection M-8 (*G. hirsutum* L.) and 'Pima S-4' (*G. barbadense* L.) on germination over a temperature range of 15.5 to 30 C, germination at 30 C, and emergence and stand survival at 27 ± 2 C in a greenhouse environment.

MATERIALS AND METHODS

High quality seed (determined by laboratory germination and tetrazolium test) of genetic selections M-8 (seed produced in 1972) and Pima S-4 (seed produced in 1973) were acid delinted and seed, which floated in water or were damaged, were removed. All seed were punctured at the chalazal end with a needle to insure uniform water uptake. Seed moisture level was established at 8% (dry wt basis) by storage over a saturated solution of KNO_3 at 30C in a closed container. Seed samples of each selection were divided into nine subsamples. Seed from seven subsamples of each type were preconditioned for 6 hours at 30 C in water. They were then chilled (submerged in water at 5 C) for 0, 1, 2, 4, 8, 16, and 32 days. One subsample was chilled for 24 hours in water at 5 C without preconditioning, and the remaining subsample was the control. Treatments were timed so that all seed could be evaluated for viability and vitality at the same time.

A temperature range of 15.5 to 30 C at 0.5 increments was established on the thermogradient plates (5). Each plate was divided in nine subsections. Two replicates of 10 seed each were placed at each of the 30 equally spaced temperatures. Seed were considered germinated if the radicle was 1 cm in length and appeared normal. Germination counts were made daily for 7 days. Moving averages were calculated for each temperature with data from the adjacent two temperature treatments.

Seed (eight replicates of 25 seed each) of each treatment were germinated in rolled paper towels at 30 C and percent normal seedlings were determined after 4 days.

Seed of each treatment were planted 4 cm deep in a sandy loam soil in greenhouse flats. Fifty seed of each treatment were planted in rows 0.8 m long and 10 cm apart with four replications. Percent normal seedlings were determined after 3 and 6 days.

Rate of water uptake for each cultivar was determined by imbibing the seed for various times. After imbibition, seed were surface dried by blotting and a warm air current, then weighed, and thereafter dried at 125 C for 48 hours and reweighed. Moisture content was expressed on a dry wt basis. A portion of each lot that was imbibed was chilled for 24 hours at 5 C and germinated at 31 C for 3 days to correlate seed moisture level with chilling injury. Four replications of 50 seed were used in each treatment.

RESULTS AND DISCUSSION

The data indicate that M-8 and Pima S-4 differed rather widely in response to preconditioning and chilling. In both species, preconditioning improved seed performance after chilling on the thermogradient plate (Fig. 1), in germination rolls (Table 1), and

Table 1. Effect of chilling on two types of cotton.

Days of chilling after preconditioning	Germination*		Emergence†, days after planting			
			3		6	
	M-8	S-4	M-8	S-4	M-8	S-4
0	99	79	58	38	80	72
1	96	63	76	30	89	84
2	94	58	78	38	89	70
4	93	43	73	18	95	57
8	89	33	80	10	92	52
16	57	17	48	6	74	46
32	15	0	15	0	55	0
Control	98	89	2	2	60	56
Chilled for 24 hours at 5 C	11	5	26	1	72	9
L. S. D. 0.05 for treatment × cultivar	6		15		13	

* Percent normal seedlings after 4 days at 30 C in rolled towels. † Percent emergence in a greenhouse at 24 C for 16 hours and 30 C for 8 hours.

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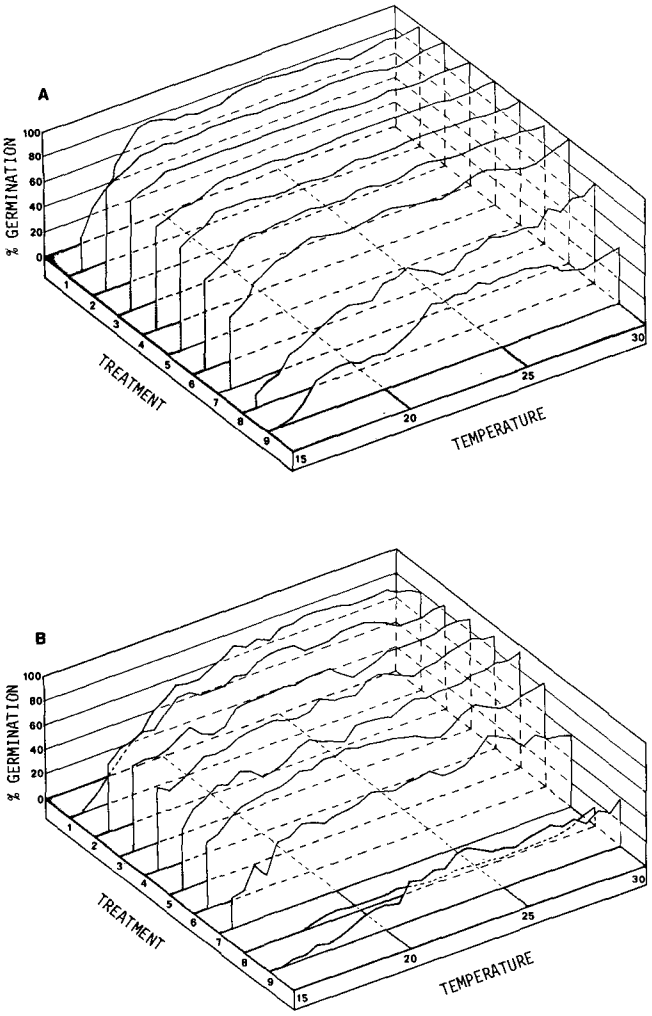

Fig. 1. Germination of cottonseed over a temperature range of 15.5 to 30 C. A) Genetic selection M-8. B) Pima S-4. 1, control; 2 thru 8, preconditioned plus 0, 1, 2, 4, 8, 16, and 32 days chilling at 5C, respectively; and 9, 24-hour chill at 5 C without preconditioning.

in greenhouse soil emergence (Table 1). Pima S-4 germination in paper rolls was reduced a significant 10% by preconditioning; however, emergence from soil improved over controls by preconditioning, which provided a large measure of protection from chilling injury (Table 1).

Species differences in response to treatment were evident in each of the three studies. Germination of preconditioned Pima S-4 seed was reduced to 63% by 1 day of chilling. By comparison, M-8 preconditioned seed germination was significantly reduced to 93% by 4 days chilling, but 16 days chilling was required to cause a major reduction to 57%. Surprisingly, 15% of the M-8 preconditioned seed that were chilled 32 days produced normal seedlings in paper rolls and 55% emerged from soil in 6 days. Examination of root systems of M-8 seedlings that survived chilling without preconditioning or those that were preconditioned and chilled for 32 days revealed that most seedlings had no tap root ("nub-rooted"), typical of previously described chilling injury (1).

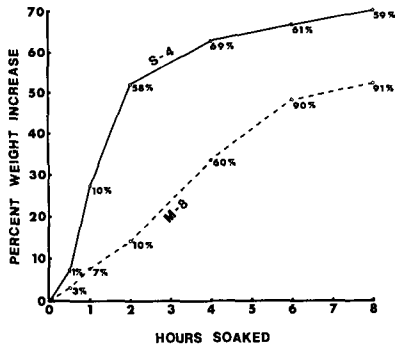

Fig. 2. Rate of water uptake and germination of two types of cottonseed. Numbers expressed as a percentage at each point represent germination following a 24-hour chilling period.

Rate of germination on the thermogradient plates was high over a wide range of temperatures for seed preconditioned and chilled for 0, 1, and 2 days. Seed chilled for greater times or nonpreconditioned seed were slower to germinate at high temperatures on the thermogradient plates. Daily thermogradient plate germination counts indicated that preconditioned seed germinated at 15 to 18 C in 2 to 3 days compared to 4 to 5 days for nonpreconditioned seed.

The present results show a species difference in response to hydration-chilling treatments and agree with previously published comparisons of differences within *G. hirsutum* (4). Some of the differences are centered in the seed coat, since puncturing or removal of the coat partially modifies the response (4); however, in the present work the seed coats were punctured. Seed of Pima S-4 hydrated at a much faster rate than seed of M-8 (Fig. 2), and the maximum protection attained from the hydration-chilling injury, although less than M-8, is gained faster. It is difficult to explain the lack of complete chilling protection afforded by preconditioning Pima S-4 seed. Rate of tissue hydration is certainly involved, and perhaps Pima S-4 tissue hydrates more rapidly because of a higher osmotic potential than M-8.

The present data and previously published results (4) suggest that genetic differences exist among *Gossypium* species in response to seed-hydration chilling. Divergent field results (8, 9) with different varieties might well be explained on the basis of genetic variance. Interaction of genetic variance with seed quality also may be involved. It is well recognized that poor quality seed are more seriously affected by adverse environment than high quality seed. Improvement in performance of low quality seed by preplanting seed hydration was previously reported (8).

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