

TEMPERATURE RESPONSE OF UPLAND COTTON

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Abstract

In the process of selecting for cold-tolerant cotton (genotypes that will eventually germinate, emerge, and grow normally after ultra-early planting), widely divergent responses to temperature were observed. Tests of response to temperature suggest a range of minima for plant growth depending on genotype. Germination occurred over the range tested, 45 to 80 F., at very slow rates at lower temperatures, and varying with genotype. Differences in plant growth response to low temperatures are also reported.

Introduction

With the hypothesis that cotton will grow at 50 degrees F. and above, and that below 50 it will not grow, we decided to test a range of genotypes at temperatures slightly lower than 50. Germination tests at 45 and 47 F. were conducted in search of genotypes that would grow normally below 50. These were followed by tests of 12 lines representing the range of genotypes at 4 temperatures from 47 to 80 degrees. This report has been developed to reflect the evolution of our research, which to date has not provided definitive answers.

Materials and Methods

Materials consisted of diverse genotypes in Seed Source germplasm. For all germination tests methods included testing 25 seed sealed in a Kroger snack bag containing a 2x6½ inch piece of Chempak and 2 tablespoons of tap water. These bags were exposed continuously to the indicated temperatures, except for the brief periods when they were removed for observation and counting. At temperatures below 50 the emergence of a white root tip (see figure 1) was considered the equivalent of germination. At higher temperatures roots ½ inch and longer were counted. All of the 79 entries in current yield tests were exposed to 45 F for 21 days, followed by 8 days at 55 F. Twenty-seven selected lines were exposed to 47 degrees for 30 days. Finally, twelve diverse entries were exposed to 47, 55, 60, and 80 F.

Plant response to low overnight temperatures was observed in 240 yield plots and 187 increase plots on 2 successive days, 44 and 45 days after planting. Plots in which plants remained turgid were noted.

Results and Discussion

Germination

Results will be presented following the chronological order of data collection. Our initial screening was testing at temperatures below 50 Fahrenheit, putative limit of growth for upland cotton. We tested 78 lines, 44 cold tolerant and 34 not cold tolerant, Table 1. Initiation of germination at 45 degrees was indicated by visible white root tips (Figure 1). Forty-six lines showed 0 germination after 21 days at 45 degrees, but only 17 of these totally failed to germinate when transferred to 55 degrees. The percentages visible roots after 21 days at 45 degrees was from 0 to 40; after these seed were moved to 55 degrees and left for 8 days, percentage germination was from 0 to 60, in this case counting only roots at least ½ inch long.

Next step was to select 27 entries that appeared promising in the above test and to move the temperature a little closer to 50. All of these lines produced the diminutive root tips after 30 days at 47 degrees, but there were significant differences in percentages with means from 1.5 to 11 (Table 2). None of these approximated root growth at warm temperatures.

Based on results to date, twelve lines representing the range of all those included in table 1 were selected for tests at 4 temperatures: 80, 60, 55, and 47. When one entry at 80 degrees had reached 100% in 3 days, we chose to use the 3day reading for all entries. Percentages for the twelve entries were from 76 to 100. The one low entry germinated 88% at 60 degrees, so we concluded the 76 was due to chance.

At 60 degrees for 9 days percentages ranged from 68 to 100. Two entries were at 68, with all the rest above 80%. These two might indicate a higher temperature requirement for full germination; both germinated 94% at 80 F.

Table 4 summarizes the temperature interaction which segregates entries 1 and 2, while the remaining 10 appear to represent a range with quantitative differences in temperature response. Our original hypothesis erred on the temperature level and was too simplistic.

Plant Growth

On the cold May nights that seem a part of every year’s weather pattern cotton plants typically lose turgidity of the leaves and appear to be wilted. On two nights in succession with the minimum temperature at or below 50, 240 yield test and 187 increase plots were observed at daybreak and the turgid ones noted. With the number involved and the short window of opportunity available, it is not surprising that of 10 yield test entries, 7 were noted in only 2 of 3 replicates. The best two entries which were in two tests each, scored T in all 6 plots. Over 10 % of the yield test entries, most of which had been previously selected for cold tolerance, were turgid, while under 5% of the broader based increases were.

Summary and Conclusions

1. Some genotypes will initiate germination at temperatures as low as 45 F.
2. At 60 some genotypes’ germination equaled 80 degree results, while others varied in degree of reduction.
3. At 55 germination % varied widely, with some genotypes failing completely.
4. Genotype determines temperature limits, and genotypes vary widely.
5. Plant growth in the field appeared to cease in most genotypes at 50 F., but there were exceptions which retained turgidity.

Table 1. Germination % of Diverse Genotypes.

Frequency	45 degrees 21 days	plus	55 degrees 8 days	12 LINES SELECTED (1-12)
1	8.		60	5
1	0		56	
1	20		48	8
3	0		44	
1	40		40	
2	8		36	6
1	4		36	
1	8		32	3
1	0		32	
1	20		28	
3	0		28	9
1	4		24	
3	0		24	7
1	16		20	
1	4		20	
5	0		20	2
1	0		16	
1	4		12	
2	12		8	
1	8		8	
2	4		8	
3	0		8	
1	8		4	
3	4		4	
3	4		4	
9	0		4	10,11
1	28		0	4
1	12		0	1
1	8		0	
5	4		0	12
17	0		0	

Table 2. Germination of 27 Lines at 47F. for 30 Days.

ENTRY	% GERM AFTER DAYS INDICATED				RANK
	18	21	24	30	
4	1	7.5	10	11	A
24	0.5	0.5	4.5	10.5	AB
22	0	0	4	10	ABC
26	4.8	4.8	7.3	10	ABC
19	2	2	4.5	10	ABC
23	0	0.5	3	9	ABCD
11	2.3	1.9	9.5	8.5	ABCDE
7	5.3	4.9	4	8	ABCDE
8	2	2	5.5	7.5	ABCDEF
10	7.3	6.9	6	7.5	ABCDEF
5	0.3	0.1	5	6	ABCDEF
25	0	0	1	5.5	ABCDEF
27	1.7	3.1	3.8	5.5	ABCDEF
20	0	0	1	5.5	ABCDEF
18	0	0	2	5	ABCDEF
17	0.3	0.1	1.5	5	ABCDEF
6	0.3	0.1	2.5	4.5	BCDEF
3	0.3	0.1	0.5	4	CDEF
15	1	2.5	2.5	3.5	DEF
13	1.5	3.5	3.5	3.5	DEF
9	1.5	1.5	2.5	3	DEF
2	0.3	0.1	0	3	DEF
12	0.3	0.1	1.5	3	DEF
14	0	0	1.5	3	DEF
21	0	0	1	2.5	EF
1	1	2.5	2.5	2.5	EF
16	0	0	0	1.5	F

Table 3. Germination of 12 Lines at 4 Different Temperatures.

Line	Temp.	Days exposure to the specified temperature																	
		3	5	6	7	8	9	10	11	12	13	14	15	16	17	18	21	24	30
1	80	100																	
	60		80		100		100												
	55			50	79	84													
	47														4.8	4.8	7.3	10	
2	80	90																	
	60		34		94		94												
	55				60	70													
	47														1	2.5	2.5	3.5	
4	80	76																	
	60		34		84		88												
	55				2	2		9		66									
	47														6.9	7.3	7.3	7.5	
3	80	90																	
	60		12		84		84												
	55							15		51									
	47														0	0	0	0	
5	80	94																	
	60		0		62		68												
	55				1	1		9		31									
	47														2	2	4.5	10	
6	80	86																	
	60		40		88		92												
	55							1		22									
	47														0.3	0.3	5	6	
7	80	94																	
	60		46		62		68												
	55																		
	47									9					0	0	1	2.5	
8	80	82																	
	60		52		74		82												
	55							3		8									
	47														2	2	4.5	10	
9	80	82																	
	60		48		78		80												
	55				2	2		3		5									
	27														0.1	0.3	0.3	3	
10	80	96																	
	60		40		82		86												
	55									1					0	0	1	5.5	
	47																		
11	80	86																	
	60		16		80		84												
	55									1									
	47														0.1	0.3	0.3	3	
12	80	85																	
	60		46		80		88												
	55									0									
	47														0.1	0.3	0.5	4	

Table 4. Genotype x Temperature Interaction.

Days	3	9	8	12
Temp.	80	60	55	55
Entry	Percent		Germination	
1.	100	100	84	
2.	90	94	70	
4.	76	88	66	
3.	90	84	51	
5.	94	68	31	
6.	86	92	22	
7.	94	68	9	
8.	82	82	8	
9	82	80	5	
10	96	88	1	
11	86	84	1	
12	85	88	0	

Table 5. Turgid rows observed with overnight low near 50 F.

SOURCE	YIELD TEST PLOTS		SOURCE	INCREASE PLOTS	
	TOTAL	TURGID		TOTAL	TURGID
11-DK	6	6	1SM406	1	1
1SM301	6	6	1SM444	1	1
1SM210	3	3	1SM449	1	1
1SM104	3	2	1SM307	1	1
1SM159	3	2	1SM36-1	1	1
1SM111	3	2	1SM47-4	1	1
1SM272	3	2	1SM209-2	1	1
1SM450	3	2	1SM209-112	1	1
1SM-38	3	2			
OSM206	3	2			
ENTRIES	77			187	
TURGID		10			8

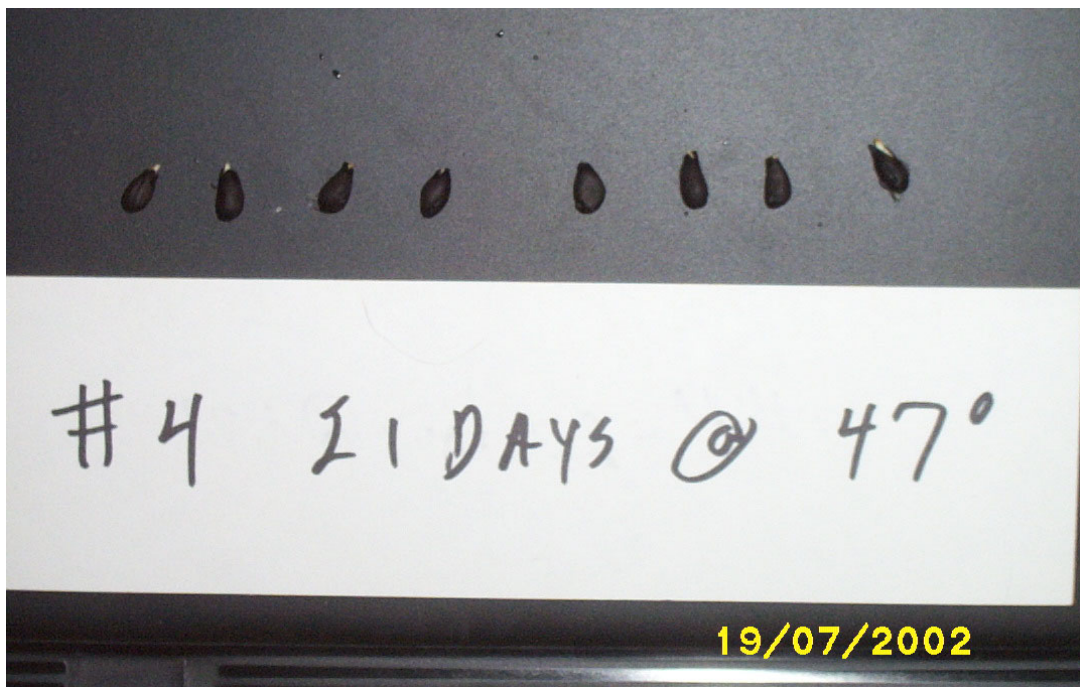


Figure 1. Root tips emerging after continuous exposure to 47 degrees Fahrenheit.



Figure 2. Typically wilted plants above and turgid plants below in early morning at 48 degrees F.