The Importance of Monitoring the *Ceutorhynchus pallidactylus* Female Flight Activity for the Timing of Insecticidal Treatment

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Abstract

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The effects of two pyrethroids and one combination of organophosphate and pyrethroid (alpha-cypermethrin, etofenprox, chlorpyrifos + cypermethrin) on *Ceutorhynchus pallidactylus* (Marsham, 1802) (*Coleoptera*: *Curculionidae*) were tested under field conditions in the Czech Republic in 2006–2008. Significant differences in the effects of the compared insecticides on *C. pallidactylus* were recorded in the particular years (2006, 2007, 2008). It was less important and somewhat less complicated to establish the most suitable time for spraying in the case of the chlorpyrifos + cypermethrin combination in comparison with the pyrethroids applied separately. The effectiveness of the tested insecticides was markedly influenced by the time of spraying. The effects of the pyrethroids applied singly achieved results comparable to those of the chlorpyrifos + cypermethrin combination only at the optimal spraying time. The most suitable time for spraying varied from the point when the first females appeared in yellow water traps in somewhat higher quantities to the time when a substantial proportion of caught females was able to lay eggs.

Keywords: *Ceutorhynchus pallidactylus*; cabbage stem weevil; winter oil-seed rape; alpha-cypermethrin; etofenprox; chlorpyrifos + cypermethrin; insecticidal effect

Oilseed rape is an economically important crop in the Czech Republic. As a result of intensive cultivation an increasing incidence of some pests has recently been observed. Among them the stem weevil (cabbage stem weevil *Ceutorhynchus pallidactylus* /Mrsh./) and the oilseed rape stem weevil (*C. napi* Gyll.) are the most important (Rotrekl 2000; Kazda 2002, 2004; Seidenglanz 2006). Farmers do not usually differentiate between the two species. For simplification they are called by one name: stem weevils (Šedivý & Kocourek 1994). The method employed for timing the insecticidal treatment is based on monitoring the stem weevil's flight activity, using yellow water traps. Spraying is recommended when the amount of caught imagos exceeds the Czech damage thresholds: 4–6 beetles/3 days/1 trap for *C. napi* and 12 beetles/3 days/1 trap for

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C. pallidactylus (Šedivý 2000). *C. napi* is considered to be somewhat more noxious in comparison with *C. pallidactylus* (Šedivý & Kocourek 1994; Kazda 2004). In actuality farmers scarcely use the yellow traps as they consider this method to be rather labour- and time-consuming. In addition some farmers have had negative experiences with the method, claiming that it is not a reliable "guide".

It was experimentally confirmed that the male and female cabbage stem weevils (*C. pallidactylus*) leave their hibernation sites at distinctly different times (Büchs 1998; Klukowski 2006). In the first yellow trap catches in spring the male weevils predominate to a large extent and the percentage of female weevils increases in the course of time. The time difference in the migration of both sexes from their hibernation sites into the rape fields is completely unrelated to the time of maximum flight activity as recorded by the yellow traps. This low percentage of female weevils at the beginning of migration into the oil-seed rape fields obviously limits the possibilities of copulation and egg-laying. It also finally limits the possibility of infesting the plants at that early stage (Büchs 1998). However, in practice, the sex of collected weevils is not determined within the samples in the yellow traps. This means that any established damage thresholds (number of beetles per trap per 3 days) are in fact "relative" because the proportions of males and females may differ considerably on particular dates. Therefore, the total number of beetles caught in one yellow trap during three days on one date is not necessarily comparable to the analogous result recorded on another date. Later appearing females settle at the crop edge in a more dispersed way than the males do. Females also have a lesser tendency to migrate into the crop. In comparison with males, females tend to aggregate (i.e. occur in clusters) more strongly and for a longer time at the edges of fields as shown in the results of the SADIE analysis (Perry 1995, 1996; Perry *et al.* 1996; Klukowski 2006).

In this study we tested the effects of two pyrethroids and one combination of organophosphate and pyrethroid (alpha-cypermethrin, etofenprox, chlorpyrifos + cypermethrin) on *Ceutorhynchus pallidactylus* (Marsham, 1802) (*Coleoptera*: *Curculionidae*) under field conditions in 2006–2008. The main objectives of this paper are: (1) to show what effects can realistically be expected from the available insecticides when the times of spraying are calculated from the monitoring of flight activity (yellow water traps) of ripe egg-carrying females; (2) to show how the effectiveness of insecticides with different residual effects can be influenced by the time of spraying and (3) to explain why it is important to evaluate also the sex in flight active individuals of the pest (and in females at the stage of ovogenesis) for the timing of insecticidal application.

MATERIAL AND METHODS

The trials were conducted in trial fields in Šumperk (Northern Moravia; Czech Republic) in 2006–2008. Exact, small-plot trials (7–13 treatments with 3–4 replications; net plot for spraying, assessing: 3.0 × 10.0 m; in addition there were 1.25 m wide untreated zones always on both sides of all net plots in the trials) were carried out with the winter oil-seed rape variety Cando (2006) or Oponent (2007, 2008). The plants in the trial were exposed to natural infestation by the pests.

The dates of spraying were derived from the results of monitoring the flight activity of *C. pallidactylus* (CEUTQU) and *C. napi* (CEUTNA) by means of yellow water traps in each of the years. The traps were situated only in the trial (4 traps per trial at least) and were emptied twice a week. The species and sex of caught beetles were identified in a laboratory as soon as possible after emptying the traps. The females were then dissected and the stage of egg development was established for each individual with the use of a binocular loupe. We distinguished between three types of females according to their egg development stage for the purposes of this study:

(1) females without visible eggs in the abdominal cavity;

(2) females with small milky-white eggs in the abdominal cavity;

(3) females with the abdominal cavity fully or almost fully filled with larger somewhat yellowish eggs.

The females in stage 3 are also called females with ripe eggs or females prepared for egg-laying.

The timings for successive sprayings, in accordance with the intended, ideal treatment plan, were as follows:

1st date – when the first imagos of the pests appeared in the traps or as soon as it was practically possible;

Table 1. The effects of insecticides on the occurrence of cabbage stem weevil (*C. pallidactylus*) larvae in plants and on the level of damage caused by the larvae (Šumperk, 2006)

Treatment[1]	Mean number of				Mean damage degree of stems[2]
	larvae per stem[2]	larvae in leaf-stalks per plant[2]	larvae per plant[2]	leaf-stalks with larvae per plant[2]	
Untreated control	0.55[a]	0.78[a]	1.33[a]	0.30[a]	1.67[a]
Alpha-cypermethrin (13. 4. 06)	0.55[a]	0.63[ab]	1.18[a]	0.27[a]	1.52[a]
(21. 4. 06)	0.43[a]	0.40[bc]	0.83[ab]	0.17[b]	1.43[a]
(28. 4. 06)	0.18[a]	0.32[cd]	0.50[b]	0.17[b]	1.20[a]
Chlorpyrifos + cypermethrin (13. 4. 06)	0.57[a]	0.75[a]	1.33[a]	0.33[a]	1.55[a]
(21. 4. 06)	0.17[a]	0.27[cd]	0.43[b]	0.12[b]	1.18[a]
(28. 4. 06)	0.17[a]	0.17[d]	0.33[b]	0.10[b]	1.20[a]

[1]1.dose of alpha-cypermethrin per ha: 10 g (Vaztak 10 SC; 0.1 l/ha); 2. dose of chlorpyrifos + cypermethri*n* per ha: 300 + 30 g (Nurelle D; 0.6 l/ha)

[2]the values marked with different letters are significantly different (Tukey's test; $P < 0.05$)

2[nd] date – when the total number of caught imagos exceeded the Czech threshold values or at least approached those thresholds;

3[rd] date – when the first females without eggs appeared in the traps in somewhat higher numbers (not only scattered individual females);

Table 2. The effects of insecticides on the occurrence of cabbage stem weevil (*C. pallidactylus*) larvae in plants and on the level of damage caused by the larvae (Šumperk, 2007)

Treatment[1]	Mean number of				Mean damage degree of stems[2]
	larvae per stem[2]	larvae in leaf-stalks per plant[2]	larvae per plant[2]	leaf-stalks with larvae per plant[2]	
Untreated control	6.40[a]	6.37[a]	13.55[a]	2.60[a]	4.93[a]
Etofenprox (15. 3. 07)	6.47[a]	5.05[ab]	11.50[abc]	1.67[abcd]	4.40[ab]
(23. 3. 07)	5.82[ab]	5.20[ab]	11.02[abc]	1.73[abcd]	4.32[abc]
(30. 3. 07)	4.02[abc]	4.02[abc]	8.05[abc]	1.37[abcd]	4.10[abcd]
(6. 4. 07)	2.97[abcd]	2.97[abc]	5.93[bcd]	1.37[abcd]	2.92[def]
Alpha-cypermethrin (15. 3. 07)	6.27[a]	6.83[a]	13.10[a]	2.57[ab]	4.20[abcd]
(23. 3. 07)	4.48[abc]	5.97[a]	10.45[abc]	2.20[abc]	3.60[abcde]
(30. 3. 07)	2.65[bcd]	2.83[abc]	5.58[cd]	1.10[bcd]	3.00[cdef]
(6. 4. 07)	1.57[d]	1.82[bc]	3.38[d]	0.97[cd]	2.18[f]
Chlorpyrifos + cypermethrin (15. 3. 07)	5.48[ab]	6.33[a]	11.82[ab]	2.20[abc]	4.33[abc]
(23. 3. 07)	2.48[cd]	3.73[abc]	6.22[bcd]	1.17[abcd]	3.12[bcdef]
(30. 3. 07)	1.50[d]	1.83[bc]	3.35[d]	0.63[d]	2.23[ef]
(6. 4. 07)	1.42[d]	1.53c	2.98[d]	0.43[d]	2.06[f]

[1]1.dose of etofenprox per ha: 45 g (Trebon 30 EC; 0.15 l/ha); 2. dose of alpha-cypermethrin per ha: 10 g (Vaztak 10 SC; 0.1 l/ha); 3. dose of chlorpyrifos + cypermethrin per ha: 300 + 30 g (Nurelle D; 0.6 l/ha)

[2]the values marked with different letters are significantly different (Tukey's test; $P < 0.05$)

Table 3. The effects of insecticides on the occurrence of cabbage stem weevil (*C. pallidactylus*) larvae in plants and on the level of damage caused by the larvae (Šumperk, 2008)

Treatment[1]	Mean number of				Mean damage degree of stems[2]
	larvae per stem[2]	larvae in leaf-stalks per plant[2]	larvae per plant[2]	leaf-stalks with larvae per plant[2]	
Untreated control	9.23[a]	23.97[a]	32.87[a]	5.93[a]	4.90[a]
Alpha-cypermethrin (3. 3. 08)	6.53[ab]	18.73[ab]	25.27[ab]	4.87[ab]	4.28[abc]
(28. 3. 08)	5.87[abc]	14.95[b]	20.83[b]	3.63[bc]	3.67[bcd]
(4. 4. 08)	2.82[cd]	6.23[cd]	9.05[de]	1.75[d]	2.69[def]
(14. 4. 08)	3.92[bcd]	8.83c	12.75[cd]	2.42[cd]	3.12[de]
Chlorpyrifos + cypermethrin (3. 3. 08)	9.33[a]	23.45[a]	32.62[a]	5.63[a]	4.68[ab]
(28. 3. 08)	5.12[abc]	8.45c	13.57[c]	2.27[cd]	3.43[cd]
(4. 4. 08)	1.92[d]	4.83[d]	6.75[e]	1.35[d]	2.03[ef]
(14. 4. 08)	1.78[d]	5.13[d]	7.13[e]	1.65[d]	1.88[f]

[1]1. dose of alpha-cypermethrin per ha: 10 g (Vaztak 10 SC; 0.1 l/ha); 2. dose of chlorpyrifos + cypermethrin per ha: 300 + 30 g (Nurelle D; 0.6 l/ha)

[2]the values marked with different letters are significantly different (Tukey's test; $P < 0.05$)

4[th] date – when a substantial portion (approximately 50%) of the total number of caught females was able to lay eggs (females with ripe eggs).

The dates of spraying in the particular years can be easily ascertained from Tables 1–3.

Insecticides were applied with a HEGE 32 automatic trial sprayer with a HEGE 76 implement carrier (HEGE Maschinen Gmbh, Hohebuch 5, Waldenburg, Germany; three separated spraying paths – each of them having six nozzles; spraying span: 3 m; type of nozzles: XR TEEJET; No. of nozzle: 80015 VS; application pressure: 0.3 MPa; flow rate: 312.5 l/ha). The insecticides were applied according to the treatment plans drawn up for each trial year (Tables 1–3).

Several larval assessments were done after instar II–III larvae were found on plants on control plots in each of the years (2006, 2007, 2008). We assessed:

(1) the number of larvae in leaf stalks per plant
(2) the number of leaf stalks infested with larvae per plant
(3) the number of larvae per stem
(4) the total number of larvae per plant and
(5) the degree of stem infestation with larvae.

As regards the degree of stem infestation, we always designated each sampled plant according to the following scheme:

degree 1: undamaged stem without larvae;
degree 2: undamaged stem with one or more larvae present inward;
degree 3: up to 10% of the stem length damaged by larvae;
degree 4: from 11 to 25% of the stem length damaged by larvae;
degree 5: from 26 to 50% of the stem length damaged by larvae;
degree 6: more than 50% of the stem length damaged by larvae.

Twenty plants (only 15 plants in 2008) per plot were sampled.

The effects of the compared treatments were assessed for all the described assessments separately. The obtained results were then statistically analyzed using one-factorial ANOVA and subsequently Tukey's test in order to determine differences among the mean values. For analysis the UNISTAT – Statistical Package, Version 4.53 was used (Unistat Ltd, London, England).

RESULTS

Results of flight activity monitoring (2006, 2007, 2008)

During the three years CEUTQU was the highly predominant species in the trial locality. The occur-

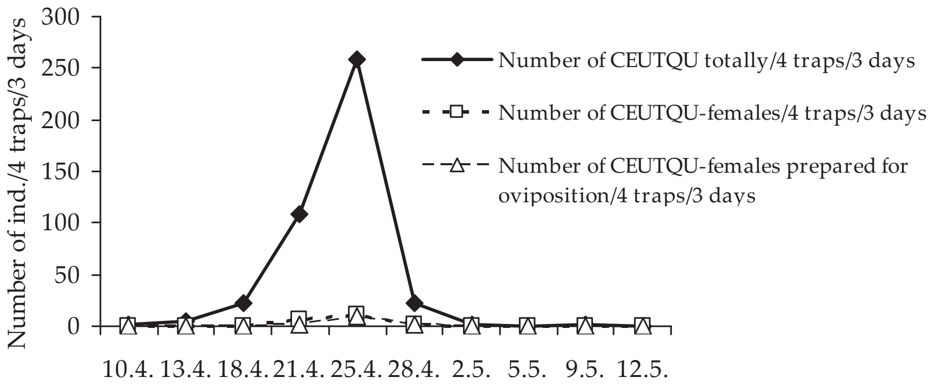

Figure 1. CEUTQU flight activity monitoring (yellow water traps) in 2006

rences of CEUTNA were negligible in the course of monitoring. The results of CEUTQU flight activity monitoring are shown in Figures 1–5. It is evident that the CEUTQU flight activities were markedly different in the compared years in regard to the total duration of flight activity periods; the total quantities of CEUTQU catches in yellow water traps; the relative amounts of females in the catches; the total amounts of females in the catches and the time-current delays of females behind males in the course of flying into the crop. It is interesting that the season with the most numerous total CEUTQU catches (2006) on the particular dates was also characterised by low occurrences of females in the yellow water traps. In contrast, the season of 2008 was characterised by relatively high proportions of females in the total CEUTQU catches and also by delays of the flight activity of females. An especially important aspect of CEUTQU flight activity in 2008 was the relatively long presence of females prepared for oviposition in the catches. Though the total (males + females) flight activity peaks in 2008 (max. 85.6 ind./4 traps/3 days) were not so numerous in comparison with the season 2006 (max. 259 ind./4 traps/3 days), the course of flight activity in 2008 was in fact much more noxious to plants (Figures 4 and 5). It was more complicated to time the insecticidal application in 2008. The females prepared for oviposition occurred in yellow water traps from 3 April to 7 May in that year and their catches were relatively high.

In general, the differences in the characteristics of flight activity resulted in a distinct variability in the levels of plant infestation during the compared seasons (Tables 1–3). It is clear that the decisive factor that substantially influenced the final level of plant infestation with larvae was the actual amount of females in the catches and the active duration of ovipositing females. The particular years can differ substantially from one another, not only in the total amounts of beetles in yellow traps but also in the amounts of females in the catches.

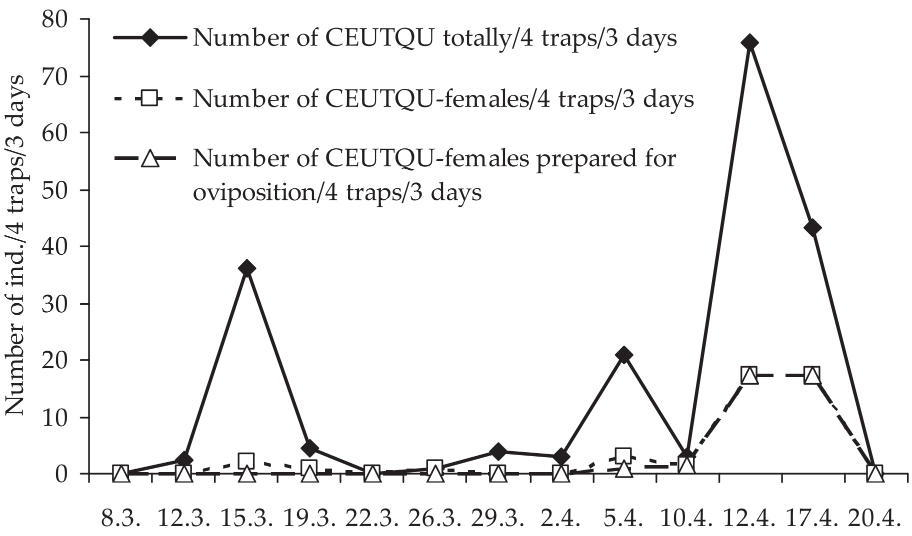

Figure 2. CEUTQU flight activity monitoring (yellow water traps) in 2007

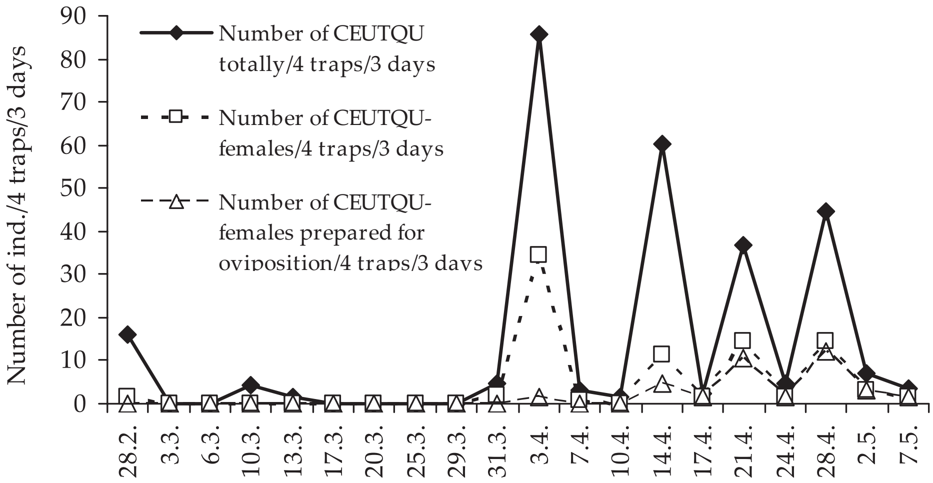

Figure 3. CEUTQU flight activity monitoring (yellow water traps) in 2008

The effects of applications in relation to the insecticide used and the dates of spraying

Regarding the numbers of larvae in stems, the insecticidal treatments in general had a significant influence on the outcomes of the trials in the particular years. This was established from the results of ANOVA (2006: F = 3.656; df = 6, 12; F_{tab} = 2.996; $P < 0.05$; 2007: F = 13.625; df = 12, 24; F_{tab} = 3.032; $P < 0.01$; 2008: F = 16.321; df = 8, 24; F_{tab} = 3.363; $P < 0.01$). In 2006 no significant differences were found between the mean values of larvae in stems (Tukey's test; $P < 0.05$) for the compared treatments (Table 1). The levels of infestations were in fact too low. Nonetheless, it is apparent from the results that the most effective were the applications done on the 28th April 06 (BBCH 50–52). This holds for both the compared products. However, whilst the chlorpyrifos + cypermethrin combination applied on the 21st April (BBCH 31–33) brought a distinct decrease in the level of stem infestation, the application of *alpha-cypermethrin* on this date was substantially less effective. The occurrence of larvae in stems in 2007 was remarkably higher than in 2006. Significant differences were found among the mean values of larvae in stems (Tukey's test; $P < 0.05$) (Table 2). It is apparent from the results that the date of application had a substantial influence on the final insecticidal effect once again. The most effective sprayings were done on the 6th April 2007 (BBCH 53–57). However, in the case of the chlorpyrifos + cypermethrin combination it was not so crucial for the resulting effect to perform the application only at the most suitable time. Hence the application of the chlorpyrifos + cypermethrin combination carried out on the 30th of March, 2007 reached practically the same decrease in stem infestation

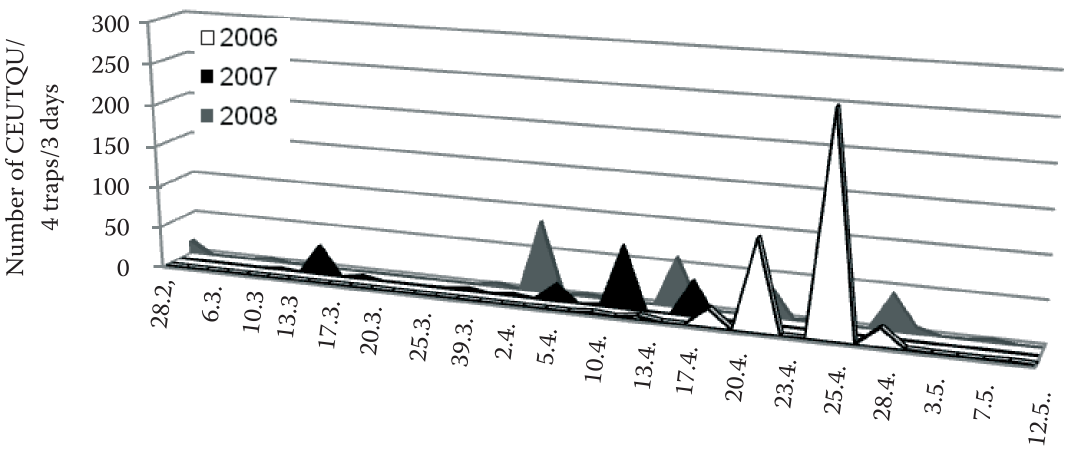

Figure 4. CEUTQU – imagos completely – flight activity monitoring in 2006–2008

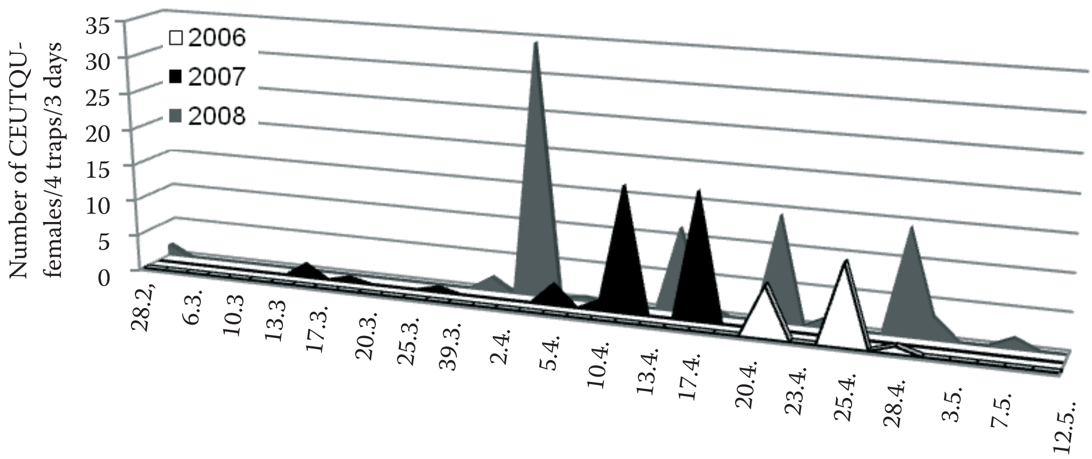

Figure 5. CEUTQU – females only – flight activity monitoring in 2006–2008

numbers as was achieved by the same treatment carried out on the 6th of April, 2007. This is not true of alpha-cypermethrin – there is an apparent decrease in the effects of the application done on the 30th of March 2007. This decrease in effectiveness is somewhat more apparent in the case of etofenprox. The highest occurrence of larvae in stems was recorded in 2008 (Table 3). Significant differences were found among the mean values of larvae in stems (Tukey's test; $P < 0.05$) for the compared treatments. In addition to the findings mentioned above it is apparent from the results listed in Table 3 that the loss of the most suitable time for spraying (probably the 4th of April, 2008) had a somewhat lower negative influence on the final effects of the treatment in the case of chlorpyrifos + cypermethrin combination in comparison with that of alpha-cypermethrin.

As regards the numbers of larvae in leaf-stalks, the insecticidal treatments in general had a highly significant influence on the outcomes of the trials in the particular years as demonstrated by the results of ANOVA (2006: F = 27.207; df = 6, 12; F_{tab} = 4.821; $P < 0.01$; 2007: F = 7.505; df = 12, 24; F_{tab} = 3.032; $P < 0.01$; 2008: F = 57.204; df = 8, 24; F_{tab} = 3.363; $P < 0.01$). Significant differences among the mean values of larvae in leaf-stalks were found for the compared treatments (Tukey's test; $P < 0.05$) in each of the years assessed (Tables 1–3). The highest occurrence of larvae in leaf-stalks was recorded in 2008 again (Table 3). In short it is possible to conclude that in the case of the chlorpyrifos + cypermethrin combination it was not so crucial (as opposed to alpha-cypermethrin and etofenprox) to perform the application only at the most suitable time to achieve a satisfactory end result.

The insecticidal treatments also had a significant influence on the outcomes of the total number of larvae per plant assessment as clearly shown by the results of ANOVA (2006: F = 10.386; df = 6, 12; F_{tab} = 4.821; $P < 0.01$; 2007: F = 14.136; df = 12, 24; F_{tab} = 3.032; P < 0.01; 2008 : F = 72,267; df = 8, 24; F_{tab} = 3.363; $P < 0.01$). The differences among the mean values are listed in Tables 1–3 (the fourth columns). The tendencies mentioned above can also be seen there.

From the assessment of the number of leaf-stalks with larvae per plant (ANOVA: 2006: F = 30.981; df = 6, 12; F_{tab} = 4.821; $P < 0.01$; 2007: F = 6.016; df = 12, 24; F_{tab} = 3.032; $P < 0.01$; 2008: F = 35.352; df = 8, 24; F_{tab} = 3.363; $P < 0.01$) it is obvious that it was somewhat less complicated to establish a suitable time for spraying with the chlorpyrifos + cypermethrin combination to obtain satisfactory results in comparison with the other insecticides. In addition, the effects of the chlorpyrifos + cypermethrin combination were always better than alpha-cypermethrin effects even when the application was at the most suitable times for both insecticides (28 April 06; 6 April 07; 4 April 2008) (Tables 1–3; the fifth column).

The results of the stem damage degree assessment (ANOVA: 2006: F = 3.968; df = 6, 12; F_{tab} = 2.996; $P < 0.05$; 2007: F = 13.261; df = 12, 24; F_{tab} = 3.032; $P < 0.01$; 2008: F = 22.266; df = 8, 24; F_{tab} = 3.363; $P < 0.01$) are listed in Tables 1–3 (the sixth column). Significant differences among the mean values of damage degrees were found for the compared treatments (Tukey's test; $P < 0.05$) in 2007 and in 2008.

DISCUSSION

The occurrences of CEUTNA have been quite negligible in the trial locality (49°58'38,027''N; 16°59'30,031''E) in recent years. The region is characterised by the high predominance of CEUTQU in spring yellow water trap catches (Seidenglanz 2006, 2007; Seidenglanz *et al.* 2008). However, it is not a solitary event in Europe, even if the Czech Republic is considered to be a region with regular common occurrences of the two species (Šedivý & Kocourek 1994; Šedivý & Vašák 2002; Nerad & Baranyk 2004; Štranc *et al.* 2008). Other large regions with multiyear predominance of CEUTQU are in Poland (Seta *et al.* 2001, 2003; Seta & Wolski 2006) and in Germany (Büchs 1998).

It is clear on the basis of trial results that it was less important (and also somewhat less complicated) to establish the most suitable time for spraying to obtain satisfactory results for the chlorpyrifos + cypermethrin combination in comparison with the other insecticides. The results of individually applied pyrethroids were not so stable. The effects of the tested insecticides were markedly influenced by the time of spraying. The most suitable time for spraying varied from the time when the first females without eggs appeared in the traps in somewhat higher quantities to the time when the substantial portion of the total number of caught females was going to lay eggs. The findings coincide with some previous results (Büchs 1998). However, there is a certain risk of missing the most suitable time for spraying. That is when waiting for higher proportions (40% and more) of ripe females in the yellow trap catches. Such an increase in proportions does not have to be recorded through the yellow traps in a season at all especially due to a sudden worsening of flight conditions during the crucial period. This does not mean that the development of eggs in female gonads is arrested when they do not fly. Waiting for higher proportions of females with ripe eggs in the yellow traps can result in the spraying taking place at a too late time. That situation occurred in the case of the fourth spraying date (14 April) in 2008. Hence it could be considered better and of greater certainty to respond to the first great increase in female numbers (10 and more females/4 traps/3 days) in yellow traps regardless of their egg development stage. Unfortunately, there are not any studies aimed at relationships between the flight activity of stem weevil females and the timing of insecticidal application among the latest literature sources.

The pyrethroids applied singly achieved comparable effects to the combination of chlorpyrifos + cypermethrin only when the time of spraying was optimal. This means that farmers who prefer the combination of chlorpyrifos + cypermethrin should have a somewhat better starting point in the decision-making process, especially in the years when the flight activity of stem weevils is lagged and the appearance of the first egg carrying females in the catches is relatively early (in relation to rape growth stage). The results are not in full agreement with some studies aimed at the evaluation of insecticidal effects of pyrethroids and their combinations with organophosphates on cabbage stem weevils. Seta *et al.* (2003) and Seta and Wolski (2006) did not record any significant differences between the effects of pyrethroids applied singly and combination of chlorpyrifos + cypermethrin. In two seasons (2007, 2008) the stem weevils were more noxious because the egg laying on plants occurred earlier (this was during the more susceptible phase for plants) and the timing of spraying was more complicated due to the lagged flight activity of females. Hence the period of egg laying could also be relatively long. There are real risks of untimely or even too late sprayings in such seasons. The problems seem to be associated with the spring being preceded by warm and short winters (2006/2007 and 2007/2008). When the flight activity starts at the end of February or at the beginning of March, it is possible to expect more important catches of females prepared for oviposition during the first part of April. However, when the snow is lying in the fields until the beginning of April (like in 2006), the whole course of flight activity, the appearance of egg-carrying females and the egg-laying period are shifted to the later growth stages. This is because the delay of females after males in flying into the crop seems to be quite regular according to several authors (Bűchs 1998; Klukowski 2006). Nonetheless, it is obvious from Figure 1 that the delay of females after males flying into the crop was not so great in 2006 in comparison with the years 2007 and 2008. In fact, we recorded egg-carrying females in yellow traps only on one date in 2006: 25 April. Perhaps we did not record the first flight activities of males before 7 April (the time of snow melting and setting the traps in the crop) or the flights of females were shifted to the second half of May. There is another possible explanation: when the weather conditions do not allow males to leave the hibernating sites at their most suitable time (due to the lasting snow cover), the potential delay of females after males could already be bound to overwintering localities (Klukowski 2006). Females could fly into the crop with smaller delays during such seasons and there could also be seasons with low occurrences of females in the final field populations in general (Seidenglanz 2006).

It is possible to draw several conclusions from the results of the individual assessments:

(1) The differences in the flight activity characteristics resulted in a distinct variability in the levels of plant infestation in the compared seasons.

(2) The decisive factors which substantially influenced the final level of plant infestation with larvae were the actual number of females in the catches and the active duration of females' carrying ripe eggs.

(3) The date of application had a substantial influence on the final insecticidal effect.

(4) In the case of chlorpyrifos + cypermethrin combination it was not so crucial (contrary to alpha-cypermethrin and etofenprox) to time the application just at the most suitable date to achieve satisfactory effects.

(5) It was easier to establish the most suitable application time for the chlorpyrifos + cypermethrin combination than for the other insecticides (alpha-cypermethrin; etofenprox).

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