

**DEGREE DAY REQUIREMENT FOR DEVELOPMENT OF THE
BLACK CUTWORM, *AGROTIS IPSILON* (Hufn.)
(LEPIDOPTERA: NOCTUIDAE).**

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Abstract

Studies were carried out to show the effect of rearing regimes combined with three different temperatures on the rate of development of *Agrotis ipsilon*. Data obtained from these experiments revealed that the degree days required for the immature stages differed according to temperature or type of food, which were 208.4, 228.5, 229.1 and 267.5 at 22°C, 27°C, 30°C and 35°C when larvae were fed on castor oil bean leaves and it was 176.3, 226.05, 226.5 and 272.7 at the previous temperatures when larvae were fed on clover (berseem) leaves. Also, the median developmental rate was between 0.019 to 0.03 at the same temperatures, but results showed that the rate of development at the lower temperature when fed on berseem leaves was higher compared with those fed on castor oil bean leaves according to the different contents of the two regimes.

INTRODUCTION

Agrotis ipsilon has long been an important pest for cotton, maize and many other crops. Larvae cut completely or partially the seedling stage of the plant directly under the ground surface ,so, the farmers are forced to replant their crops.

Many investigators showed that the rate of development was affected significantly with kind of feeding and rearing temperature. Abdel Hadi (1968) mentioned that the larval periods of *Agrotis ipsilon* were 20.2 ,24.3 and 27.7 days when fed on berseem ,cotton and maize leaves, respectively, while El-Hemisi (1970) stated that the larval duration lasted for 29.3 days when reared on cotton leaves . El-Kifl *et al.* (1972) mentioned that the life cycle of *Agrotis ipsilon* was affected by temperature which is an important determinant for development . The whole life cycle lasted for 125.6 days at 15°C, 79.6 days at 25°C and 45.4 days at 30°C .Thus, the aim of the present study was to investigate the correlation between the rate of development and degree days requirement in which it may be useful for forecasting pest occurrence.

MATERIALS AND METHODS

Eggs of *Agrotis ipsilon* were collected from laboratory rearing culture. Newly hatched larvae were kept under constant temperature of 22°C, 27°C, 30°C and 35°C, and 70 ± 5% RH.

In the first treatment, newly hatched larvae were fed on castor oil bean leaves. In the second treatment larvae were fed on clover (berseem) leaves. Each treatment was replicated three times.

Larvae were kept at the same temperatures until pupation. Emerging moths were fed on 20 % sucrose solution. Deposited eggs were reared at the same temperatures until hatching.

Larval, pupal and egg durations were recorded. Larvae and pupae, considered in analysis, are those included only when completed development to the pupal or adult stage. Estimate of median rate (proportion of development per day), Zesis *et al.* (1996) was calculated by taking the reciprocal of median stadium which is the number of days required for 50% of individuals to reach a given stage.

The linear regression equations for minimum developmental threshold was used to convert the median stadium from units of days to units of degree days by subtracting minimum developmental threshold from rearing temperatures and multiplying the difference by median stadium as follows:

$$\text{Median developmental rate} = \frac{\text{degree above temperature threshold}}{\text{stadium degree} - \text{days for total development}}$$

median degree = degree above minimum threshold temp. X total developmental days.

RESULTS AND DISCUSSION

Degree days calculation of *Agrotis ipsilon* when larvae were fed on castor oil bean leaves or clover (berseem) leaves are presented in Tables 1 and 2, respectively.

Linear regression equation for degree days of each stage versus temperatures are listed in Table 4. Analysis of the degree days under the two rearing regimes showed that the mean degree days required for whole life stage differed according to temperature or type of food, Table 3. Degree days were 208.4, 228.52, 229.1 and 267.5

when larvae were fed on castor oil bean leaves at 22°C, 27°C, 30°C and 35°C, respectively. Significant variances were shown between 22°C and other rearing temperatures. On the other hand, no significant difference was obtained between 27°C and 30°C.

Similarly, when larvae were fed on berseem leaves, the average means of degree days were 176.3, 226.05, 226.59 and 272.73 at 22°C, 27°C, 30°C and 35°C, respectively.

As shown in Tables 1 and 2 the median developmental rate differed according to rearing regimes or temperatures.

From Table 4 it can be concluded that the correlation between temperature versus degree days was highly positive and significant for all stages. It is evident that the rate of development was in positive correlation with the rearing temperature, as an important factor for development. The mean median developmental rate when larvae were fed on castor oil beans leaves was 0.18 at 22°C and increased to 0.02, 0.02 and 0.03 at the other temperatures. The same observation was noticed when larvae were fed on berseem leaves.

Table 1. Calculation of degree day requirement for total development of *A. ipsilon* fed on castor oil bean leaves.

| Temp. | Rep. | Egg stage | Larval stage | Pupal stage | Median stadium for total devep. | Degrees above min.devep. threshold | Median degree days for total devep. | Median development rate |
|-------|------|-----------|--------------|-------------|---------------------------------|------------------------------------|-------------------------------------|-------------------------|
| 22°C | 1 | 6 | 34.8 | 11.8 | 52.6 | 11.6 | 610.16 | 0.019 |
| | 2 | 7 | 35.6 | 12.1 | 54.7 | 11.6 | 634.52 | 0.018 |
| | 3 | 6.5 | 36 | 11.9 | 54.4 | 11.6 | 631.04 | 0.018 |
| 27°C | 1 | 5 | 27.8 | 10.4 | 43.2 | 16.6 | 717.12 | 0.02 |
| | 2 | 4.8 | 26 | 9.8 | 40.6 | 16.6 | 673.96 | 0.02 |
| | 3 | 4.9 | 25.8 | 9.4 | 40.1 | 16.6 | 665.66 | 0.03 |
| 30°C | 1 | 4.2 | 22.4 | 9.6 | 36.2 | 19.6 | 709.52 | 0.03 |
| | 2 | 4.1 | 21 | 9 | 34.1 | 19.6 | 668.36 | 0.03 |
| | 3 | 4.7 | 20.8 | 9.4 | 34.9 | 19.6 | 684.04 | 0.03 |
| 35°C | 1 | 3.9 | 19.4 | 9.5 | 32.6 | 24.6 | 806.88 | 0.03 |
| | 2 | 4.2 | 19.8 | 9.1 | 33.1 | 24.6 | 814.26 | 0.03 |
| | 3 | 3.8 | 18.8 | 9.4 | 32 | 24.6 | 787.20 | 0.03 |

Table 2. Calculation of degree day requirement for total development of *A. ipsilon* fed on berseem leaves.

| Temp. | Rep. | Egg stage | Larval stage | Pupal stage | Median stadium for total devep. | Degrees above min.devep. threshold | Median degree days for total devep. | Median development rate |
|-------|------|-----------|--------------|-------------|---------------------------------|------------------------------------|-------------------------------------|-------------------------|
| 22°C | 1 | 4.02 | 24.7 | 12.4 | 46.12 | 11.6 | 534.44 | 0.021 |
| | 2 | 4.18 | 28.80 | 11.80 | 44.78 | 11.6 | 519.44 | 0.022 |
| | 3 | 4.50 | 28.7 | 12.7 | 45.90 | 11.6 | 532.44 | 0.022 |
| 27°C | 1 | 3.52 | 25.8 | 11.4 | 40.72 | 16.6 | 675.45 | 0.024 |
| | 2 | 3.42 | 24.8 | 12.4 | 41.12 | 16.6 | 682.59 | 0.024 |
| | 3 | 3.85 | 25.7 | 11.8 | 40.15 | 16.6 | 666.49 | 0.024 |
| 30°C | 1 | 2.93 | 21.5 | 9.07 | 33.5 | 19.6 | 656.6 | 0.029 |
| | 2 | 3.22 | 22.4 | 9.82 | 35.44 | 19.6 | 694.62 | 0.028 |
| | 3 | 3.11 | 21.9 | 10.1 | 35.11 | 19.6 | 688.15 | 0.028 |
| 35°C | 1 | 2.54 | 20.4 | 9.8 | 32.74 | 24.6 | 805.40 | 0.030 |
| | 2 | 3.1 | 21.0 | 8.94 | 32.04 | 24.6 | 788.18 | 0.031 |
| | 3 | 3.6 | 21.2 | 9.2 | 33.00 | 24.6 | 811.8 | 0.030 |

Table 3. Degree days requirements for *A. ipsilon* under two rearing regimes.

| Host | Temp. | Egg stage | | | | Larval stage | | | | Pupal stage | | | | total | Mean xx | mean |
|------------|-------|-----------|--------|-------|--------|--------------|--------|--------|---------|-------------|--------|--------|--------|---------|---------|--------|
| | | 1 | 2 | 3 | total | 1 | 2 | 3 | total | 1 | 2 | 3 | total | | | |
| Castor oil | 22 | 69.6 | 81.2 | 75.4 | 226.2 | 403.68 | 412.96 | 417.6 | 1234.24 | 136.88 | 140.36 | 138.04 | 415.28 | 1875.75 | 625.25 | 208.41 |
| | 27 | 83.0 | 79.68 | 81.34 | 244.02 | 461.48 | 431.6 | 428.28 | 1321.36 | 172.64 | 162.68 | 156.04 | 441.36 | 2056.74 | 685.58 | 228.52 |
| | 30 | 82.32 | 80.36 | 92.12 | 254.80 | 439.04 | 411.6 | 407.68 | 1258.32 | 188.16 | 176.4 | 184.24 | 548.8 | 2061.92 | 687.3 | 229.1 |
| | 35 | 95.94 | 103.32 | 93.48 | 292.74 | 477.24 | 487.08 | 462.48 | 1426.8 | 233.7 | 223.8 | 231.24 | 688.8 | 2408.34 | 802.78 | 267.59 |
| Beesseed | 22 | 46.63 | 48.4 | 52.2 | 147.23 | 344.52 | 334.08 | 332.92 | 1011.52 | 143.84 | 136.38 | 147.32 | 428.04 | 1586.79 | 528.93 | 176.31 |
| | 27 | 58.43 | 54.61 | 63.91 | 176.95 | 428.28 | 411.68 | 426.62 | 1266.58 | 189.24 | 205.34 | 195.88 | 590.96 | 2034.49 | 678.16 | 226.05 |
| | 30 | 57.42 | 63.11 | 60.95 | 181.48 | 421.4 | 439.04 | 429.24 | 1289.63 | 177.7 | 192.47 | 197.96 | 568.2 | 2039.36 | 679.78 | 226.59 |
| | 35 | 62.48 | 76.26 | 88.56 | 227.3 | 501.84 | 516.6 | 521.52 | 1539.96 | 241.08 | 214.92 | 226.32 | 687.32 | 2454.58 | 818.19 | 272.73 |

Mean xx = mean of total degree days requirements from three replicates

Table 4. Linear regressions of median development rate ($\frac{1}{d}$) versus rearing temperature.

| rearing regime | stage | Equation | R | Standard error of intercept | Standard error of slope |
|-------------------|------------|-----------------------|------|-----------------------------|-------------------------|
| castor oil leaves | egg | $Y = 36.92 + 1.6 x$ | 0.97 | 0.84 | 0.08 |
| | larva | $Y = 313.26 + 4.33 x$ | 0.82 | 0.043 | 0.0024 |
| | pupa | $Y = 20.24 + 8 x$ | 0.98 | 0.0178 | 0.0033 |
| | whole life | $Y = 109.94 + 4.33 x$ | 0.95 | 0.0023 | 0.0021 |
| berseem leaves | egg | $Y = 4.79 + 1.97 x$ | 0.95 | 0.0061 | 0.0009 |
| | larva | $Y = 55.29 + 12.99 x$ | 0.98 | 0.0425 | 0.0062 |
| | pupa | $Y = 13.28 + 6.18 x$ | 0.94 | 0.0189 | 0.003 |
| | whole life | $Y = 192.1 + 0.35 x$ | 0.86 | 0.022 | 0.0039 |

Y = is the inverse ($\frac{1}{d}$) of the duration of life stage

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الإحتياجات الحرارية اللازمة لنمو وتطور الدودة القارضة السوداء

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أجريت دراسة لمعرفة الإحتياجات الحرارية اللازمة لنمو وتطور الدودة القارضة السوداء تحت ظروف درجات حرارة مختلفة ٢٢م، ٢٧م، ٣٠م، ٣٥م وباستخدام نوعين من الغذاء لليرقات وهما أوراق الخروع وأوراق البرسيم.

تشير النتائج إلى أن متوسط الإحتياجات الحرارية اللازمة فى حالة التغذية على الخروع كانت ٢٠٨,٤ و ٢٢٨,٥ و ٢٢٩,١ و ٢٦٧,٥ على درجات حرارة ٢٢م، ٢٧م، ٣٠م، ٣٥م على التوالي، بينما كانت ١٧٦,٢ و ٢٢٦,٠٥ و ٢٢٦,٥ و ٢٧٢,٧ عند التغذية على البرسيم على نفس درجات الحرارة السابقة، ومن الملاحظ أن الإحتياجات الحرارية لم تكن بينها اختلافات معنوية عند التربية على درجة حرارة ٢٧م أو ٣٠م. أما معدل النمو اليومي فيتراوح ما بين ٠,٠١٩ إلى ٠,٠٣٠ باختلاف درجات الحرارة. كما لوحظ أن معدل النمو على الدرجات الصغرى أعلى عند التغذية على البرسيم منه عند التغذية على أوراق الخروع نظراً لاختلاف المكونات الأساسية لكلا النوعين من الأوراق.