# LABORATORY SIMULATION OF COTTON MODULES

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## Abstract

Two methods of exploring cotton module behavior under laboratory conditions have been examined. These two methods have been employed to test the ability of an enzyme preparation to ameliorate the sticky nature of seedcotton contaminated with honeydew secreted by *Bemisia argentifolii*. One method utilized plastic buckets packed with seedcotton to the density of a cotton module. The second method employed 4 X 4 X 4' boxes of seedcotton. Both methods provide a possible alternative to utilization of entire modules for experimentation.

## Introduction

Cotton modules represent a major step following field harvest and the cotton processing continuum to the textile mill (Roberts et al., 1996). Cotton module experimentation has been difficult under laboratory conditions. A number of studies have followed the thermal behavior of modules in the field which contained seedcotton with various moisture contents (Colwick, 1972; Curley, 1990). However, using full-sized modules as an experimental unit demands a commitment to a considerable amount of seedcotton to achieve the replication required for statistical significance in experimentation. In addition, modules are only available in the field for experimentation for a short period each season. To overcome these problems, two systems have been designed to allow investigators to study some of the dynamics of seedcotton in modules under laboratory conditions.

Stickiness caused by excreta from phloem-feeding insects (honeydew) is a major problem in many cotton-growing regions around the world (Hendrix et al., 1995, 1996; Henneberry et al., 1996). Since about 1987, cotton fiber grown in the irrigated regions of the southwestern United States has been subject to infestations of the silverleaf whitefly, *Bemisia argentifolii*, Bellows and Perring, leading to honeydew-contaminated cotton lint. This honeydew sticks to machinery in both cotton gins and textile mills, slowing or preventing the fiber's processing. To overcome this problem, an experimental enzyme preparation from Genentech Corporation (Elkhart, IN) has been tested and in small-scale experiments appeared to be a promising means of reducing lint stickiness. The following exper-imentation represents two attempts to scale up these experiments from the laboratory bench to module application of the enzyme to honeydew-contaminated seedcotton.

## Materials and Methods

Two systems were utilized in these experiments. The first, referred to as the micromodule experimentation, employed 3.5 gal (0.55 $ft^3$) plastic buckets as experimental containers. Approximately 6.5 lb seedcotton was sprayed with various enzyme dilutions by arranging them on a concrete floor at about one locule thickness and spraying the solution over the seedcotton array. These sprays consisted of aqueous solutions of either 1 or 3% enzyme and 0.5% Triton X100. This mixture was pumped through a Conjet TXVS-3 nozzle at 60 psi (0.05 gal $min^{-1}$). After spraying half the calculated volume of liquid, the cotton was turned over and the rest of the liquid was applied. Buckets were packed with the sprayed seedcotton to a density equivalent to that in modules (12 lb $ft^3$) by compression supplied by an automobile jack. Following packing, lids were placed on these buckets and a T-type thermocouple (Omega 20 awg type T twisted/shielded cable with integral drain wire) inserted in the middle of the seedcotton during packing. The packed buckets were then placed inside household refrigerators which contained a 250 watt heat lamp as a heat source and an identical thermocouple to measure the air temperature inside the chamber. These thermocouples were connected to a computer interface board (National Instruments AT-MIO-16D) and multiplexer (National Instruments AMVX-64T) and their output utilized by a computer program (LabView Graphical Programming ver. 3.1.1) operated on a personal computer (486 DX66 with 32 Mb RAM) which controlled the heating inside the chamber. This computer program maintained the temperature inside the chamber the same as inside the bucket of seedcotton. Care had to be taken in designing this program to avoid 'thermal runaway.' This was prevented by designing into the computer program criteria for decision making in which changes in incubator temperature were only made after consideration of a number of container vs. chamber temperatures. At weekly intervals, buckets were opened and the seedcotton tested for water content by ASTM method D 2495-87 and stickiness by the thermodetector test (Brushwood and Perkins, 1993).

The second laboratory-scale module experiment involved the use of seedcotton packed into 4 X 4 X 4 ft plastic-lined boxes of 1/2 in CDX plywood reinforced with 2 X 4 boards. Seedcotton was sprayed with various enzyme dilutions as it emerged from a small (16 in) ginstand feeder which was utilized to produce a relatively uniform bat of seedcotton. Spraying was accomplished with an array of six nozzles (type TX1, TX2 or TX3 for low, medium and high moisture, respectively) through which enzyme solution was

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pumped at 60 psi. Treated seedcotton was then transported to the boxes by means of a conveyor belt and compressed to the approximate density of a module by means of a ram consisting of a heavy metal plate mounted on a front loader of a farm tractor. T-type thermocouples identical to those used with the micromodules were inserted into the boxes during packing. Leads from these thermocouples were led to a Campbell model 21X data logger (with multiplexer) which was downloaded periodically using a portable computer. Samples were removed from the packed boxes weekly and tested for stickiness, extractable reducing sugar content and fiber quality.

## Results and Discussion

An experiment was designed to test whether the computer program used in the micromodule experiments to control the temperature inside the incubators would work without thermal runaway or overshoot. In this preliminary experiment, a program of temperatures was fed into the computer in place of the thermocouple inside the micromodules and the computer's response monitored as the incubators temperature with time. In this test, the sensing and controlling software behaved as desired, and no thermal overshoot or runaway was observed (Fig. 1). An experiment was then conducted with sticky seedcotton which had been sprayed with various concentrations of water and enzyme and packed into minimodules. This particular batch of seedcotton rated a score of 32 (very sticky) on the thermodetector rating scale prior to this experiment (Brushwood and Perkins, 1993). The temperature of the incubators holding minimodules packed with seedcotton which had no water added maintained room temperature (Fig. 2), whereas those sprayed to 14% water heated markedly (Fig. 3). The result of analyses of the stickiness of these cotton samples is shown in Table 1. Those samples treated by spraying to 14% water content had their stickiness reduced from a thermodetector reading of 32 (very sticky) to less than 10 (not sticky). Note that all cotton harvested on post treatment day 0 (day of application) were exposed to the various treatments for ca. 5 h prior to drying. Cotton in buckets sprayed to 12% water content exhibited a lessened reduction in stickiness. An unexplained result in this experiment was the lowering of stickiness in control buckets which had no water added.

The 4 X 4 modules which were sprayed to a low water content (ca. 8%) did not heat much above ambient (Fig. 4); however, those sprayed to a high water content (ca. 14%) heated well above ambient (Fig. 5) but quite a bit less than that of entire modules of equivalent water content (Curley et al., 1988). The thermodetector readings of these samples showed that after three weeks the stickiness of cotton sprayed to ca. 8% water was reduced very little if enzyme was not included in the spray, but significantly (to under a reading of 10, indicating not sticky) if either 1 or 3% enzyme was a part of the spray mixture (Table 2). This pattern did not hold for seedcotton in those boxes sprayed to ca. 12% water content. However, for all enzyme treatments of cotton sprayed to the highest water content (ca. 14%) a significant reduction in stickiness was observed after 21 days of incubation.

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Experiment Stations of South Carolina, Mississippi and Texas. pp. 66-77.

Table 1. Stickiness of treated seedcotton determined by Thermodetector[a/]

| Treatment | | Week 1 | Week 3 | Week 5 |
|---|---|---|---|---|
| Water | Enzyme | | | |
| 0% | 0% | 8.5 | 19.8 | 15.8 |
| 12 | 0 | 9.5 | 7.3 | 11.8 |
| 12 | 1 | 13.0 | 12.5 | 11.5 |
| 12 | 3 | 17.3 | 10.8 | 8.3 |
| 14 | 0 | 10.3 | 7.0 | 1.5 |
| 14 | 1 | 14.0 | 7.3 | 6.6 |
| 14 | 3 | 11.8 | 2.0 | 4.3 |

[a/]Stickiness of all cotton at week zero was 32 on thermodetector scale

Table 2. Moisture percentages[a/] and stickiness ratings in control, water, or water plus enzyme B treated seed cotton. Samples from mini-modules.

| | Seed Cotton Moisture % on | | Thermodetector Counts on | |
|---|---|---|---|---|
| Moisture level/ ml enz.[b/] /lb. | PostTreatment Day 0 | 21 | Post Treatment Day[c/] 0 | 21 |
| Control | | | | |
| 0.00 | 4.95 | 4.92 | 27.2 | 23.4 |
| Low | | | | |
| 0.00 | 7.81 | 6.78 | 25.1 | 20.8 |
| 0.30 | 8.64 | 7.66 | 13.4 | 5.2 |
| 0.75 | 8.95 | 7.52 | 16.3 | 8.9 |
| Medium | | | | |
| 0.00 | 11.78 | 10.59 | 18.6 | 20.3 |
| 0.32 | 12.22 | 10.22 | 22.8 | 18.3 |
| 0.91 | 12.06 | 10.66 | 20.7 | 23.9 |
| High | | | | |
| 0.00 | 13.95 | 12.55 | 21.2 | 4.7 |
| 0.31 | 15.62 | 13.35 | 19.9 | 0.0 |
| 0.86 | 15.83 | 13.56 | 14.6 | 10.3 |

[a/] Mean moisture content for all pre-treatment samples was 5.27 with a range of 4.63 to 6.20.

[b/] Calculated on basis of seed cotton moisture increase.

[c/] Post treatment 0 = day of enzyme application.

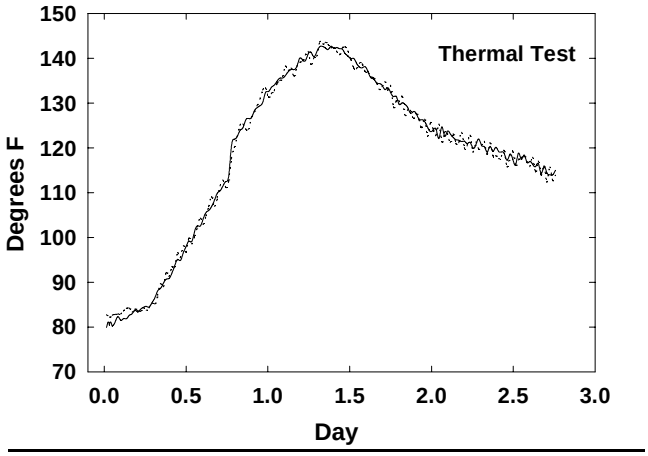


Figure 1. Test of responsiveness of the incubator response circuitry in the minimodule experiments. Solid line = temperature program input into circuitry, dashed line = response of the incubator temperature.

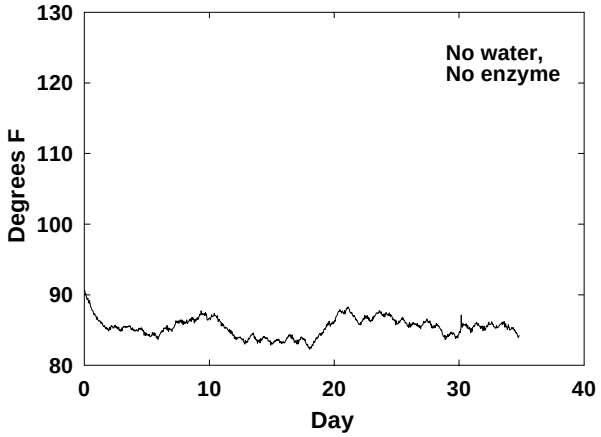


Figure 2. Incubator response in minimodule experiment involving seedcotton which was not sprayed.

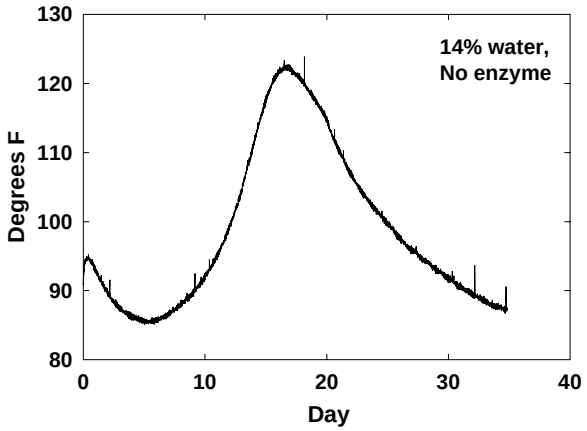


Figure 3. Incubator response in minimodule experiment involving seedcotton sprayed with water to 14% water content.

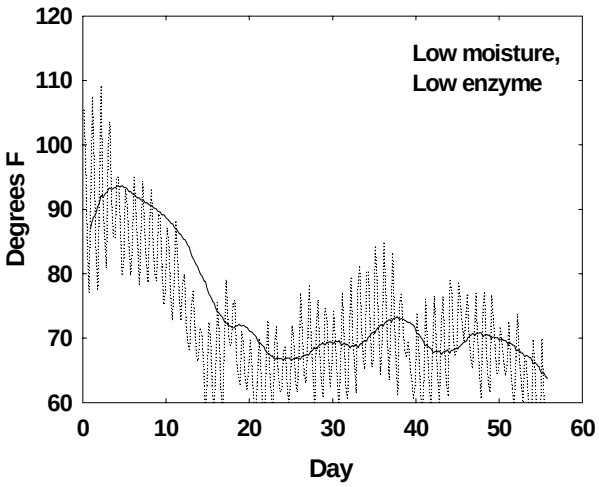


Figure 4. Temperature of 4 X 4 module sprayed to 8% water content with a mixture consisting of 1% enzyme and 0.5% Triton X100. Dashed line represents ambient temperature, solid line represents temperature of module determined with a T-type thermocouple.

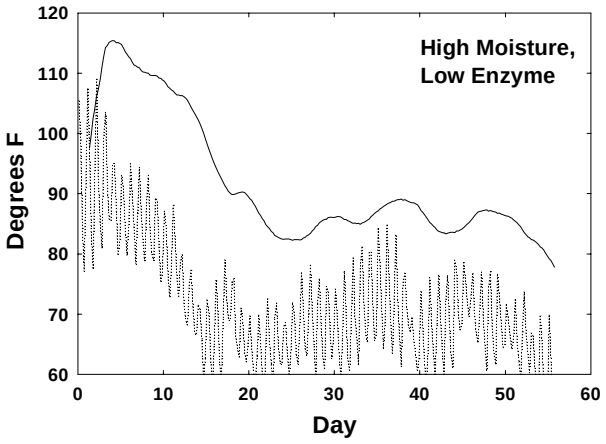


Figure 5.. Temperature of 4 X 4 module sprayed to 14% water content with a mixture consisting of 1% enzyme and 0.5% Triton X100. Dashed line represents ambient temperature, solid line represents temperature of module determined with a T-type thermocouple.