BIONOMICS AND ECONOMIC MEANING OF BRASSICA POD MIDGE (*DASINEURA BRASSICAE,* WINNERTZ) IN NEW TECHNOLOGIES OF WINTER RAPE CULTIVATION*

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Brassica pod midge (*Dasineura brassicae* /Winnertz/) now belongs to the most serious pests of winter rape in the Czech Republic. In the years 2002–2004 field small-plot trials were established on several locations – Prague-Uhříněves, Humpolec, Opava and Nechanice. The study was aimed at explaining bionomics, economic meaning and protection against this pest. Harmful presence of adult midges was found from the beginning of May to the half of June. Ovipositing was observed repeatedly from up to 5 cm long pods without mechanical damage. The best results in protection were obtained with application of preparations in the time of finishing blossoming or even later. In this period efficient substances in system preparations affect the larvae. When pyretroids were applied in the time of flowering, they were found as inefficient. The effect of time of treatment is statistically significant on the number of damaged pods as well as on the yield. The best variant of protection increased the yield by approximately 10% when compared with untreated control.

winter rape; animal pests; pod pests; bionomics of brassica pod midge; pesticides; protection; economic meaning

INTRODUCTION

The Czech Republic belongs to important rape growers in relation to the size of cultivated areas. Winter seed rape in the 1990s started to be gradually cultivated in all regions of the Czech Republic. In 1990 it was cultivated on 105,000 hectares, in 1993 on 162,000 hectares, in 1997 on 220,000 hectares and in 1999 – 349,000 hectares and even in the years 2002 and 2003 (in unfavourable years for winter rape) its area was about 300,000 hectares. Average percentage of winter rape on arable land varies slightly above 12%, but this number does not reflect actual conditions on Czech field. On some locations the percentage of winter rape and other cabbage family species (spring rape, mustard and traditional vegetables etc.) it reaches 30%, up to 50% of arable land in extreme cases. The percentage of plants of the cabbage family has been increasing in the recent period by their utilization as catch crops.

The situation is worsened when on farms with high percentage of plants from the cabbage family no tillage technology of stand establishment is introduced, though it is cheaper, but in view of soil fertility and protection against diseases and pests. However, the situation is more complex, because soil processing is affected also by a useful entofauna, particularly of the ground beetles (*Carabidae*) and the rove beetles (*Staphylinidae*). Rotrekl (2003) did not found more significant differences between tilled soil and that processed by minimum technologies, though their number was slightly increasing on areas without tillage in some predatory species.

In recent years problems of rape growers have been rising with protection of stands against diseases and pests. Except formerly usual protection against pollen beetle, regular protection against turnip ceutorrhynchus (*Ceutorhynchus napi* /Gyllenhal/) and cabbage stem weevil (*Ceutorhynchus pallidactyllus* /Marsham/) started at the end of the 1980s at the beginning of spring. Since the mid of the 1990s many growers, especially in warmer regions, have to treat the rape constantly after emergence and during autumn against flea beetles (*Phyllotreta*), moths (*Agrotis*) and grey field slugs (*Deroceras*). In recent years the so-called pod pests of rape caused great economic damage to many fields, although economic meaning of seed weevil (*Ceutorhynchus obstrictus* /Marsham/) is falling gradually.

Weevil adults appear before anthesis, though, abundant in the stands together with pollen beetle *(Meligethes aeneus* /Fabricius/, but greater damage to pods has not been found in recent years. Anyway, insecticides against pollen beetles often exterminate adults. Larvae in pods cause damage only to several seeds and pods are normally developing. In particular, in new varieties with greater pods, damage is not so visible. Small larvae appear usually as late as during random control of pods.

The first serious damage caused by brassica pod midge (*Dasineura brassicae*) started to appear significantly on greater areas. The significance of this danger-

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ous pest has risen considerably since the last century and particularly in weak stands of rape of 2003 it caused here and there that looked very seriously during visual control of the rape stand. Repeated damage to stands despite intensive chemical protection on some locations was so extensive that growers revaluate economic advantage of rape cultivation (Kazda, 2002). At the beginning of the 1990s infestation reaching 10–15% of damaged pods on the boundaries of the plot was considered strong. Nowadays, such damage is unexceptional and almost is not meant as serious. Šedivý and Vašák (2002) reported e.g. damage to pods in winter rape Lirajet ranging between 44% and 55.3% and in spring rape on average from 46.4% to 53.6%. Harmfulness of pod midge was higher on lateral stems of the plant than on the main inflorescence.

Economically significant changes in incidence of pests and diseases from the recent period are many times documented in Czech conditions and in neighbouring countries Germany, Poland, Hungary and Slovakia as well (Kaczmarzyk, 2003; Mrowczynski et al., 2004).

Brassica pod midge has many qualities identical with other representatives of the pod midge family (*Cecidomyiidae*). Adults are tiny mosquitoes 1–2 mm long insects with extra long extremities, what is a reliable differentiating feature for field workers that differs pod midges in rape from other similar minute species of dipterous or hymenopterous insects (Skuhravá, Skuhravý, 1960).

The first cases of the presence of brassica pod midge are recorded at the turn of April and May. Adults leave the pupa in soil especially in morning hours, then eggs are lying. Males fly mainly near the ground, where they copulate and soon die. Females move around the flowers and rape pods. Maximum of their incidence is usually at noon and in the afternoon under windless sunny weather. They cannot be found in evening and nocturnal hours. Adults almost do not eat during their life. They live very short – 1 to 3 days. Fertilized females look for ovipositing also mechanically undamaged pods practically of all sizes, although they prefer young pods up to 3 cm. Females oviposit several tens of eggs, because several females oviposit into single pod, more than 100 apodic acephal small pupae can be developed. Larvae enzymatically dissolve the wall of pod. Then they suck out the pre-digested content. Seeds are not directly damaged. Nevertheless, pods are deformed, burst and seeds fall out. It is typical that no residues of excrements are present in damaged swollen pod, so frequent in damage caused by larvae of butterflies and sawflies, because larvae do not excrete it.

Pods are opening and larvae leave them before developing into a pupa and they do it in the ground up to depth of 5 cm in maximum. The time of pupating lasts 5–15 days. So, the development of single generation persists maximum 3–4 weeks. The second generation appears at the turn of May and June. Polish observations showed that the second generation is 100–1000 times more numerous than the first one (verbal communication). Adults of this second generation according to authors' monitoring oviposit even into relatively great mechanically undamaged pods.

Pod midge may have in Czech conditions as many as 6 generations, the most harmful are those of the 1^{st} and 2^{nd} generations, later pod midge is developed in weeds of the cabbage family.

It is typical for pod midge that pupae stay lying. A part of adults is not hatching from pupae on a usual date, but hatching can be delayed by several days, months or even years. The length of diapause is possibly affected by temperature and intensity of solar radiation and may be different in each region of spreading. The authors found that the strongest correlation is between diapause and amount of global solar radiation. If it measured less than 71.1 kWh/m^2 larvae entered the stage of diapause (Axelsen et al., 1997). Cloudy weather and thick rape stands as well as other crops, maybe also they decrease the number of hatching adults, as we observed it in 2004. Exact data on the length of diapause of brassica pod midge are not known in the Czech conditions, but lying too long – up to 12 years – in some other species of brassica pod midge is described in the literature (Skuhravá, Skuhravý, 1960). Williams et al. (1987) reported the lasting of diapause even 5 years. Practical consequence is that adults of pod midge species occur in the stands practically continuously only in dependence on the temperature and moisture. They may appear gradually also on the plots where a crop of the cabbage family has been cultivated in recent years.

Chemical protection is difficult and full of problems. Adults appear in the stands continuously almost from May. Their life cycle in spite of pollen beetle or seed weevils is fast. Hatching, copulation and ovipositing take place frequently for 24–48 hours. Brassica pod midge then naturally dies and is replaced by another adults in several days. Regarding the protection of bees the selection of suitable insecticides is limited. Repeated treatments are complicated due to bad access to stands of grown rape by technology applied. The situation is changing quickly and more and more growers own modern sprinklers of high throughput.

The Department of Plant Protection of the Czech University of Agriculture Prague in co-operation with the Union of Growers and Processors of Oilseed Crops has been dealing with the problems of pod pests since 2000, when growers monitored strong incidence and great damage, despite the fact that they carried out in that time recommended protection by pyretroids at the onset of flowering. At first the development and way of damage to stands seed weevil and brassica pod midge in the stands and the data compared with so far published data. At the same time an actual harmfulness of this pest was studied, although growers by their visual estimation of damage to stand reported decreased yield by 30% and more. Regressive control of such great losses and by comparison of actually achieved yield confirmed they as improbable. Since 2001 small-plot trials have been establishing initially small, but gradually they were extending. These experiments were aimed at objective verifying bionomics of this pest and finding sensitive period in its development that can be used in efficient protection. It was found with time that it is necessary to bring new strategy of protection, as the registered preparations of those times were inefficient. Based on authors' experience with other pests of agricultural crops from the dipterous (*Diptera*) and some pod midges they supposed that it is necessary to prepare the system of protection including combination of cultural practices and systems of sprayings with so far not employed efficient substances against pod midge. Necessary partial aim was to find an actual harmfulness of pod midge and decrease in the yield, because with respect to economic situation of majority of grower it was inevitable to take into account return of invested finance.

Based on the field observations in 2000 and experiments performed in 2001 it was proved that the life cycle of brassica pod midge is partly different from usually available data. The relation to the development of seed weevil was not clear, because common damage to pods, so often described in literature, was not found. The course of harmfulness was longer and probably could not be caused only by the first generation of pod midge that supposedly oviposits into small pods after blossoms shedding. It was proved in experiments in 2001 that routine application of registered as well as newly tested preparations in the time of blossoming was inefficient. The same observations were obtained from many growers in the whole territory of the Czech Republic.

MATERIAL AND METHODS

In the years 2002–2004 The Department of Plant Protection of the Czech University of Agriculture Prague in co-operation with the Union of Growers and Processors of Oilseed Crops and some producers and distributors of pesticides established exact small-plot trials (the area of a plot was 10 m^2 in 3 replications in 2003 and 4 replications were in 2004) on some locations – in Prague-Uhříněves, Humpolec, Opava and Nechanice. Except Prague-Uhříněves, all experimental stations were accredited for registration trials SRS.

The presence on pod midge was extra abundant on all experimental locations in 2003 and was lower in 2004, but significantly exceeding so far given critical number (the threshold of harmfulness).

Zero variants of the area 10 m^2 were included among different experimental variants that perfectly isolated experimental plots in both the years. The number of small plots in the block was in fact double.

In the cultivation year 2002–2003 variants from Table 1 were included in the trial on the location Prague-Uhříněves, Humpolec and Opava:

The rate of spray mixture was 500 l/ha.

The trial was established with the hybrid of winter rape Kapitan.

Based on the experience from the previous year the trial was established in the growing year 2003–2004 and expanded by further variants – their survey is in Table 2. The basic methodology remained the same.

The trial was established in the locations – Prague-Uhříněves, Humpolec and Nechanice near Hradec Králové. The rate of spraying mixture was 400 l/ha.

The trial with hybrid rape Pronto was established in the year 2003–2004.

The evaluation of pod infestation was done by two following ways:

1) According to the methodology, when minimal three plants are chosen from each experimental plot and the number of infested and healthy pods are estimated, then expressed in percentage. The number of evaluated pods must not decrease below 200.

2) Regarding the fact that these experiments were not carried out only for efficiency of preparations, but the authors wanted to explain at least partially the bionomics of the pest, the above method seemed be a little accurate. They tested their own method that has become to be good since the year 2001. On different plots and on opposite places areas of 0.25 m^2 were demarcated and the total number of damaged pods was determined.

Table 1. Survey of experimental variants in the year 2002–2003

Variant	Preparations	Experimental dose	Application date	Active ingredient (content)
1	Control	–	–	–
2	Decis EW 50	0.15 l/ha	full blossom	deltamethrin
3	Mospilan 20 SP	120 g /ha	full blossom	acetamipirid
4	Mospilan 20 SP	120 g /ha	overblowing	acetamipirid
5	Calypso 480 SC	0.2 l/ha	full blossom	thiacloprid
6	Combination Decis + Calypso 240 OD (oil formulation)	0.15 l/ha + 0.4 l/ha		deltamethrin+ thiacloprid
7	Spodnam DC	1.25 l/ha	full blossom (2 sprayings after 7 days)	pinolene
8	Botanical insecticide	1.5 l/ha	full blossom	experimental mixture of natural substances
9	Frutapon 7E	4%	full blossom (3 repetitions in four days interval)	oil

Table 2. Survey of experimental variants 2003–2004

Variant	Preparations	Dose	Date	Active ingredient
1	Control	–	–	–
2	Karate Zeon 5 CS	0.15 l/ha	full blossom	lambda – cyhalothrin
	Mospilan 20 SP	0.120 kg/ha		acetamipirid
3	Karate Zeon 5 CS	0.15 l/ha	full blossom	lambda – cyhalothrin
	Mospilan 20 SP	0.120 kg/ha	tank mix	acetamipirid
	Frutapon 7E	2%		oil
4	Mospilan 20 SP	0.150 kg/ha	overblowing	acetamipirid
	Mospilan 20 SP	0.120 kg/ha	after 3 weeks	acetamipirid
5	Mospilan 20 SP	0.180 kg/ha	overblowing	acetamipirid
6	Calypso 480 SC	0.2 l/ha	full blossom	thiacloprid
7	Calypso 480 SC	0.2 l/ha	overblowing	thiacloprid
8	Proteus	0.6 l/ha	full blossom	thiacloprid + deltamethrin
9	Calypso 480 SC	0.2 l/ha	full blossom	thiacloprid
	Horizon	1 l /ha	tankmix	tebuconazole
10	Greemax	40 ml	overblowing	non-pesticide substance
	Botanical insecticide	1.5 l/ha	tankmix	mixture of natural substances
11	Greemax	40 ml	full blossom	non-pesticide substance
	Calypso	0.2 l/ha	tankmix	thiacloprid
12	Greemax	40 ml	full blossom	non-pesticide substance
	Calypso	0.15l/ha	tankmix	thiacloprid
13	Karate Zeon 5 CS	0.15 l/ha	full blossom*)	lambda – cyhalothrin
14	Karate Zeon 5 CS	0.15 l/ha	full blossom	lambda – cyhalothrin
	Amistar	1l/ha	tankmix	azoxystrobin
15	Karate Zeon 5 CS	0.15 l/ha	full blossom	lambda – cyhalothrin
	Alto Combi 420 SC	0.5 l/ha	tankmix	carbendazim cyproconazole

*) on the location Humpolec at overblowing

In 2003 the trials were assessed on the date 19th May to 22nd May. Regarding the presence of the pod midge of the second generation in 2003, the Prague-Uhříněves location was evaluated two times in 2003 and the second evaluation was done in the mid-June. In 2004 only the first generation of pod midge caused damage and the trials were evaluated on all locations in the mid-June.

The trials were similarly exactly evaluated by the yield and the results were calculated for 12% moisture. Statistical evaluation was done by variance analysis.

Application of preparations was in both years done by exact back sprinkler according to the requirements SRS for registration trials.

Plants were not significantly infested by other species of animal pests, fungal diseases did not appear in 2003, even slight incidence of fungi *Sclerotinia sclerotiorum* and *Leptosphaeria maculans* was found in 2004.

RESULTS

It is evident from Table 3 that the results on the location Prague-Uhříněves in the variants are divided into two groups by the yield. The yield was positively affected by the application of the preparations in variants 4, 6 and 9. The other variants of the treatment practically did not affect the yield compared to the control.

Statistical evaluation is presented in Table 4.

The number of damaged pods in three effective preparations was on the first date significantly lower, but during following three weeks was increasing faster than in the other inefficient variants. Statistical evaluation is presented in Tables 5 and 6.

The difference among groups of efficient and inefficient variants is in the number of damaged pods on the first and the second date of observation and the yield statistically significant on the level of significance 95%.

Similar results were recorded on the location Humpolec. The treatment with the preparation Decis is relatively better compared with the Prague-Uhříněves location and very good results were obtained after application of the preparation Spodnam. However, this was not confirmed on the other locations (Table 7).

The total results for all locations are summarised in Tables 8 and 9.

It should be pay attention to high increase of the yield in Opava is caused by very strong damage to the control and extremely low yields. Results in Uhříněves and Humpolec are more standard for practice. The yield level in Uhříněves over 4 t/ha and in Humpolec ranged be-

Table 3. Results – location Prague-Uhříněves 2003

Variant		Number of damaged pods 20 May 2003	Number of damaged pods 17 June 2003	Increment of infestation (numbers of pods)	Increment of infestation (percentage)	Yield (counted to t/ha)
1	**Control**	1713	1831	118	6.9	4.19
2	**Decis EW 50**	1340	1691	351	26.2	4.19
3	**Mospilan 20 SP-full blossom**	1310	1362	52	4.0	4.18
4	**Mospilan 20 SP-overblowing**	**763**	**961**	**198**	**26.0**	**4.54**
5	**Calypso 480 SC**	967	1219	252	26.1	4.25
6	**Combination Decis + Calypso 240 OD (oil formulation)**	**458**	**1030**	**572**	**124.9**	**4.65**
7	**Spodnam DC**	1432	1704	272	19.0	4.28
8	Botanical insecticide	1614	1770	156	9.7	4.16
9	**Frutapon 7E**	**480**	**728**	**248**	**51.7**	**4.62**

Table 4. Statistical evaluation of yield, locality Prague-Uhříněves.

Source of variability	Df	Sum of squares	Mean square	*F*-ratio ++
Variant	8	1.156	0.145	4.04 ++
Repetition	2	0.304	0.152	4.25 +
Residual	16	0.573	0.036	
Total	26	2.033		
	Yield	0.01	0.05	
6.	Proteus	4.65	A	A
9.	Frutapon	4.62	AB	A
4.	Mospilan (e.f.)	4.54	ABC	AB
7.	Spodnam	4.28	ABCD	BC
5.	Calypso	4.22	ABCD	BC
2.	Decis	4.19	BCD	C
1.	Control – Standard	4.19	BCD	C
3.	Mospilan (f.f.)	4.18	CD	C
8.	Azadirachtin	4.16	D	C

Table 5. Statistical evaluation of number of damaged pods, 1st assessment, locality Prague-Uhříněves, arranged in descending order – control variant most damaged, Frutapon variant least damaged

Source of variability	Df	Sum of squares	Mean square	*F*-ratio ++
Variant	8	592076.667	74009.583	33.47 ++
Repetition	2	11630.889	5815.444	2.63
Residual	16	35379.111	2211.194	
Total	26	639086.667		
	0.01	0.05		
1.	Control – Standard	A	A	
8.	Azadirachtin	AB	AB	
7.	Spodnam	AB	BC	
2.	Decis	B	C	
3.	Mospilan (f.b.)	B	CD	
5.	Calypso	C	D	
4.	Mospilan (ob.)	CD	DE	
9.	Frutapon	D	E	
6.	Proteus	D	E	

Table 6. Statistical evaluation of number of damaged pods, 2nd assessment, locality Prague-Uhříněves, arranged in descending order – control variant most damaged, Frutapon variant least damaged

Source of variability	Df	Sum of squares	Mean square	*F*-ratio ++
Variant	8	434966.519	54370.815	15.62 ++
Repetition	2	38950.296	19475.148	5.60 +
Residual	16	55679.704	3479.981	
Total	26	529596.519		
		0.01	0.05	
1.	Control – Standard	A	A	
8.	Azadirachtin	AB	A	
7.	Spodnam	AB	A	
2.	Decis	AB	A	
3.	Mospilan (f.b.)	BC	B	
5.	Calypso	C	BC	
6.	Proteus	CD	CD	
4.	Mospilan (ob.)	CD	CD	
9.	Frutapon	D	D	

Table 7. Damage of pods, Humpolec 6. 6. 2003 (Table 1)

	Variant	Damaged pods	Yield (t/ha)
1	**Control**	1020	2.29
2	**Decis**	1070	2.42
3	**Mospilan**	860	2.29
4	**Mospilan**	785	2.53
5	**Calypso**	913	2.39
6	**Decis + Calypso**	1040	2.4
7	**Spodnam**	942	2.62
8	**Botanical insecticide**	1075	2.27
9	**Frutapon 7E**	**740**	**2.61**

tween 2 and 2.5 t/ha, it did not reach even a tonne in Opava.

The order of variants and efficiency of different sprayings are evident from Tables 8 and 9. Strategy of protection started to shape up, the development of adult pod midge is probably too fast and preparations are not able to prevent ovipositing. Suitable system preparations may prevent further development of pupae. Differences in application of the preparation Mospilan were particularly important on different dates of treatment. Application of Frutapon 7E was efficient, but existing way of application is too expensive. Botanical insecticide was practically inefficient, because it was found out during laboratory testing that it only a little penetrates into tissues through the skin of plants.

It also follows from the results obtained in Prague-Uhříněves that females of pod midge probably oviposited also close before and 14 days after the control done on 20th May, because the number of damaged pods increased significantly particularly in efficient variants. There were enough non-infested pods. In that time pods measured several centimetres, because the development of the rape in 2003 was very fast. This was confirmed also by many observations done on the location Prague-Uhříněves and Humpolec. It was succeeded to make photographs multiple and repeated ovipositing of females on pods up to 5 cm (photos 1 and 2). Mechanical damage was not found on pods, because seed weevil did not appear in the stands in this period. Further develop-

Table 8. Summary of the results 2003 – 3 locations

	Preparation	Prague-Uhříněves	Humpolec	Opava
1	**Control**	inefficient	efficient	inefficient
2	**Decis EW 50**	inefficient	inefficient	efficient
3	**Mospilan 20 SP – full blossom**	**excellent**	**highly efficient**	**excellent**
4	**Mospilan 20 SP – overblowing**	efficient	efficient	efficient
5	**Calypso 480 SC**	**excellent**	efficient	**excellent**
6	Combination Decis + Calypso 240 OD (oil formulation)	efficient	**excellent**	efficient
7	**Spodnam DC**	inefficient	inefficient	inefficient
8	**Botanical insecticide**	**excellent**	**excellent**	*not evaluated*
9	**Frutapon 7E**			

Table 9. Increase of the yield in percentage compared with the control 2003

	Preparation	Opava	Prague-Uhříněves	Humpolec
1	**Control**			
2	**Decis EW 50**	0	6	8
3	**Mospilan 20 SP – full blossom**	**0**	**0**	**40**
4	**Mospilan 20 SP – overblowing**	**8**	**11**	**51**
5	**Calypso 480 SC**	**2**	**4**	**30**
6	**Combination Decis + Calypso 240 OD (oil formulation)**	**11**	**5**	**62**
7	**Spodnam DC**	**2**	**15**	**16**
8	**Botanical insecticide**	**not increased**	**3**	**13**
9	**Frutapon 7E**	10	**14**	*not evaluated*

Photo 1

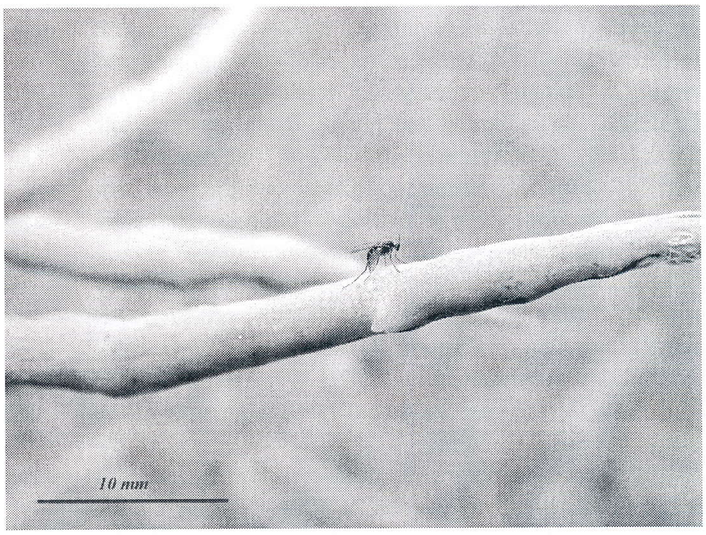

Photo 2

ment of eggs and small pupae into great pods has not been tested directly, because suitable laboratory equipment was not available. This knowledge will be tested in the season 2004–2005 in a laboratory. However, it is sure that pod midge oviposits much longer period of time than it was presupposed. It is usually reported in the literature that pod midge cannot oviposit into undamaged pods. Yet Buhl (1957) has been convinced that pod midges oviposit only mechanically damaged pods but he reported that small pupae of pod midge kill pupae of seed weevil. Skuhravá, Skuhravý (1960) as well as Miller (1956) report similar data. Since that time practically all publications quote this date. Hallberg, Ahman (1987) explain it that anatomic structure of the body of pod midge does not allow ovipositing into pods into undamaged pods. The majority of the authors have identical opinion that damage caused by seed weevil contributes to it the most frequently (Ferguson et al., 1995). Some authors suppose that damage caused by other pests is suitable, e.g. by bugs (Matheson, 1976.). It is from time to time confounded by the fact that bugs occur more significantly in the stands later (Hughes, Evans, 2003).

In 2004 ovipositing into greater pods by pod midges was again observed without any visible damage, but the presence of pod midges in 2004 was irregular. Owing to rainy and windy weather adults appeared abundantly a day and then they were not found in the stands several days. The second generation of pod midges did not develop to the mid-June.

The authors modelled also further development of small pupae after the end of development in pod. The damage of 65–90% of all pods was found in June 2003 in the damage similar to the authors' experiments carried out in Opava. According to very approximate estimation, theoretically more than 10,000,000 pupae can be found in soil after harvest per hectare. Nielsen et al. (1994) found that 400–1200 pod midge pupae per 1 m^2 occurred during winter. In fact much less are hatched, because a strong parasithosis of larvae and pupae is reported. Fergusson et al. (2004) found in England in detailed experiments that emerged from eggs only 7% from larvae of the first generation emerged adults of insects before diapause and only 0.2% of larvae of the first and second generation after diapause. Parasitoids formed 42% of insect adults emerging from pod midge cocoons before diapause and 49% after diapause.

Nevertheless, it has not been clear so far from how many pupae emerges from the following generation and how many larvae and pupae stay lying during winter. Ploughing in into the depth of 15–20 cm can kill the remaining pupae, when regarding the changed temperature and moisture conditions die or emerging small adult is not able to get from the depth to the ground. Soil processing by discs or small ploughshares even into greater depth does not cover reliably pupae and most of them survive.

If winter rape is cultivated in a fast sequence on identical or adjacent plots, ideal conditions for pod midge for the development of its population are prepared in Czech cultivation systems. At the same time, classical soil processing by tillage is reduced that was evidently decisive for destroying of larvae and pupae. Based on the trials Rotrekl (2003) flight of adults from tilled plot is lowered approximately 5 times compared with the plots processed by minimisation technology. Natural enemies are killed by numerous replicated insecticide sprayings.

In foreign countries when the rape is cultivating after a lapse of time 8–11 years on single plot and it is regularly tilled, damaged pods do not appear practically (NPZ – oral communication, 2002).

Results for the year 2004 confirmed the results of the previous year.

The presence of pod midge on the location Prague-Uhříněves was uneven in 2004, because the results were included in the great block of trials and only marginal effect was manifested. At the same time, statistical evaluation showed that the effect of replication was greater than the effect of the variant – Table 10. It follows that the effect of replication seems to be more significant on the location Prague-Uhříněves than the effect of variants, it is probably caused by marginal effect during the presence of pod midges. Therefore the authors used the location Uhříněves only partial evaluation and did not summary evaluation. Fig. 1 summarises the results of damage to pods that are expressed relatively – control = 100%. Statistical evaluation is in Tables 10 and 11.

Evaluation of damaged pods

It follows from Fig. 1 that treatment in the time of overblowing was much more efficient, even when the same preparations were applied. The differences were in variants 2, 3 and 4, 5 or 6 and 7. These results are the same as in the previous year. It is interesting that this effect was manifested also in 2004, when the second generation of pod midge did not cause so great damage like in 2003. The efficiency of the treatment with pyretroid alone in the time of full blossoming was very little, the date of pyretroid application on the location Humpolec was a little delayed by a fault into the time of blossom shedding and efficiency increased – variant 13.

The number of damaged pods:

Variant	Nechanice – full blossom	Humpolec – overblowing
Karate Zeon 5 CS 0.15 l/ha	103% of control	83% of control

Higher efficiency on pod midge was confirmed on none of the locations in variants, where application of insecticide and fungicide was combined – variants 9, 14, 15.

Significantly dropped rate of oil was not manifested favourably on the location Nechanice and Humpolec variants 2 and 3 or 8.

The differences between preparations Calypso 480 SC and Mospilan 20 SP are minimal. If both ways of evaluations are compared, they manifest a high efficiency of both preparations with application in the time of overblowing and their mutual order is changing. Nevertheless the differences are minimal and are given by a necessary error during evaluation – variants 4, 5, 7. Natural insecticide with adding of Greemax was tested to be very good, efficiency of this combination is fully

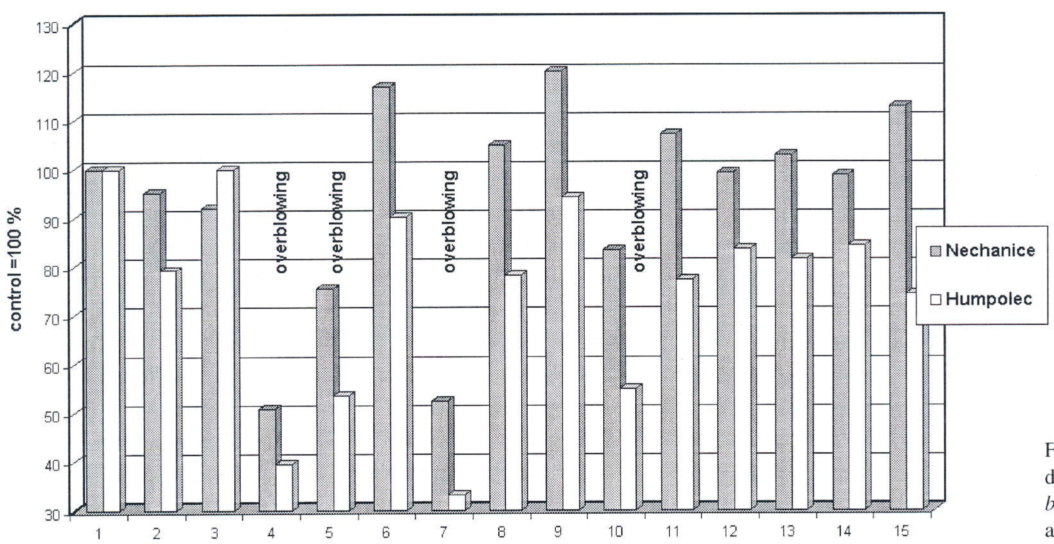

Fig. 1. Number of pods damaged by *Dasineura brassicae* – Nechanice and Humpolec 2004

Table 10. Statistical evaluation of number of damaged pods, locality Humpolec

Source of variability	Df	Sum of squares	Mean square	*F*-ratio ++
Variety	14	64850.933	4632.210	8.19 ++
Repetition	3	5416.183	1805.394	3.19 +
Residual	42	23769.067	565.930	
Order of variants		*)	$p = 0.01$	$p = 0.05$
1.	Control – Standard	164.75	A	A
2.	Karate + Mospilan + oil	164.50	A	A
3.	Calypso + Horizon	155.25	A	AB
4.	Calypso (f.b.)	148.50	A	AB
5.	Karate + Amistar	138.75	A	AB
6.	Greemax + Calypso 0.15	137.75	A	AB
7.	Karate (f.b.)	134.50	AB	B
8.	Karate + Mospilan (f.b.)	130.50	ABC	B
9.	Proteus	128.75	ABC	B
10.	Greemax + Calypso 0.2	127.25	ABC	B
11.	Karate + Alto	122.50	ABC	BC
12.	Greemax + bot. Insecticide	90.25	BCD	CD
13.	Mospilan (ob.)	88.00	CD	DE
14.	Mospilan + Mosp. (3 weeks)	65.00	D	DE
15.	Calypso (ob.)	54.50	D	E

*) Average number of damaged pods per repetition

Table 11. Statistical evaluation of number of damaged pods, locality Nechanice

Source of variability	Df	Sum of squares	Mean square	*F*-ratio ++
Varieties	14	9350.933	667.924	1.60
Repetition	3	666.733	222.244	0.53
Residual	42	17494.267	416.530	
Total	59	27511.933		
Order of variants		*)	$p = 0.01$	$p = 0.05$
1.	Calypso + Horizon	74.50	A	A
2.	Calypso (f.b.)	72.50	A	A
3.	Karate + Alto	70.00	AB	A
4.	Greemax + Calypso 0.2	66.50	AB	A
5.	Proteus	65.00	AB	A
6.	Karate	63.75	AB	A
7.	Control – Standard	62.00	AB	A
8.	Greemax + Calypso 0.1	61.50	AB	AB
9.	Karate + Amistar	61.25	AB	AB
10.	Karate + Mospilan (f.b.)	59.00	AB	ABC
11.	Karate + Mospilan + oil	57.00	AB	ABC
12.	Greemax + bot. Insecticide	51.75	AB	ABC
13.	Mospilan 180 g	46.75	AB	ABC
14.	Calypso (ob.)	32.50	B	BC
15.	Mospilan + Mosp. (3 weeks)	31.50	B	C

*) Average number of damaged pods per repetition

comparable with the best classical insecticides. Greemax much intensified penetration of the preparation into plants. This is confirmed by foreign data that botanical insecticides, which contain natural biologically active substances, can be used also in protection of winter rape like in some other agricultural systems against many pests (Prakash, Rao, 1997; Isman, 1999). Botanical insecticides are preparations containing active sub-

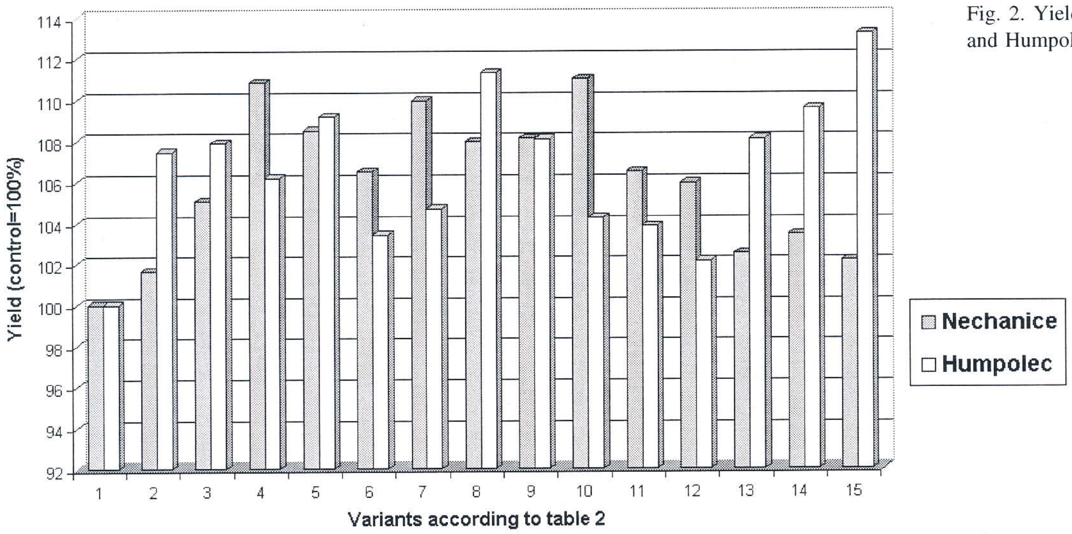

Fig. 2. Yield 2004 – Nechanice and Humpolec

stances azadirachtin and other limonoids, such as salanine, nimbine, nimbiline, what is caused by synergism of effects (Prakash, Rao, 1997). These substances are active only on developing larvae, because they affect disorders of shedding in juvenile stages of insects and have also antiphedant and repellent effects and they decrease reproduction (Mordue et al., 1998; Walter, 1999). Insect adults, i.e. neither useful bees nor different parasites and parasithosis, are endangered. The efficiency of azadirachtin was demonstrated on more than 180 species of pests, comprising also pests of the plants of the cabbage family (Pavela et al. 2002, 2004).

Evaluation of the yield

The yield found from the small-plot trials was calculated for 12% moisture. The yielding level was significantly higher than in the previous year in about 6 t/ha and in Humpolec about 5t/ha.Results are summarised in Fig. 2. Statistical evaluation is in Tables 12 and 13.

Table 12. Statistical evaluation of yield, locality Humpolec

Source of variability	Df	Sum of squares	Mean square	*F*-ratio ++	
Variants	14	15553.733	1110.981	2.75 ++	
Repetition	3	2945.383	981.794	2.43	
Residual	42	16951.867	403.616		
Total	59	35450.983			
Variant order		Variant number	%Stand	*p* = 0.01	*p* = 0.05
1.	15.	K + Alto (f.b.)	113.1	A	A
2.	8.	Proteus (f.b.)	111.3	AB	AB
3.	14.	K + Amistar (f.b.)	109.4	ABC	ABC
4.	5.	M + blossoming	109.0	ABC	ABCD
5.	9.	C + H + (f.b.)	108.0	ABCD	ABCDE
6.	13.	K blossoming	108.0	ABCD	ABCDE
7.	3.	K + M + O + (f.b.)	107.9	ABCD	ABCDE
8.	2.	K + M + (f.b.)	107.3	ABCD	ABCDE
9.	4.	M + M (ob.)	106.0	ABCD	BCDEF
10.	7.	C + (ob.)	104.7	BCD	CDEF
11.	10.	G + BI (ob.)	104.3	BCD	CDEF
12.	11.	G + C lower dose (f.b.)	103.8	BCD	CDEF
13.	6.	C + (f.b.)	103.3	BCD	DEF
14.	12.	G + C higher dose (f.b.)	102.1	CD	EF
15.	1.	Control – Standard	100.0	D	F

Table 13. Statistical evaluation of yield, locality Nechanice

Source of variability	Df	Sum of squares	Mean square	F-ratio ++	
Variants	14	20459.233	1461.374	3.63 ++	
Repetition	3	1587.933	529.311	1.31	
Residual	42	16923.567	402.942		
Total	59	38970.733			
Variant order		Variant number	%Stand	p = 0.01	p = 0.05
1.	10.	G + BI (ob.)	111.0	A	A
2.	4.	M + M (ob.)	110.7	A	A
3.	7.	C + (ob.)	109.8	AB	AB
4.	5.	M + (ob.)	108.3	ABC	ABC
5.	9.	C + H + (f.b.)	108.2	ABC	ABC
6.	8.	Proteus (f.b.)	107.8	ABC	ABC
7.	11.	G + C lower dose (f.b.)	106.5	ABCD	ABCD
8.	6.	C + (f.b.)	106.4	ABCD	ABCD
9.	12.	G + C higher dose (f.b.)	105.9	ABCD	ABCD
10.	3.	K + M + O + (f.b.)	105.1	ABCD	BCDE
11.	14.	K + Amistar (f.b.)	103.4	BCD	CDE
12.	13.	K (ob.)	102.5	CD	DE
13.	15.	K + Alto (f.b.)	102.1	CD	DE
14.	2.	KARATe + Mosp (f.b.)	101.6	CD	DE
15.	1.	Control – Standard	100.0	D	E

Table 14. The effect of treatment by fungicides (scale 9–1; 9 = without incidence)

Variant	Preparation	Dose per 1 ha	Date	Sclerotinia and Nechanice	Sclerotinia and Prague--Uhříněves	Sclerotinia and Humpolec
13	Karate Zeon 5 CS	0.15 l/ha	full blossom	6	6	5.75
14	Karate Zeon 5 CS	0.15 l/ha	full blossom			
	Amistar	1 l/ha	tankmix	8.25	8	7.25
15	Karate Zeon 5 CS	0.15 l/ha	full blossom			
	Alto Combi 420 SC	0.5 l/ha	tankmix	8	8.5	7
9	Calypso 480 SC	0.2 l/ha	full blossom			
	Horizon	1 l /ha	tankmix	6.5	6	6.5
1	Control	–	–	5.5	5	6

Yield increase compared with the controls in the best variants ranged in 2004 in a similar way like in the previous year by approximately 10%, in spite of the fact that this year was observed weaker pod infestation of pod midge than in the previous year and yield level was much higher.

Classical pyretroid treatment in the full blossom brought only a slight increase of the yield. Better results were obtained in Humpolec with delayed application of pyretroids (variant 13). The combination of pyretroid with Mospilan in full blossom increased the yield only a little (variant 2). The addition of oil to this combination increased the yield in Nechanice by 4%, but its effect was not found in Humpolec.

Almost all applications in time of overblowing increased the yields (variants 4, 5, 7, 10). The comparison of both dates of application of Calypso is particularly clear, when later application brought higher yield even by 200 kg (variants 6, 7). However, in 2004 increase of the yield in these variants compared with others is not so high, as it could be expected according to the decrease found in damaged pods. It testifies probably about the capacity of compensation of rape of certain yield losses, if damage does not exceed certain level.

High yield on all locations were recorded after application of the preparation Proteus (variant 8), despite the fact that this preparation did not lower significantly infestation of pods. Satisfactory explanation of this phenomenon has not been found so far.

The results of the preparations Mospilan and Calypso under the dame date of application are fluctuating, but relatively high (variants 4, 5, 7 or 2, 3, 6). It cannot be settled, which preparation increases the yield significantly on all evaluated locations.

Authors' experience with protection against pod midge found in the experiments carried out in last two years are different from the formerly routinely recommended in the Czech Republic treatment by pyretroids at the onset of anthesis. Later application of insecticides or their combination was not recommended earlier (Vašák et al., 2000; Kazda, 2002).

Increases of the yields in variants 9, 14, 15 on the location Humpolec is caused above all by the effect of fungicides to *Sclerotinia sclerotiorum*, because their application showed this year as extra suitable and efficient, as it is presented in Table 14.

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Bionomie a hospodářský význam bejlomorky kapustové (*Dasineura brassicae*, Winnertz) v nových technologiích pěstování ozimé řepky.

Scientia Agric. Bohem., *36*, 2005: 121–133.

Bejlomorka kapustová (*Dasineura brassicae* /Winnertz/) patří v současné době k nejdůležitějším škůdcům ozimé řepky v České republice. V letech 2002–2004 byly založeny polní maloparcelkové pokusy na několika lokalitách – v Praze-Uhříněvsi, Humpolci, Opavě a Nechanicích. Cílem bylo objasnit bionomii, hospodářský význam a ochranu proti tomuto škůdci. Škodlivý výskyt dospělců bejlomorek byl zjištěn od začátku května až do poloviny června. Opakovaně bylo pozorováno kladení vajíček do šešulí až 5 cm dlouhých bez mechanického poškození. Nejlepších výsledků v ochraně bylo dosaženo při aplikaci přípravků až v době odkvétání nebo i později. V tomto období účinné látky systémových přípravků působí na larvy. Aplikace pyretroidů v době květu se ukázala neúčinná. Vliv termínu ošetření je statisticky průkazný na počet poškozených šešulí i na výnos. Nejlepší varianty ochrany zvýšily výnos až o 10 % oproti neošetřené kontrole.

ozimá řepka; živočišní škůdci; šešuloví škůdci; bionomie bejlomorky kapustové; pesticidy; ochrana, hospodářský význam

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