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FLIGHT REACTION OF THE PINK BOLLWORM, **Pectinophora gossypiella** (Saunders)), TO THE TEMPERATURE AND LIGHT INTENSITY *

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The attraction to light is an often--observed behavior of night flying moths, this phenomenon is not well understood yet [Bennet (1)]. Insects often orient toward a light source by maintaining a constant angle to the light source [Wigglesworth (17)]. Mazokhin-Porshnyakov (14) points out that this behavior is a breakdown of a natural mechanism. Field-dwelling insects initially fly towards artificial light sources because light is an indication of open space; but as the insects converge upon the source, the increasing brightness decreases the insect's sensitivity to the point where only the light source can be seen, they become 'dazzled' and irresistibly attracted to the light [Robinson and Robinson (15)]. Blue light is the most attractive, followed in order by white, yellow, and red [Gui et al (8)].

Pink Bollworm moths, *P. gossypiella* (Saunders) are more active on the dark, and flight activity from 1 to 4AM, when light intensity is below 0.02 foot-candle is greater than any other time of the day [Squire (16), Glick and Eitel (7)]. Laidlaw (12) states that the visible radiation from the source is being confused with some other invisible stimulus. Callahan (3) expands this theory by proposing that structures on the antennae act as dielectric rods which receive electromagnetic radiation in the visible and infra--red regions of the spectrum. These structures could possibly function as the detector mechanism for such behavioral stimuli as light, temperature, and chemical sex attractants [Callahan (2)].

The rise of temperature that is normally associated with muscular activity is particularly evident in the pterothorax of alate insects where the flight muscles are located [Dorsett (5)]. The need for a preliminary warming period suggests that the power that can be produced by the flight muscles at the normal environmental temperatures is insufficient to raise the insect from the ground or sustain it in controlled flight [Jensen (9), Kammer (10)].

Our study attempts to asses the significance of the light and temperature on the flight activity of Pink Bollworm, *P. gossypiella* (Saunders).

MATERIAL AND METHODS

Pink Bollworm moths, *P. gossypiella* (Saunders) from Cotton Research Laboratory on Campbell Farm, Tucson, Arizona, were used in the experiment. The moths were anesthetized with carbon dioxide and trans-

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fered to small plastic cups measuring 50mm top diameter and 55mm in height approximately. Two moths were placed into each cup and a total of nine small cups were maintained at constant light, supplied by a 25-watt fluorescent lamp. After this, two moths were transfered to a screened cage measuring 20.5X20.0X31.0cm and containing paper towel simulating cotton leaves. The cage with the moths, was transfered to a Environator Chamber at half maximum illumination and 29°C (the highest temperature during the test). The temperature was controlled and the range of variation was: 29°C to 17°C during thirty minutes. The activity of the moths was observed through a glass window on the Environator, and this procedure was replicated three times.

For the light test, a plywood cage measuring 60.0X65.0X70.0cm was used. The front part of the cage was covered by a black plastic. Two moths from the small plastic cups were placed (free) on the bottom of the cage and a 100-watt incandescent lamp, placed 30cm above the bottom was used as light source. The light intensity was controlled by a Powerstat and the range of variation was: 50 to 0 foot-candle during thirty minutes. Measures of light intensity were recorded by a exposure meter (GE, type DW — 68) located on the bottom of the cage. Moth activity was observed through a hole, 5mm in diameter, made on the black plastic. This test was replicated six times. All the experiments were conducted at night, that is, from 7 to 10PM.

RESULTS

Positive reaction for temperature and light tests were considered when Pink Bollworm moths, *P. gossypiella* (Saund). took flight, on the other hand, negative reaction for no flight activity.

Results of flight reactions to the fluctuating temperatures, are shown on Table I; only one moth was able to fly.

TABLE II shows: means, sum of squares, and variances for the two moth populations under fluctuating temperatures. These parameters are essentials on the determination of the Student's "t" test [Cochran (4)].

Common statistical parameters for positive and negative reactions to the fluctuating temperatures, such as: mean difference (d), weighted average (S_p^2), standard deviation ($S_{\bar{d}}$), Student's "t" calculated and "t" tabulated are shown on Table III. Two-tailed

TABLE I

Flight Reactions of the Pink Bollworm, *Pectinophora gossypiella* (Saunders) to the Fluctuating Temperatures (1), Tucson, Arizona, 1971.

Positive reactions	Negative reactions
0.000	2.000
1.000	1.000
0.000	0.000

(1) — Temperatures fluctuated from 29°C to 17°C.

TABLE II

Statistical Parameters for Positive and Negative Flight Reactions of Pink Bollworm, *Pectinophora gossypiella* (Saunders) to the Fluctuating Temperatures, Tucson, Arizona, 1971.

PARAMETERS					
Positive reaction			Negative reaction		
Mean	Sum of squares	Variance	Mean	Sum of squares	Variance
0.330	0.670	0.335	1.660	0.670	0.335

TABLE III

Common Statistical Parameters for Positive and Negative Flight Reactions of Pink Bollworm, *Pectionophora gossypiella* (Saunders) to the Fluctuating Temperatures. Tucson, Arizona, 1971.

PARAMETERS				
Mean difference $(\overline{d})$	Weighted average (S_p^2)	Standard deviation $(S_{\overline{d}})$	Student's "t" calculated	Student's "t" tabulated (2)
1.330	0.335	0.470	2.820	2.776

(2) — Four degrees of freedom, 0.05 level, and two-tailed test.

test and 90% confidence interval, that is, 0.05 level in each tail of the "t" distribution are common in biological experiments [Cochran (4)]. The degrees of freedom were deducted from: 2n — 2, that is, 2 x 3 — 2 = 4.
The results of Table III were summarized on Diagram 1 that shows a "t" distribution curve (see Appendix).

Results of flight reactions to the light intensity are shown on Table IV; five moths exhibited positive flight response. Common statistical parameters for positive and negative reactions to the light intensity are shown on Table VI.

TABLE IV

Flight Reactions of Pink Bollworm, *Pectinophora gossypiella* (Saunders) at Light Intensity below three foot-candle Tucson, Arizona, 1971.

Positive reactions	Negative reactions
0.000	2.000
0.000	2.000
1.000	1.000
1.000	1.000
1.000	1.000
2.000	0.000

DISCUSSION

Based on the data of Table I, only one moth responded positively and five moths adversely; this positive reaction was observed at 20°C. According to Table III, "t" calculated was greater than "t" tabulated, so, there is evidence that temperature did not play any role on the stimulation of flight in this experiment; "t" calculated fell beyond the acceptance region (Diagram 1). Probably the time that the moths were under high temperature limits (29°C) was not sufficient to promote discharges of impulses from the corresponding ganglion to the flight muscles on the pterothorax [Krogh and Zeuthen (11)].

According to Table IV, five moths took flight and seven did not present

TABLE V

Statistical Parameters for Positive and Negative Flight Reactions of Pink Bollworm, *Pectinophora gossypiella* (Saunders) at Light Intensity below three foot-candle, Tucson, Arizona, 1971.

PARAMETERS					
Positive reaction			Negative reaction		
Mean	Sum of squares	Variance	Mean	Sum of squares	Variance
0.833	2.834	0.566	1.166	2.834	0.566

TABLE VI

Common Statistical Parameters for Positive and Negative Flight Reactions of Pink Bollworm, *Pectinophora gossypiella* (Saunders) at Light Intensity below three foot-candle, Tucson, Arizona, 1971.

PARAMETERS				
Mean difference ($\bar{d}$)	Weighted average ($S^2_{\bar{d}}$)	Standard deviation ($S_{\bar{d}}$)	Student's "t" calcutated	Student's "t" tabulated (3)
0.333	0.067	0.320	1.043	2.228

(3) — Ten degrees of freedom, 0.05 level, and two-tailed test.

any flight reaction. Positive responses were observed below three foot-candle of light intensity. Lukefahr and Griffin (13), found that Pink Bollworm moths, *P. gossypiella* (Saunders) are able to start positive flight reaction when light intensity is below three foot-candle. Statistically there was not difference in positive and negative flight reactions caused by the light intensity. This could be explained by the fact that stimulation for flight in Pink Bollworm moths are more associated to the quality of light of the electromagnetic spectra than its intensity [Glick and Hollingsworth (6), Glick and Eitel (7)].

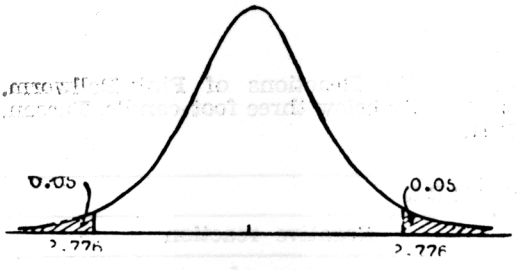
SUMMARY

Flight reaction of the Pink Bollworm moths, *Pectinophora gossypiella* (Saunders) to the temperature and light intensity were studied. Fluctuating temperature from 29°C to 17°C, failed to achieve any flight response. One the other hand, levels of light intensity below three foot-candle (*) may induce a positive flight response. Statistical interpretation was included.

(*) Foot-candle: the illumination on a surface at 30.48 cm distance from one standard candle [Gui et al (8)].

Diagram 1. Student's t-curve for flight reactions of Pink Bollworm, *Pectinophora gossypiella* (Saunders) to the fluctuating temperatures, Tucson, Arizona, 1971.

— t values equal or less than minus 2.776, and equal or greater than 2.776 are criticals.

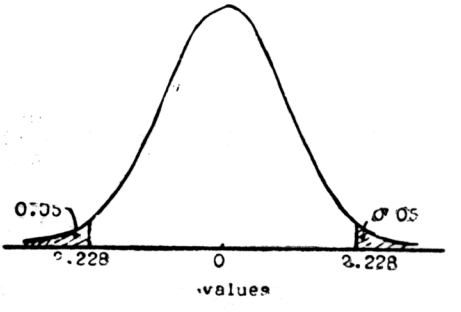


t — values

Four degrees of freedom, 0.05 level, and two-tailed test.

Diagram 2. Student's t-curve for flight reactions of Pink Bollworm, *Pectinophora gossypiella* (Saunders) to the light intensity below three foot-candle. Tucson, Arizona, 1971.

— t values equal or less than minus 2.228, and equal or greter than 2.228 are criticals.



t — values

Ten degrees of freedom, 0.05 level, and two-tailed test.

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