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Brief Articles

SEED HYDRATION-CHILLING TREATMENT EFFECTS ON GERMINATION AND SUBSEQUENT GROWTH AND FRUITING OF COTTON[1]

R. O. Thomas and M. N. Christiansen[2]

ABSTRACT

Good and poor quality cottonseed (*Gossypium hirsutum* L.) were given the following pre-planting treatments: (a) hydrated in water for 6 hr at 31 C; (b) hydrated as in (a) and chilled for 24 hr at 5 C in water; (c) chilled at 5 C for 24 hr in water; and (d) control or no treatment. Field plantings of both good and poor seed were adversely influenced by chilling the seed. Preconditioning hydration prevented chilling injury and also improved performance of plantings of nonchilled poor quality seed. A hydration-chilling treatment significantly increased yields of plantings from poor quality seed above the control.

Additional index words: Gossypium hirsutum L.

LOW temperature incidence during seed germination has both immediate and long-term effects on survival, growth, and fruiting of cotton (*Gossypium hirsutum* L.) plants (2, 3, 6). Periods as short as 12 hr at 5 to 10 C, occurring during initial water uptake by the seed, can reduce germination drastically and cause aborted radicle tips in surviving seedlings (4). If chilling occurs after germination has proceeded for 24 to 36 hr at a favorable temperature, a radicle cortex injury and long-term growth inhibition may result, which causes reduced yields or at best delayed fruiting (2, 3, 6).

We recently demonstrated that a seed preconditioning-hydration treatment will eliminate sensitivity to hydration chilling injury in cotton (4). If seed moisture is elevated to 14% or above, chilling sensitivity is eliminated (5). The early work of Kidd and West (8) demonstrated growth stimulation as a result of presowing seed soaking treatments applied to a number of plant species. The same relationship between seed moisture level and susceptibility to chilling has been demonstrated in several genera other than *Gossypium* (9, 10). Preliminary field tests of nonhydrated and hydrated cottonseeds indicated that the long-term effects of chilling during seed hydration can be overcome by seed moisture adjustment (11).

Seed hydration-chilling experimentation with cotton received much attention in Russia where some favorable vernalization responses were reported (7). Subsequent research in Russia and in other areas opposed these findings (7), although Zanini (13) recorded a 14-day reduction in the time to first flowering of cotton after subjecting imbibed (45% moisture) seed to temperatures of 5 to 7 C for 30 days. In similar research, Agakishiev (1) reported a low temperature treatment of imbibed cottonseed accelerated germination and seedling growth in saline soils.

Although our previously reported field experiments with seed preconditioning were not designed to ascertain growth and yield differences between plants from chilled and nonchilled hydrated-seed treatments, there was evidence that a combination of seed hydration followed by chilling stimulated growth, hastened flowering, and increased final yields (11). The earlier reports, and our present observations, suggest that when closely controlled wetting-chilling sequences are applied to seed they may alter flowering and perhaps increase yield of cotton. The present research was conducted at Stoneville, Mississippi, to determine if combinations of such seed treatments affect growth and fruiting of cotton.

MATERIALS AND METHODS

Two lots of 'Stoneville 213' cultivar of *Gossypium hirsutum* L. were used in the experiments. One lot was selected for high vigor and viability and the second for reduced vigor and viability (90 and 70% germination, respectively). Seed quality of the lots was determined by germination tests and tetrazolium (TTZ) staining techniques. The seed was acid-delinted prior to treatment.

The preplanting treatments applied to the two seed lots were as follows:

A. Preconditioned by immersion in water at 31 C for 6 hr and dried overnight in ambient air.
B. Preconditioned as in A then chilled in water for 24 hr at 5 C, dried overnight in ambient air.
C. Nonpreconditioned, chilled at 5 C in water 24 hr, and dried overnight in ambient air.
D. Nonpreconditioned, nonchilled (control).

The treatments were timed so that all treatments were planted simultaneously in the field. Seeding rate for treatments with chilling alone was 12 per row foot and for other treatments it was 8 per foot. Plantings were thinned to uniform stand during the fourth week after planting, after stand counts were completed. At this time the plants had reached the second true-leaf stage.

To determine treatment effect under diverse environmental conditions, complete tests were planted on April 28 and May 13. These dates fall within the normal planting period for Stoneville, Mississippi.

The experimental design was a split-split plot, replicated 10 times. Plots consisted of seed lots, first subplots of chilling vs no chilling, and split subplots of preconditioning vs nonpreconditioning. This afforded greatest precision in measuring the effects of preconditioning within the other variables.

The data obtained from the April 28 planting included emergence counts at 7 and 17 days after seeding and final yields. More detailed data were obtained from the May 13 planting, and included emergence counts at 7 and 14 days; surviving plants at season's end; productive plants; total flowers produced; bolls set by July 30th; and yield, as stratified (weekly) harvest of lint and seed. Data on flowering, boll set, and plants surviving at maturity were obtained on four of the 10 replications planted.

RESULTS AND DISCUSSION

Stand counts at 1 and 2 weeks showed no improvement in emergence over the control by either preconditioning or by preconditioning plus chilling of good quality seed. There was some improvement in rate

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[2] Plant Physiologists, Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture, Stoneville, Miss., and Beltsville, Md., respectively.

of emergence of low quality seed induced by preconditioning (Table 1). Protection from chilling injury induced prior to planting was provided by preconditioning in both seed lots. The final stand showed a reduction in normal or productive plants in chilled treatments, although all plots were thinned to a uniform stand when plants reached the second true-leaf stage. This was true of plantings from both good and low quality seed (Table 2).

Total flower production to July 30 was not significantly influenced by any combination of pretreating or chilling of good seed. Plants from the chilled low quality seed produced fewer flowers than other treatments. Flower production, although not significantly reduced, was also lower on plants from the chilled good seed treatment. This, coupled with a significant reduction in total bolls produced to July 30 by plants from chilled treatments of both good and low quality seed, indicated that chilling induced a delay in maturity. Plants from the preconditioned and preconditioned + chilled low quality seed fruited earlier than comparable controls, indicating some improvement in earliness induced by preconditioning.

Total yield was reduced by chilling in both plantings of each seed lot, and protection as indicated by yield data was afforded by preconditioning (Table 2). Performance of the low quality seed plantings indicated an apparent benefit from preconditioning followed by chilling that was more than just protection from chilling injury. Yield differences were more pronounced in the early planting, but were also evident in the May 13 planting. Chilling delayed maturity when applied to either good or low quality seed (Table 3). Preconditioning overcame this effect and, in the treatments with low quality seed, permitted increased earliness over that of the control.

The lower yields induced by chilling treatment applied to imbibing seed are primarily attributable to delayed maturity and a reduced number of normal plants in the stand after thinning. In all chilling treatments of nonpreconditioned seed, the number of abnormal or nonbearing plants was higher. The delayed emergence of many seedlings from chilled seed plantings probably resulted in the high number of unproductive plants, since Wanjura (12) has reported that the seedlings which emerge earlier develop into more productive plants than those emerging later.

Our data show definite advantages for elevating seed moisture to prevent postplanting cold injury to seed. An added factor is the apparent improvement in performance of low quality seed as a result of preconditioning. Much of the presently used cotton planting seed is of mediocre quality (75 to 85% germination) and might be expected to respond to preconditioning in a like manner.

Techniques other than soaking may be used to increase seed moisture. Storage at 95-98% relative humidity at a relatively low temperature of 15 C for 2 weeks is an effective preconditioning treatment in the laboratory. Such treatments may be more feasible for commercial usage, than a seed soaking process.

Table 1. Effect of preconditioning cottonseed prior to imbibitional chilling on seedling emergence.

Treatment	Seeds per 30 cm	No. of emerged plants per 30 cm and % of seeding rate: 7 days No.	7 days %	17 days No.	17 days %	7 days No.	7 days %	14 days No.	14 days %
Seed lot A†		Planted April 28				Planted May 13			
Preconditioned + chilled	8	1.2 a**	15	5 a**	63	5.3 a*	66	5.8 a*	73
Chilled	12	.04 b	.3	1.2 b	10	.8 b	7	2.8 b	23
Preconditioned	8	1.1 a	14	5 a	63	5.3 a	66	5.9 a	74
Control	8	1.2 a	15	5 a	63	4.9 a	61	5.4 a	67
Seed lot B‡									
Preconditioned + chilled	8	1.3 a**	16	4.1 b**	51	4.1 ab*	51	5 a*	63
Chilled	12	.03 c	.25	.5 c	4	1.9 c	16	3.7 b	31
Preconditioned	8	1.6 a	20	4.4 a	55	4.5 a	56	5.4 a	67
Control	8	.9 b	11	4.6 a	57	3.7 b	46	4.9 a	61

*, ** 5 and 1% levels of probability. a, b, c Means for treatments within same seed lot not followed by the same letter are significantly different by Duncan's test.
† Stoneville 213, 90% germination, 100% normal or slightly damaged in TTZ tests.
‡ Stoneville 213, 70% germination, 60% normal or only slightly damaged and 15% nub-root in TTZ test.

Table 2. Effect of preconditioning and chilling treatments of cottonseed on stand and productivity and of preconditioning prior to chilling on yield.

Treatment	Survival stand†	Flowering rate in July§	Bolls from July flowers¶	Seed cotton yield, kg/ha: April 28	May 13
	May 13 planting				
Seed lot A††					
Preconditioned + chilled	77 a**	304 a†	64 a*	2,540 a*	2,612 a*
Chilled	56 b	295 a	47 b	2,181 b	2,328 b
Preconditioned	85 a	337 a	67 a	2,323 ab	2,375 b
Control	80 a	322 a	66 a	2,439 a	2,440 ab
Seed lot B‡‡					
Preconditioned + chilled	78 a**	355 a*	70 a*	2,826 a*	2,541 a*
Chilled	57 b	228 b	44 b	2,008 c	2,266 b
Preconditioned	79 a	343 a	72 a	2,501 b	2,380 ab
Control	73 ab	306 a	49 b	2,426 b	2,322 b
Replications	4	4	4		
Coeff. variability, 1%	11	13	19.4		

†, *, ** 10, 5, and 1% levels of probability. a, b, c Means for treatments within same seed lot not followed by same letter are significantly different by Duncan's test. † Plants per 10 meters, bearing 4 or more bolls per plant at maturity. § Total flowers per 10 meters per 10 days tagged at intervals up to July 31. ¶ Total bolls per 10 meters harvested from flowers tagged in July. †† Stoneville 213, 90% germination, 100% normal or only slightly damaged in TTZ tests. ‡‡ Stoneville 213, 70% germination, 60% normal or only slightly damaged and 15% nub-root in TTZ tests.

Table 3. Percentage of total lint in first harvest (9/30) from planting of preconditioned, preconditioned + chilled, chilled, and nontreated seed.

Seed treatment	Seed lot A*	Seed lot B†
Control	46.9	34.21
Chilled	36.2	29.1
Preconditioned	43.6	46.2
Preconditioned + Chilled	44.4	45.2

* Stoneville 213, 90% germination, 100% normal or only slightly damaged in TTZ tests.
† Stoneville 213, 70% germination, 60% normal or only slightly damaged and 15% nub-root in TTZ tests.

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INFLUENCE OF PHOTOPERIOD AND THERMOPERIOD ON THE IVDMD AND CELL WALL COMPONENTS OF TALL FESCUE[1]

D. W. Allinson[2]

ABSTRACT

'Kenwell' and 'Kentucky 31' tall fescue (*Festuca arundinacea* Schreb.) were grown in chambers under the following conditions: (a) 27/16 C day/night temperature, 16-hour photoperiod, (b) 27/16 C day/night temperature, 10-hour photoperiod, (c) 16/4 C day/night temperature, 16-hour photoperiod, and (d) 16/4 C day/night temperature, 10-hour photoperiod. Two harvests were taken. Both long days and high temperatures significantly ($P<0.01$) lowered the percent *in vitro* dry matter digestibility (IVDMD) and also lowered the percent *in vitro* cellulose digestibility of tall fescue. These changes in digestibility were associated with increased levels of structural cell wall components. In the second harvest Kenwell was significantly greater in percent IVDMD ($P<0.01$) and hemicellulose ($P<0.05$) than Kentucky 31.

Additional index words: **Acid-detergent fiber, Acid-detergent lignin, Hemicellulose, *In vitro* cellulose digestibility.**

THE information available concerning the influence of temperature and photoperiod on forage crop *in vivo* digestibility is, at best, suggestive. Sullivan et al. (1956) noted the structural constituents of eight forage grasses were highest in periods characterized by long daylengths. Buckner et al. (1967), using 'Kenwell' and 'Kentucky 31' tall fescue (*Festuca arundinacea* Schreb.) and two ryegrass × tall fescue hybrids, indicated that structural cell constituents decreased while soluble cell constituents increased in the fall. However, Bowman and Law (1964) using orchardgrass (*Dactylis glomerata* L.) and bromegrass (*Bromus inermis* Leyss.) indicated daylength and percent cellulose to be negatively and significantly correlated. The percent lignin in both grasses increased significantly under an 18-hour photoperiod compared to a 14-hour photoperiod.

Deinum, Van Es, and Van Soest (1968) noted the *in vivo* digestibility of perennial ryegrass (*Lolium perenne* L.) by sheep was slightly improved by increased light intensity and greatly reduced by increased temperature. Similarly, Hight, Sinclair, and Lancaster (1968) reported intake, liveweight gains of sheep, and digestibility were greater for unshaded than for shaded ryegrass herbage while shading reduced the proportion of soluble carbohydrate and increased that of cellulose and lignin.

The influence of temperature on the non-structural carbohydrates of forage crops has been discussed by Eagles (1967), Hamilton, Dermine, and Hidiroglou (1966), and Smith (1969) who concluded that sugars tended to accumulate as temperatures became cooler. Smith (1969) further indicated alfalfa (*Medicago sativa* L.) grown under a cool regime was higher in the concentration of *in vitro* digestible dry matter than alfalfa grown under a warm regime. Contradictory data have been obtained by Bowman and Law (1964) who indicated the percent lignin and cellulose content of orchardgrass and bromegrass was higher when these grasses were grown at 18C rather than 29 C.

This study was initiated to evaluate the influence of temperature and photoperiod on the *in vitro* dry matter digestibility of tall fescue. Much of the data concerned with environmental influences on forage quality have been obtained from field experiments. This is necessary when large quantities of forage are required for standard digestion/intake determinations. However, such data may be criticized on the basis that many factors are unfortunately confounded. The use of *in vitro* techniques and controlled environmental conditions should aid in alleviating such difficulties.

MATERIALS AND METHODS

Kenwell and Kentucky 31 tall fescue were seeded in 1.1 liter cans containing a Woodbridge fine sandy loam soil. Initial soil analyses indicated a pH of 5.5 and P and K values of 2 and 199 kg/ha, respectively. Prior to seeding the equivalent of 6720, 74, 89, and 301 kg/ha of limestone, N, P, and K respectively were incorporated to the soil. The seedlings, 15 per can, were established during a 6-month period in a heated greenhouse. Following establisbment, the plants were cut back to a 1.25 cm stubble, N in the form of ammonium nitrate in solution was added at the rate of 74 kg N/ha, and the cans were placed in growth chambers. The chambers were adjusted for the following conditions: (a) 27/16 C day/night temperature, 16-hour photoperiod (27/16 LD), (b) 27/16 C day/night temperature, 10-hour photoperiod (27/16 SD), (c) 16/4 C day/night temperature, 16-hour photoperiod (16/4 LD), and (d) 16/4 C day/night temperature, 10-hour photoperiod (16/4 SD). The light source was a combination of fluorescent tubes and incandescent lamps. Light intensity at stubble height at the initiation of the growth period was adjusted to 15,000 lux. At the termination of the growth period the light intensity at the canopy surface of the most vigorous plants was 17,200 lux.

Two successive harvests were made. The first harvest was taken after 8 weeks, N applied as before, and the second harvest after an additional 11 weeks. At the time of the first harvest all tissues were in a vegetative stage except for a few tillers at the anthesis stage in the 27/16 LD treatment. At the second harvest a few tillers at the anthesis stage were present in the 16/4 LD treatment. Harvested tissues were dried at 60 C and ground through a 40-mesh screen.

In vitro dry matter digestibility (IVDMD) was determined using the technique of Tilley and Terry (1963). However, fol-

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[2] Assistant Professor, Department of Plant Science.