SCHEDULING PESTICIDE TREATMENTS FOR CONTROLLING THE APPLE SAWFLY *Hoplocampa testudinea* (KLUG.)

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ABSTRACT

Recently, the apple sawfly is one of the most important pests in commercial orchards. This pest became a serious problem during 90th of the last century when significant damages of the early blossoming apples (‘Idared’, ‘Julia’, ‘Šampion’, etc.) and also of other varieties (‘Golden Delicious’, ‘Jonagold’) appeared. The infestation varies from 10% to nearly 100% of attacked flowers or the fruitlets. The high infestation can be observed even if the protection against the apple sawfly was managed successfully during foregoing season. The most effective way of the protection is the application of insecticides before larvae hatching (‘red eyes stage’). For this purpose the embryonic development of sawfly larvae must be observed. However, this monitoring method may appear difficult and time consuming for the most of growers. To simplify the pest control the sum of the effective temperatures (SET) above 10°C corresponding to optimum application date was calculated. The data were obtained from electronic meteorological station and on the base of the observation of embryonic development of sampled eggs. The observations were carried out during period 2001-2005. It can be said that the SET value measured for the treatment of early blossoming apples (2837 ± 164.8 hourly degrees, $\alpha = 0.01$) appear to be relatively reliable and this sum could be used in praxis. On the other hand, the SET value for treatment of later blossoming apples has shown higher data variability (3144 ± 744.3 HD, $\alpha = 0.01$).

Key words: apple sawfly, temperature sums, apples

INTRODUCTION

Several biological agents including parasitoids and nematodes have been investigated in terms of their usefulness in controlling the apple sawfly (*Hoplocampa testudinea* Klug.). However, none of them is available for

commercial use (Babendreier, 2000; Belair et al., 1998; Jaworska, 1987). Bitter food preparation (Quassan) is used in organic orchards in other countries, but has not been approved for use in the Czech Republic. Therefore, insecticides such as thiacloprid and chlorpyrifos have to be used for effective control. Insecticides have to be applied at the end of embryonic development before or during larvae hatching. In cultivars, which blossom later, two larvicide treatments are sometimes needed, especially if May temperatures are low. The apple sawfly is sensitive to larvicide treatments only during a very short period. Therefore, pesticide applications have to be precisely timed. Using the sum of effective temperatures (SET) appropriately can make pest management simpler and more reliable. Since the 1980s and 1990s, this approach has been commonly used in controlling other pests such as the apple blossom weevil, the European red spider mite, the codling moth and the plum fruit moth (Lánský and Kneifl, 2000). Using SET in controlling the apple sawfly has also been studied. Software which use SET to monitor the apple sawfly is available in the Czech Republic (SUMATOR distributed by the State Phytosanitary Administration).However, this program provides data only on the flight activity of the apple sawfly and does not help determine the optimum treatment date. The aim of this study was to correlate the sum of effective temperatures with the developmental stages of the apple sawfly in order to precisely determine the optimum treatment date.

MATERIAL AND METHODS

From 2001 to 2005, samples of apple fruitlets attacked by the apple sawfly were collected separately for early blossoming varieties (‘Julia’, ‘Idared’, ‘Šampion’) and late blossoming varieties (‘Golden Delicious’, ‘Melrose’). Egg preparation was made by removing the surface tissues from the inner side of the calyx. Flowers with eggs were placed into a Erleyenmayer flask filled with water and stored in a meteorological box about one kilometer from the experimental plot. Samples were evaluated each day under a binocular microscope until the sawfly larvae hatched.

Nine different stages of embryonic development can be distinguished (Kocourek et al., 2001). To simplify our evaluations, we have divided the embryonic development into four stages

1) young eggs (transparent, no visible structure);
2) half-developed eggs (body of larvae visible, vitelline almost disappeared);
3) eggs close to hatching (red eyes visible on the developed head, movement of embryo; later, eyes become brown or black, other organs are becoming fully developed); and
4) larvae hatching.

The meteorological data needed for the calculation of SET were obtained from electronic station METEOS-3. SET was calculated as follows:

$$\mathbf{SET_h} = \sum_{i=1}^{n} (Th - K),$$

where **K** = development threshold [°C], $\mathbf{T_h}$ = average hourly temperature (air temperatures measured each 15 minutes with a sensor two meters above ground level), provided that $\mathbf{T_h > K}$. The temperature sum was related to the date on which 50% of eggs reached Stage 3 (red eyes). Hourly temperatures were used to calculate SET. Especially in the beginning of a vegetation season, this method is more accurate than measuring day-degrees (Litschmann and Svoboda, 1999). Data were collected from 2001 to 2005 in Holovousy, a sugar beet growing region at an altitude of 321 m with a mean annual temperature of 8.1°C and a mean annual precipitation of 654.7 mm.

RESULTS AND DISCUSSION

Table 1. Treatment days and SET calculated for larvicide treatments against the apple sawfly (*Hoplocampa testudinea*) in Holovousy during period 2001-2005

<table>
<tr><th rowspan="2">Year</th><th colspan="2">Treatment date/group of varieties</th><th colspan="4">SET [HD* >10°C]/group of varieties</th></tr>
<tr><th>early blossoming var.</th><th>late blossoming var.</th><th colspan="2">early blossoming var.</th><th colspan="2">late blossoming var.</th></tr>
<tr><td>2001</td><td>May 14</td><td>May 14</td><td colspan="2">2985</td><td colspan="2">2985</td></tr>
<tr><td>2002</td><td>May 9</td><td>May 12</td><td colspan="2">2700</td><td colspan="2">3200</td></tr>
<tr><td>2003</td><td>May 8</td><td>May 13</td><td colspan="2">3000</td><td colspan="2">3400</td></tr>
<tr><td>2004</td><td>May 12</td><td>May 18</td><td colspan="2">2650</td><td colspan="2">2850</td></tr>
<tr><td>2005</td><td>May 15</td><td>May 22</td><td colspan="2">2850</td><td colspan="2">3285</td></tr>
<tr><td colspan="3">Mean</td><td colspan="2">2837</td><td colspan="2">3144</td></tr>
<tr><td colspan="3">Standard deviation</td><td colspan="2">143.1</td><td colspan="2">646.1</td></tr>
<tr><td colspan="3">Coefficient of variance</td><td colspan="2">0.05</td><td colspan="2">0.21</td></tr>
<tr><td colspan="3">Interval of confidence (α = 0.05) [HD/days]</td><td>± 125.4</td><td>± 1.03</td><td>± 566.3</td><td>± 4.68</td></tr>
<tr><td colspan="3">Interval of confidence (α = 0.01) [HD/days]</td><td>± 164.8</td><td>± 1.36</td><td>± 744.3</td><td>± 6.15</td></tr>
</table>

The obtained results are presented in Table 1. Application dates were from May 8 to May 15 for the early blossoming varieties and from May 12 to May 22 for the later blossoming varieties. Except in 2001, the difference between application dates for the early and later blossoming varieties was 3 to 7 days. The average SET was 2837.0 HD for the early varieties and 3144.0 HD for the later varieties. Both coefficients of variance and confidence intervals were lower for early blossoming varieties. The coefficient of variance was 0.05 for early varieties and 0.21 for later varieties. The confidence interval at $\alpha = 0.05$ were ± 125.4 HD for the early varieties and 566.3 HD for the later varieties. The confidence interval at $\alpha = 0.01$ was ± 164.8 HD for the early varieties and 744.3 HD for the later varieties. If we express these values in '± days', we can assess the error in the timing of larvicide treatments. The last two rows in the table show that this error is ± 1.4 days for the early varieties and ± 6 days for the later varieties ($\alpha = 0.01$). Of course, the intervals were shorter at $\alpha = 0.05$ where the intervals of confidence were ±1.0 for the early varieties and ± 4.7 days for the later varieties. The difference between the groups was probably caused by a weaker and a discontinuous pest flight in the later blossomig varieties.

CONCLUSIONS

1) With the early blossoming varieties, SET can be used to calculate the optimum treatment date, particularly if infestation is not extreme. Treatment should be carried out when the SET is approximately 2800 HD. The maximum error in estimating the application date did not exceed ± 1.5 days. However, the calculated sums should be verified in other locations, particularly in those with different climate conditions. In addition, SET should be used together with other monitoring methods when infestation is extremely high.
2) With the later blossoming varieties, SET is more variable. The difference between the estimated and the actual optimum application dates was almost one week ($\alpha = 0.01$). This is too long for reliable application scheduling. Therefore, traditional monitoring of pest development should be performed. On the other hand, infestation in later varieties is usually not as high as in earlier varieties.

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WYZNACZANIE TERMINÓW ZABIEGÓW ZWALCZAJĄCYCH OWOCNICĘ JABŁKOWĄ *Hoplocampa testudinea* (KLUG.)

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STRESZCZENIE

W ostatnich latach owocnica jabłkowa jest jednym z najgroźniejszych szkodników sadów jabłoniowych. Szkodnik ten zaczął stwarzać poważne problemy w latach dziewięćdziesiątych minionego wieku, powodując poważne szkody przede wszystkim na wcześnie zakwitających odmianach jabłoni (‘Idared’, ‘Julia’, ‘Sampion’ itp.), ale także na innych (‘Golden Delicious’, ‘Jonagold’). Porażały one kwiaty lub zawiązki od 10, a nawet do 100%. Wysoką liczebność uszkodzonych zawiązków stwierdzono nawet w sytuacjach, kiedy w poprzednich sezonach ochrona przed owocnicą była skuteczna. Najbardziej skutecznym sposobem ochrony przed tym szkodnikiem jest stosowanie insektycydów przed wylęgiem larw (stadium „czerwonych oczu”). W tym celu należy prowadzić obserwacje rozwoju embrionalnego larw. Metoda jest jednak dla większości sadowników trudna i czasochłonna. Aby uprościć zwalczanie szkodnika obliczono sumę efektywnych temperatur (SET) powyżej 10°C korespondującą z optymalnym terminem zabiegu. Potrzebne dane uzyskano z elektronicznej stacji meteorologicznej i na podstawie obserwacji zachodzącego w jajach rozwoju embrionalnego. Obserwacje prowadzono w latach 2001-2005. Wartość SET określona dla wykonania zabiegu na wcześnie kwitnących jabłoniach (2837 ± 164,8 stopniogodzin, $\alpha = 0{,}01$) jest stosunkowo niezawodna i suma ta może być stosowana w praktyce. Z kolei wartość SET w odniesieniu do zabiegu na później kwitnących odmianach wykazywała dużą zmienność (3144 ± 744,3 stopniogodzin, $\alpha = 0{,}01$).

Słowa kluczowe: *Hoplocampa testudinea,* terminy zwalczania, suma efektywnych temperatur