Influence of Application Term on Effectiveness of Some Insecticides Against Brassica Pod Midge (*Dasineura brassicae* Winn.)

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Abstract

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In 2005 we determined the effectiveness of two preparations against gall pod midge in dependence on different terms of application, i.e. at full flowering (BBCH 65) and after flowering (BBCH 67) of winter oilseed rape. The tests were carried out at three localities in the Czech Republic, and the two preparations used were Calypso 480 SC (a.i. thiacloprid) and Karate Zeon 5CS (a.i. lambda-cyhalothrin). It was found that applying the preparations at BBCH 67 was significantly more effective than treatment at BBCH 65.

Keywords: brassica pod midge; *Dasineura brassicae*; oilseed rape; insecticides; pest control

Oilseed rape (*Brassica napus* L.) production has greatly increased on every continent over the last 50 years, with a fivefold increase in Europe. Collectively, the European Union is the largest producer with 9.2 million tons in 2002/03 vs. 8.9 million in 2001/02 and a late 1990's average of about 9 million tons. Germany is generally the largest producer within the EU (Winfield 1992). The crop is also important in the Czech Republic, in relation to the size of cultivated area. At the end of the 1990-ies, rape was cultivated on 105 000 ha, and by 2002–2003 the area had increased up to 300 000 ha. The average percentage of winter rape of the arable land varies slightly above 12%, but this level is not uniform throughout the country. At some locations the percentage of winter rape and other species of the cabbage family reaches 30%, up to 50% of arable land in extreme cases. The percentage of crops of the cabbage family has been increasing recently due to their use as catch crops (Kazda *et al.* 2005).

Oilseed rape is host to a wide variety of insect pests, including the pod gall midge (*Dasineura brassicae* Winn.). As a result of infestation, seed development is interrupted, siliquae senesce and eventually exhibit premature dehiscence, or they "shatter" (Coll 1991). This small, delicate fly has a week ovipositor and, except for when pods are young and tender, it is usually considered to be unable to oviposit in undamaged brassica seed pods (Ankersmith 1956; Doberitz 1973). Although the first generation of midge larvae is

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almost entirely dependent on the damage done by weevil feeding, later generations may oviposit in pods damaged by wind, fungal disease or by blossom beetles (Winfield 1967; Czajkowska & Dmoch 1975). The eggs are laid in clusters in the pod and cannot be seen with the unaided eye. The larvae are at first very tiny and transparent, soon growing to about 2 mm long and there may be up to 50 in each pod. Pod midge larvae feed for about 4 weeks, then pupate in the soil (Winfield 1992). Adult midges emerge from their pupae about mid-May. The insect overwinters as an aestivating larva in a cocoon in an earthen cell, and is stimulated to pupate when soil temperature and especially moisture are optimal. Not all the larvae break aestivation and pupate in any one year; small numbers of adults may emerge from old oilseed rape 3 years after the crop was last grown. The new season's adults, produced from larvae in oil seed rape pods, emerge and attack the crop anew; there might be three to four overlapping generations during the summer (Anonymous 1983). Four generations were reported at Rothamsted, two overlapping in May/June, a third in July and a fourth in August (Winfield 1992).

In the Czech Republic, repeated damage was so extensive to stands at some locations, despite intensive chemical protection, that growers reevaluated the economic advantage of growing rape (Kazda 2002). At the beginning of the 1990's, an infestation of 10–15% damaged pods on the boundaries of the plot was considered high. Nowadays, such damage is unexceptional and is almost taken as not serious (Kazda *et al.* 2005). Šedivý and Vašák (2002) reported e.g. damage to pods in winter rape ranging between 44% and 55.3%, and in spring rape from 46.4% to 53.6%. Damage by the midge was higher on lateral stems of the plant than on the main inflorescence.

Manufacturers of insecticides recommend the time of application according to the flying activity of pod midge; the time of maximal flying activity is at the beginning of rape flowering to the stage of full flowering (Anonymous 2003, 2005b). Farmers often consider that application at this term is not sufficiently effective, some think that this could be caused by a weak active ingredient.

For our tests we chose the two most used insecticides that are permitted for use in rape against the pod midge. Calypso 480 SC contains the active ingredient thiacloprid (Figure 1) from the group of neonicotinoids. It acts as contact and feeding poison, has excellent systemic characteristics and a new way of interfering with the transmission of nervous impulses. The preparation Karate with Zeon Technology contains the active ingredient lambda-cyhalothrin (Figure 2), is a non-systemic, synthetic pyrethroid with broad spectrum action against pests at all stages of development. It kills as contact and feeding poison. In our experiments we used the dosages recommended by the manufacturers. Our work aimed to clarify the influence of application terms, and whether date of application has any effect on the level of damage caused by gall pod midge and on final yields of rape.

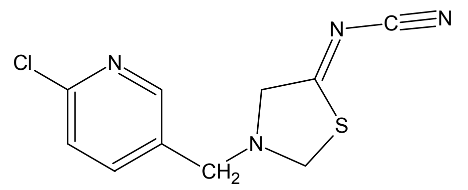

Figure 1. Active substance thiacloprid: (*Z*)-[3-[(6-chloro-3-pyridinyl)methyl]-2-thiazolidinylidene] cyanamide

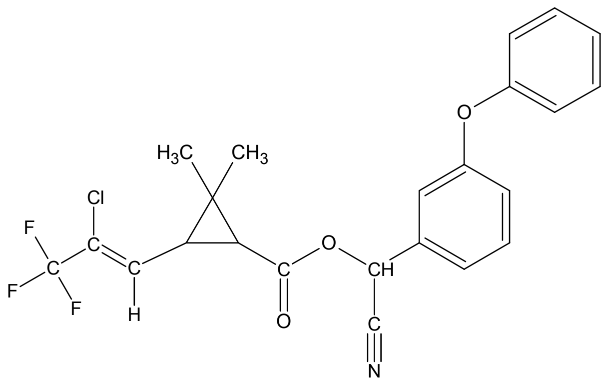

Figure 2. Active substance lambda-cyhalothrin: alpha-cyano-3-phenoxybenzyl-3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2dimethyl-cyclopropane-carboxylate

MATERIALS AND METHODS

Localities. The experiments were done at the three localities Humpolec (49°32'N, 15°21'E), Nechanice (50°12'N, 15°40'E) and Uhříněves (50°10'N, 14°40'E) in the Czech Republic. Cv. Liprima was used in the trials that were seeded on 28 August 2004, at 12.8 × 8 cm spacing in 5 × 5 m plots in a randomised block design with four replicates of each treatment and 80 cm between plots. Standard agronomic practices (without insecticides) were used. At each locality the activity of the pod midge was monitored with six Möricke dishes placed in growth of untreated winter rape. The monitoring lasted from 6 May (BBCH 57) till 6 July (BBCH 77). These dates are at the beginning and the end of flying activity in growth of winter rape. An overview of the flying activity is shown in Figure 3.

Treatment. Application of lambda-cyhalothrin (Karate Zeon 5CS, 7.5 g a.i./ha, Syngenta International AG) was compared with that of thiacloprid (96.0 g a.i./ha, Calypso 480 SC, Bayer GmbH) at different growth stages. These were BBCH 65 at full-flowering, and BBCH 67 at the end of flowering (Meier 2001). All treatments were applied at 3.4 bars (0.34 MPa) with 400 l/ha, using a SOLO 432 backpack sprayer with a solid cone swirl nozzle. The early treatment was done on 20 May at stage BBCH 65, and the later one on 4 June at stage BBCH 67. Control plots were sprayed with water only.

Evaluation and data analysis. Two hundred pods were collected from 10 plants selected at random in each plot 20 days after the later application, i.e. on 24 June at all localities. The mean percentage of infested pods (% efficiencies of treatments against pod midge) were determined for each treatment and using Abbott's formula and efficiency data transformed as $y' = \arcsin\sqrt{(y/100)}$, the mean corrected % efficiencies were calculated. All plants at Humpolec and Nechanice were harvested with a Seedmaster Advance on 5 and 7 August, respectively, and the undamaged seeds were air-separated and weighed.

RESULTS

The earlier treatment of rape was done when catches in the traps indicated that the first flying activity of adults (Figure 3) had finished. The later treatment was done at the beginning of the flying activity of the second generation (Figure 3).

The biological efficiency of the preparations was evaluated on the 20th day after the second application. At Uhříněves and Nechanice the mean number of pods of the control plots damaged by the midge was 25.0% and 19.5%, respectively. At Humpolec there was heavy infestation, with 86.0% of the pods in the control damaged by gall pod midge (Table 1).

At all localities, the efficiency of neonicotinoid thiacloprid was higher when applied after flowering, stage BBCH 67, than at full flowering, stage BBCH 65 (Table 1). Significantly higher differences between terms of treatments were found at Uhříněves and Nechanice ($F = 8.48$; d.f. = 4,15; $P < 0.001$ and $F = 3.48$; d.f. = 4,15; $P < 0.033$; respectively). The efficiency of treatment at full flowering was so low at Uhříněves and Nechanice, that the percentage of damaged pods was not significantly different ($P \leq 0.05$) from the untreated control. Such low efficiency was also reflected by the yield at Nechanice (Table 1). Though the average yield after treatment at stage of flowering was about 11.5% higher than in the control, the difference was not statistically significant ($P \leq 0.05$). At Uhříněves, yield could not be evaluated because of heavy damage from a hailstorm before harvest. At Humpolec, where very heavy

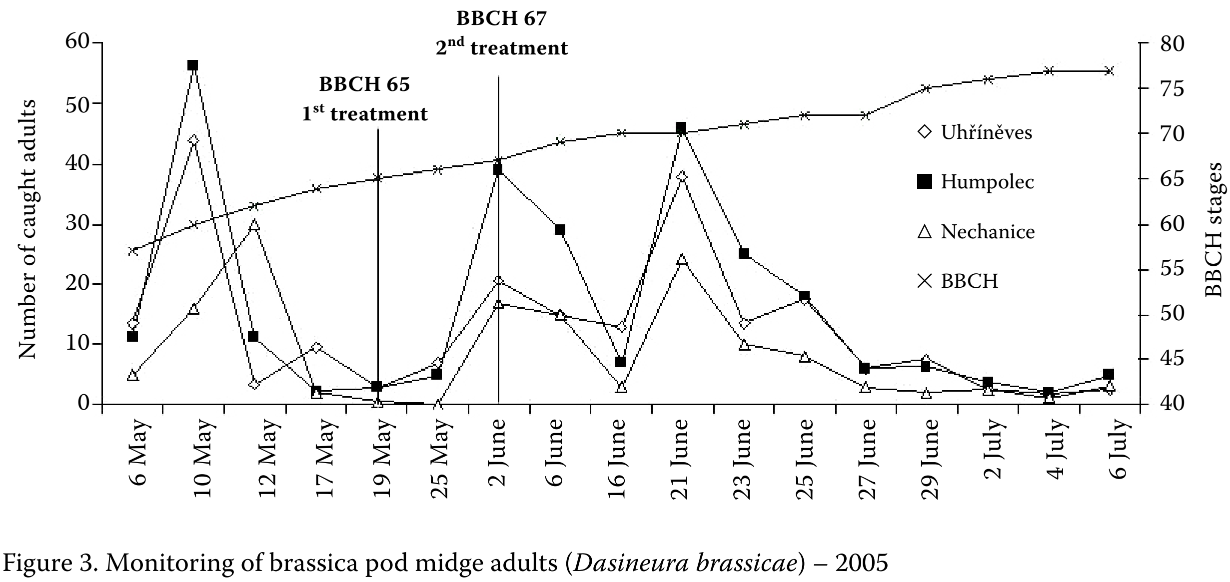

Figure 3. Monitoring of brassica pod midge adults (*Dasineura brassicae*) – 2005

Table 1. Effects of thiacloprid and lambda-cyhalothrin applied against brassica pod midge on oilseed rape at Uhříněves, Humpolec and Nechanice

Location	Active ingredient	Insecticide	Dose (g a.i./ha)	Term of treatment (BBCH)	Mean % infested pods (± SE)	Mean corrected % efficiency of treatment	Mean yield of undamaged seeds (t/ha)	Mean corrected % efficiency of treatment
Uhříněves	Thiacloprid	Calypso 480 SC	96.0	20 May (65)	$21.3 \pm 4.5^{ab*}$	14.8	ND	ND
	Thiacloprid	Calypso 480 SC	96.0	4 June (67)	7.5 ± 2.9^{c}	70.0	ND	ND
	Lambda-cyhalothrin	Karate Zeon 5 CS	7.5	20 May (65)	13.8 ± 3.9^{b}	44.8	ND	ND
	Lambda-cyhalothrin	Karate Zeon 5 CS	7.5	4 June (67)	9.8 ± 3.8^{c}	60.8	ND	ND
	Control				25.0 ± 6.5^{a}	0	ND	ND
Humpolec	Thiacloprid	Calypso 480 SC	96.0	20 May (65)	43.0 ± 11.3^{bc}	50.0	4.97 ± 0.1^{a}	102.0
	Thiacloprid	Calypso 480 SC	96.0	4 June (67)	15.0 ± 7.3^{d}	82.6	5.38 ± 0.1^{b}	110.5
	Lambda-cyhalothrin	Karate Zeon 5 CS	7.5	20 May (65)	35.5 ± 11.5^{bcd}	64.5	4.99 ± 0.1^{a}	102.5
	Lambda-cyhalothrin	Karate Zeon 5 CS	7.5	4 June (67)	27.5 ± 19.4^{cd}	72.5	5.39 ± 0.1^{b}	110.7
	Control				86.0 ± 35.3^{a}	0	4.87 ± 0.1^{a}	100.0
Nechanice	Thiacloprid	Calypso 480 SC	96.0	20 May (65)	11.3 ± 3.3^{ab}	42.3	3.92 ± 0.3^{ab}	111.5
	Thiacloprid	Calypso 480 SC	96.0	4 June (67)	10.0 ± 1.9^{b}	48.7	4.05 ± 0.1^{b}	115.4
	Lambda-cyhalothrin	Karate Zeon 5 CS	7.5	20 May (65)	16.0 ± 4.6^{ab}	17.9	3.94 ± 0.2^{ab}	112.1
	Lambda-cyhalothrin	Karate Zeon 5 CS	7.5	4 June (67)	10.5 ± 4.9^{b}	46.2	4.01 ± 0.1^{b}	114.1
	Control				19.5 ± 5.8^{a}	0	3.51 ± 0.2^{a}	100.0

*Means followed in the same column by the same letter are not significantly different ($P \leq 0.05$); ND = not determined damage by pod midge (86 % in the control) was found, the efficiency of neonicotinoid thiacloprid was the most significant of all localities (Table 1). Compared with the control, the number of damaged pods was decreased by 50% through application at full flowering, and by 82.6% by treatment after flowering (F = 3.30; d.f. = 4,15; P < 0.039). Nevertheless, the yield of seeds was significantly higher (F = 5.53; d.f. = 4,15; P < 0.006) only when the application was done after flowering.

The effect of pyrethroid lambda-cyhalothrin was also higher at all localities if it was applied after flowering rather than in the stage of full flowering (Table 1). A significantly higher difference (P ≤ 0.05) between terms of treatment was found only at Uhříněves. Only with the later term of application, after flowering, was the yield significantly higher (by 10.7% and 14.1%, respectively), than that of the control (P ≤ 0.05) at both Humpolec and Nechanice (F = 5.53; d.f. = 4,15; P < 0.006 and F = 7.71; d.f. = 4,15; P < 0.001; respectively). With application at full flowering, the yield of seeds was also higher against the control (12.1% and 2.5%, respectively) at both Nechanice and Humpolec, but the differences were not statistically significant (P ≤ 0.05) (Table 1).

DISCUSSION

The gall pod midge has usually three generations per year in Europe. The first and second generations attack winter rape, while part of the second generation develops on spring rape (Axelsen 1992; Kelm & Kaczmarzyk 2003; Kazda *et al.* 2005). In our experiments, the flying activity of adults of the midge was determined with yellow dishes which were placed in growth of untreated winter rape. The mean number of adults caught at every locality made it possible to determine the flying activity of two generations in 2005. While the flying activity of the first generation was of only short duration (maximum 3–5 days), that of the second generation lasted far longer (maximum 18–20 days). The much reduced flying activity on 16 June was caused by a cold and rainy period.

Losses in yield caused by gall pod midge damage are generally increasing (Kazda *et al.* 2005). Manufacturers producing insecticides for plant protection recommend applying insecticides according to flying activity of the midge, i.e. at its maximum flying activity (Anonymous 2005a, b), or according to the growth stage of rape in time from yellow bud BBCH 59 to the stage of full flowering BBCH 65 (Anonymous 2005b). In the present experiment we found that preparations were significantly more efficient if applied at the stage after flowering or, according to signalisation from trap catches, at the beginning of flight activity of the second generation. The gall pod midge is not able to lay eggs into undamaged pods (Ankersmith 1956; Doberitz 1973); in earlier papers the authors showed that it can lay eggs only into young pods that are damaged by cabbage seed weevil (Winfield 1967; Czajkowska & Dmoch 1975). Other authors found, however, that the midge is not dependent solely on occurrence of the cabbage seed weevil, but could lay its eggs also into older pods that had been damaged by different factors (fungus, hailstones and other mechanical damages (Kazda *et al.* 2005). Our experimental results showed that treatment against the second generation of adults is more important than an early treatment against the first generation of adults. Treating the first generation with its very short period of flight activity has to be timed exactly and would thus be very complicated in practice; furthermore, the application could negatively affect nontarget invertebrate fauna (Raw 1989). Our experiments demonstrated that treatment against the second generation in the final stage of flowering (BBCH 67–68) promises significant increases of yield.

The two active ingredients we tested are registered against gall pod midge in the Czech Republic; at the same time they are amongst the most used insecticides (Kazda *et al.* 2005).

The ingredient thiacloprid, used by us in preparation Calypso 480 SC, has effects as contact and feeding poison with systemic impact (Anonymous 2003, pp. 111). Its mechanism of effect is based on interference with nervous transmission impulses of the insect's nervous system (Kagabu *et al.* 2002).

The second preparation we used, Karate with Zeon technology 5 CS, is an non-systemic pyrethroid insecticide with the active ingredient lambda-cyhalotrin. This active ingredient has very good UV stability, and because of minimal volatility gives long-lasting residual effect. This efficiency could remain for 10 days in optimal conditions (Whitacre & Ware 2004). Through these characteristics of the active ingredients (systemic or stability in different conditions), applying these preparations would not protect the plants from the beginning of flowering to full flowering, and would no longer be sufficient against the second generation of gall pod midge. In our experiments we found that the best term of treatment is in the final stage of flowering or according to catches in insect traps that signal the beginning of flight activity of the second generation. The harm done by the second generation seems to be very important economically, thus calling for further studies that will determine the harmful threshold of gall pod midge.

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