DEVELOPMENT OF A LABORATORY SCREENING TEST FOR THE EVALUATION OF COLD TOLERANCE IN COTTON SEED GERMINATION

B. Duesterhaus, [1] N. Hopper ,[1,2]
J. Gannaway[2] and G.M. Jividen[3]
[1]Texas Tech University
Lubbock, TX
[2]Texas Agricultural Experiment Station
Lubbock, TX
[3]Cotton Incorporated
Raleigh, NC

Abstract

The objective of this study was to develop a test to determine metabolic and imbibitional cold tolerance of cotton (Gossypium hirsutum L.) seed genotypes. Metabolic cold tolerance was determined by planting cotton seed in a sand media, exposing the seed to a constant temperature of 18^{O}C for 21 days, and then counting and adjusting emergence percent for viable seed by dividing the emergence by the warm germination percent. Imbibiitonal cold tolerance was determined by chilling the seed in rolled foam pads at 5^{O}C for six hours, planting the seed in a sand media, exposing the seed to a constant temperature of 30^{O}C for 14 days, and then counting and adjusting emergence for viable seed by dividing emergence by warm germination percent. Varieties whose imbibitional and metabolic emergence percents were both above 80% ranked as having excellent cold tolerance. If both emergence percents were from 70% - 80%, the variety ranked as having good cold tolerance. Varieties that had both imbibitional and metabolic emergence percents between 50% and 70% had fair cold tolerance, and if either emergence percent was below 50%, the variety had poor cold tolerance.

Introduction

Cotton (Gossypium hirsutum L.) development and production depends on many environmental factors. One important determinant is temperature, especially at planting. Cool temperatures, those below 20^{O}C, may cause chilling injury to seedlings and reduce stand establishment (1). Therefore, varieties with enhanced cold tolerance are desired. Currently, breeders plant new lines in field trials early in the season to help determine their cold tolerance. In many years, environmental conditions do not allow for proper evaluation because cool planting temperatures are difficult to predict. Therefore, a laboratory method to determine cold tolerance is needed. The objective of this study was to develop a laboratory method to determine a variety's overall cold tolerance by evaluating its cold tolerance to both metabolic and imbibitional chilling. In addition, this study evaluated the performance of twenty common varieties grown on the Texas High Plains using this test.

Materials and Methods

Metabolic Chill Test

Three 50 seed replications of each variety were planted in plastic boxes (20 x 33 x 8 cm) on top of 3.8 cm (1.5 in) of sterile sand previously wetted to field capacity. The seed were covered with 2.5 cm (1 in) of dry sand and placed in a chamber at a constant temperature of 18^{O}C for 21 days. After 21 days, the Establishment Percent – Metabolic was calculated for each variety.

Imbibitional Chill Test

From each variety, 150+ seeds were spread on and subsequently rolled in a polyurethane foam pad (34 x 42 x 1 cm). The pads were placed inside plastic tubes (33.5 cm long x 5 cm diameter) and soaked with 750 ml of 5^{O}C water. The tubes were drained of excess water and placed in a 5^{O}C chamber for six hours. After six hours, the seed were divided into three 50 seed replications and planted in sand using the same procedure as described above. The planted seed were then exposed in a chamber to a constant temperature of 30^{O}C for 14 days. After the 14 days, the Establishment Percent – Imbibitional was calculated for each variety.

Warm Germination Correction Factor

A standard warm germination test was conducted on the 20 varieties using four replications of 50 seeds each. The seeds were placed on wetted germination towels, rolled and placed into a germination chamber. Temperatures alternated between 30^{O}C for eight hours and 20^{O}C for 16 hours. After 10 days, seedlings with normal radicles 3.8 cm in length were counted to determine the percent germination. Each variety's 10 day percent germination was divided into the corresponding variety's Emergence Percent – Metabolic and Emergence Percent – Imbibitional from the previous tests. This allowed the cold tolerance ratings to be determined only on actual viable seed. These corrected values are used to determine the cold tolerance rating.

Imbibition

Ten grams of seed for each variety were distributed on the foam pads as described above. The foam pads were rolled, placed in the plastic tubes, and soaked with 750 ml of 5^{O}C water. The tubes were drained of excess water and placed in a chamber at 5^{O}C for six hours. After six hours, the seed were removed from the pad, air dried, and weighed again to determine the weight gain due to water imbibition. The moisture percentage is reported as the percent weight gain. The procedure was replicated three times.

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Results and Discussion

From the Emergence Percent-Metabolic and Emergence Percent- Imbibition of the 20 varieties from the two chilling tests, a two way plot was produced (Fig. 1). This graph indicates how each variety performed in each test with the x-axis representing the variety's emergence in the imbibitional chill test and the y-axis representing the variety's emergence in the metabolic chill test. The higher the value on each axis indicates higher levels of cold tolerance to that chilling test. Overall cold tolerance for a variety can be determined by plotting the Emergence Percentages of both tests. Varieties with Emergence Percents from both tests 80 or above were classified as having excellent overall cold tolerance. Those with both Emergence Percents between 70 and 80 ranked as having good overall cold tolerance. If both Emergence Percents were between 50 and 70, a variety had a fair overall cold tolerance. A poor ranking was given to varieties that had either or both Emergence Percents below 50.

Emergence Percents for each variety from the metabolic and imbibition chill test were regressed on the corresponding variety's percent moisture increase after six hours of imbibition. This was to note if the imbibition rate was related to either type of chilling tolerance. The regression of Imbibitional Emergence Percent with Imbibition (Fig. 2) was significant with an R^2 of 0.40. This suggests that 40% of a variety's imbibitional chilling tolerance can be explained by imbibition rate. The regression of Metabolic Emergence Percent with Imbibition (Fig. 3) was not significant and had an R^2 value of 0.17. This suggests that only 17% of a variety's metabolic chilling tolerance can be explained by its imbibition rate.

The twenty varieties used in this study were evaluated using this test. The test values and rating for each variety may be noted in Table 1.

Acknowledgements

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References

Cole, D.F. and J.E Wheeler. 1974. Effect of pregermination treatments on germination and growth of cottonseed at suboptimal temperatures. Crop Sci. 14:451-454.

Entries

Altex Atlas	Holland 186
Stoneville BG 4740	JH 126
AFD 2525	NuCotton 33b
DP 50	PM 2200RR
DP 2156	PM 2326 RR
DP 2379	AFD Rocket
DP 5415	Stoneville 239
DP 5690	Suregrow 125
AFD Explorer	Tejas
Altex Express	Ute

Table 1

Variety	EP Met.	EP Imb.	Rank
1	81.4	83.3	Excellent
2	81.0	82.5	Excellent
3	80.3	78.1	Good
4	75.9	82.3	Good
5	73.7	86.9	Good
6	73.4	81.3	Good
7	71.6	75.2	Good
8	71.4	78.0	Good
9	70.7	86.9	Good
10	69.7	75.7	Good
11	68.8	84.2	Fair
12	67.7	76.8	Fair
13	61.9	85.5	Fair
14	61.1	88.4	Fair
15	60.3	72.3	Fair
16	54.6	80.1	Fair
17	53.6	74.0	Fair
18	43.9	60.7	Poor
19	41.8	12.4	Poor
20	17.8	33.8	Poor

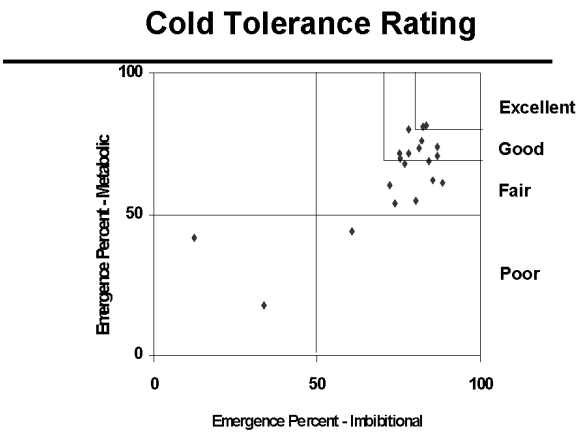

Figure 1

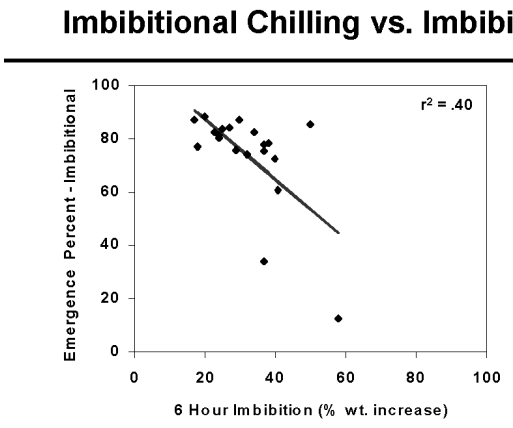

Figure 2

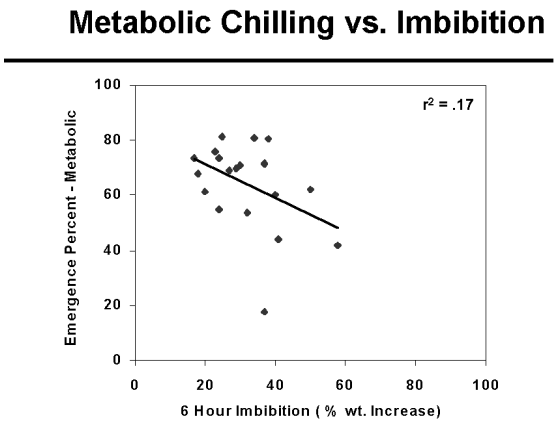

Figure 3