

THERMAL THRESHOLD AND TEMPERATURE ACCUMULATION FOR THE COTTON BOLLWORM

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ABSTRACT

The temperature response of the cotton bollworm, *Heliothis zea* (Boddie), was studied at constant temperatures of 75°F and 65°F. The temperature threshold for development was found to be 54.7° and the thermal requirements necessary for development through the egg, larval and pupal stage up to the average time for 75% moth emergence was 691.00 day-degrees above the temperature threshold.

INTRODUCTION

The life history of the cotton bollworm, *Heliothis zea* (Boddie), has been known for some time (Garman and Jewett, 1914; Ditman and Cory, 1931) but none of these investigators utilized the theories of thermal constants to characterize growth. To obtain information on the temperature threshold and temperature accumulation for the cotton bollworm, studies were conducted at 2 constant temperatures, i.e., 75±0.5°F and 65±0.5°F.

MATERIALS AND METHODS

The cotton bollworm moths employed to initiate the laboratory culture were derived from a natural population occurring near Urbana, Illinois. Fifteen field collected moths were confined in an oviposition cage described for the black cutworm (Mangat, 1970). Strips of cheesecloth were placed inside the cage, and these served as a surface for oviposition. Eggs of comparable age were obtained by exposing these strips for only 2 hours. The eggs were disinfected by soaking for 5 minutes in a freshly prepared 0.15% sodium hypochlorite solution and washed with sterile distilled water. Newly laid eggs were transferred with a sterilized brush to a rearing vial (95x25mm) containing the rearing medium (Mangat, 1970). There was only one egg per vial. These vials were exposed to two test conditions. The test conditions were 2 constant-temperature cabinets operating at 75±0.5°F and 65±0.5°F. These vials were examined 2 times daily for the appearance of adult moths. The average number of days required by cotton bollworm to attain 75% moth emergence at the two constant temperatures is presented in Table 1.

RESULTS

The data indicate that 34.1 days at a temperature of 75°F were necessary for the development of this species

from newly laid egg to 75% moth emergence, while at a temperature of 65°F, 67.2 days were required. Using the data from the constant temperature cabinet study, a table (Table 2) was constructed showing the number of day-degrees which must accrue at various temperature thresholds for comparable development. Rearing the cotton bollworm at 75°F., for example, shows 852.5 day-degrees would have accumulated if 50°F. were the temperature threshold for development, while a total of 1008 would have accumulated in the 65°F. cabinet culture if the same temperature threshold was used. These data (the day-degrees corresponding to various base lines) are plotted graphically in Figure 1. The point of intersection represents the best estimate of the thermal threshold and temperature accumulation necessary from egg to adult development.

TABLE 1: Development of cotton bollworm from newly laid eggs to moth emergence at two constant temperatures.

Temperature (°F)	Individuals Reaching Moth Stage	Average Days to 75 percent Moth Emergence	Standard Deviation of Mean
75	60	34.1	±1.2 Days
65	45	67.2	±2.1 Days

The straight line for development in the 75°F. incubator is expressed by the equation

$$y = 74.99 - 0.0294x \quad (1)$$

TABLE 2: The number of day-degrees (DD) necessary from the egg to adult development of *H. zea* (Boddie) using hypothetical temperature thresholds below rearing temperatures of 75°F. and 65°F.

Temperature Thresholds	75°F. (34.1 Days) DD	65°F. (67.2 Days) DD
48	920.7	1142.4
49	886.6	1075.2
50	852.5	1008.0
51	818.4	940.8
52	784.3	873.6
53	750.2	806.4
54	716.1	739.2
55	682.0	672.0
56	647.9	604.8
57	613.8	537.6

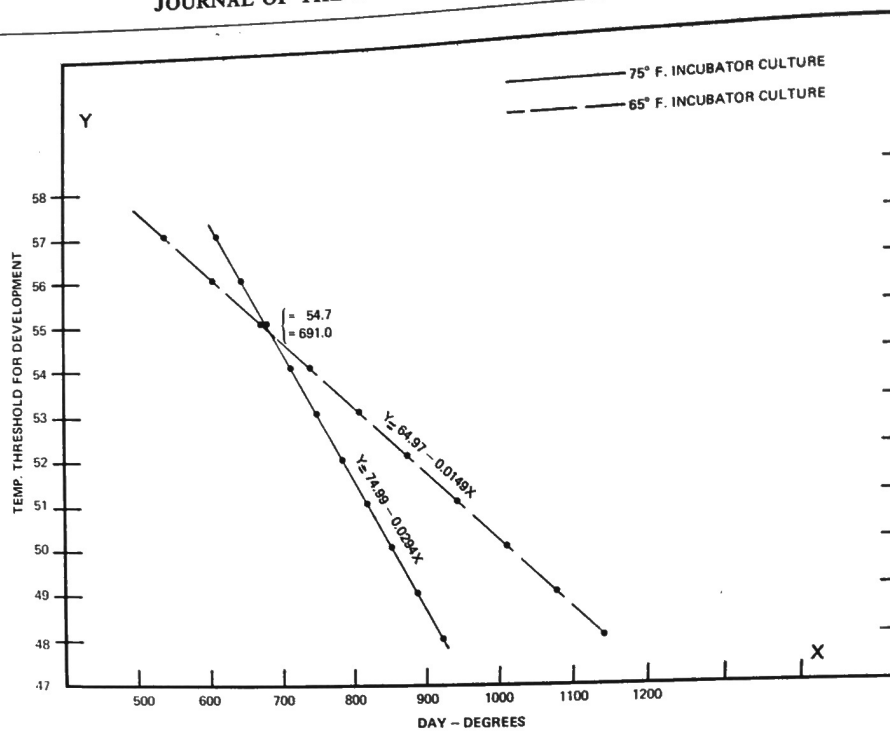


FIG. 1: Day-Degrees accumulating in 75°F. and 65°F. incubator cultures of cotton bollworm at various temperature thresholds for development.

The straight line for development in the 75° F incubator is expressed by the equation $y = 74.99 - 0.0294x$. In equation (1), "y" is the threshold temperature; 74.99 is the y intercept; $- 0.0294$ is the slope of the line and "x" equals the day degrees.

The equation of the straight line for the culture at 65°F. is

$$y = 64.97 - 0.0149x \quad (2)$$

The simultaneous solution of (1) and (2) gives "y" (the threshold temperature for development) equal to 54.7°F. and "x" (the day-degrees necessary for development) equal to 691.0. It is recognized that the

true threshold temperature is undoubtedly below 54.7° because of the disproportionate contribution of lower temperatures to growth. Also, ambient outdoor temperature might produce a somewhat different response than that recorded at constant temperatures.

LITERATURE CITED

- Ditman, L. P. and E. N. Cory. 1931. The corn earworm: Biology and Control. Md. Agr. Exp. Sta. Bull. 328:443-482.
- Garman, H. and H. H. Jewett. 1914. The Life History and Habits of the Corn Earworm, *Chloridea obsoleta*. Ky. Agr. Exp. Sta. Bull. 187:513-591.
- Mangat, Baldev S. 1970. Rearing the Black Cutworm in the Laboratory. J. Econ. Entomol. 63:1325-26.

THE QUESTION OF LIFE ON MARS STILL UNCLEAR

Even though the two Viking mission to Mars have been extraordinarily successful with a total of 13 different types of scientific investigations completed, the question of life on the planet remains unanswered. The Viking spacecraft are designed to continue the orbiting and landing mission for at least one complete Mars year.