

Biology and harmfulness of Brassica pod midge (*Dasineura brassicae* Winn.) in winter oilseed rape

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SUMMARY

The Brassica pod midge (*Dasineura brassicae* Winn.) is an important pest in oilseed rape (*Brassica napus* L.). It develops two generations per year and overwinters in the larval stage in cocoons in soil. Immigration of the first generation adults lasted from the beginning of April until the end of May. Larvae developed in pods from mid-April to mid-June, causing pod deformation and cracking, which resulted in premature falling out of seeds and yield reduction. Pod damage amounted to 11.6%. The emergence of the second generation adults was detected at the end of May and in the first ten days of June. *D. brassicae* was found to lay eggs in healthy pods and no correlation was found with the cabbage seed weevil, *Ceutorhynchus assimilis* Paykull.

Keywords: Brassica pod midge; Oilseed rape; Life cycle

INTRODUCTION

The brassica pod midge (*Dasineura brassicae*), along with *Meligethes aeneus* (Fabricius), *Ceutorhynchus napi* Gyllenhal, *C. assimilis* Payk., *C. pallidactylus* (Marsham) and *Psylliodes chrysocephala* (L.), belongs to a group of most important pests of oilseed rape in Europe (Alford et al., 2003). It causes damage primarily to pods of winter wheat and spring oilseed rape, but also to other species in the family Brassicaceae.

Larvae enzymatically dissolve the inner tissue of infested pods (Kazda et al., 2005), causing colour change

in the pods, their deformation and cracking, which results in premature seeds dropping. Seed loss of oilseed rape caused by attacks of this species amount to 82% (Williams, 2010).

Over the previous decades, it became an economically important species in many countries. Damage of oilseed rape has been registered in Germany (Büchs & Katzur, 2005; Aljml, 2007), Great Britain (Ferguson et al., 2004), Czech Republic (Kazda et al., 2005; Pavla et al., 2007), Latvia (Grantiņa, 2012), and Sweden (Nilsson et al., 2004).

Over the past thirty-five years of faunistic research in Serbia (1965-2000), *D. brassicae* has been recorded as

a potentially dangerous pest of *Brassica oleracea* and *B. napus* in many localities (Simova-Tošić et al., 2000). In recent years, it has been reported in lower numbers in oilseed rape in the Banat region, (Milovanović, 2007).

Our investigation was motivated by different reports on the importance and harmfulness of this species by foreign authors, and by a very insufficient knowledge of this species in Serbia. The purpose of this work was to monitor the life cycle and harmfulness of the brassica pod midge in oilseed rape, and its correlation with the cabbage seed weevil, *Ceutorhynchus assimilis* Payk.

MATERIALS AND METHODS

A survey of *D. brassicae* was carried out in oilseed rape (*Brassica napus* L.) in 2011, as well as in winter wheat grown in crop rotation with oilseed rape in 2012. The survey was carried out in the locality Stari Žednik near Subotica, where oilseed rape was grown in a 1.5 ha field. Oilseed rape was sown on September 17, 2010, and harvested on June 22, 2011. The growth stages of winter oilseed rape were determined according to the BBCH scale of Weber & Bleiholder (1990).

In the same field, winter wheat was sown on October 20, 2011 and harvested on June 21, 2012.

Yellow Water Traps (YWT), Syngenta type, were used to detect the emergence of first generation adults of *D. brassicae*. They were set up in four places in the middle of the field at 50 m distance.



Figure 1. A funnel trap used to monitor the time when larvae leave pods and go into soil

In order to detect the time when larvae leave into the ground to cocoon, funnel traps were installed underneath plants. On each experimental plot, 8 funnel traps were installed at the beginning of the phenophase BBCH 65 and were kept there until harvest. A funnel trap consists of a plastic funnel leading into a plastic dish with 5% sodium benzoate solution (Figure 1). On the experimental plot, 8 emergence traps were also installed at a distance of 50 m, at the beginning of the phenophase BBCH 68 and were kept there until harvest. Emergence traps are tent-shaped with photo-electors on top, where insects are collected (Figure 2). All traps were checked every 7 to 14 days.

Samples were conserved in 70% ethyl alcohol and conveyed to an entomological laboratory to study them under a stereomicroscope.

Pod damage percentage and the number of larvae of *D. brassicae* per pod were determined by dissection of all pods of the main raceme from 15 plants at the phenophase BBCH 71-73. The percentage of infested pods of both species was calculated using the formula:

$$\text{Infested pods (\%)} = \frac{\text{Infested pods}}{\text{Total pods}} \times 100$$

RESULTS AND DISCUSSION

D. brassicae midges developed two generations per year on the trial site and overwintered in the larval stage in cocoons in soil, as they do in most other European countries (Williams et al., 1987; Ferguson et al., 2004;



Figure 2. An emergence trap used to monitor the emergence of *D. brassicae* from the ground

Aljmi, 2007). The beginning of immigration of the first generation *D. brassicae* adults was detected on April 12, when oilseed rape starts flowering (BBCH 60-62). The immigration of adults was rather extended and lasted until the end of May (BBCH 77-78). Both males and females were found in the samples, although some reports had mentioned that only fertilized females immigrated to oilseed rape fields from their overwintering sites (Williams et al., 1987). The long immigration period of first generation imagines, lasting a month and a half, enables very fragile and short-lived midges to find an adequate phenophase of either winter or spring oilseed rape for their development. However, they prefer winter oilseed rape (Axelsen, 1992; Alford et al., 2003).

A female lays eggs into pods, where larvae develop. In our investigation, larvae dropped on the ground through cracked pods at the end of their three-week long development. Funnel traps were used to monitor the time when they leave pods, and the number of larvae dropping on the ground (Table 1).

First larvae caught in the funnels were found on May 3 (BBCH 71-73) and their abundance was 13.5 larvae/m². Their numbers increased in funnels until June 5 (BBCH 79-80), when the maximum of 11116.5 larvae/m² was reached. Over the following period, the number of larvae decreased until June 21 (BBCH 87-88), when the last ones were found in funnels, i.e. all larvae have left pods and reached soil. The pupal stage lasted for about three weeks after which period the emergence of second generation adults was recorded and monitored using photoelector cages (Table 1).

The beginning of emergence of second generation imagines *D. brassicae* was recorded on May 26 (BBCH

76-78) when 49.4 larvae/m² were found. The highest number of imagines was 177.0/m² and it was recorded on June 5 (BBCH 79-80), while the end of emergence was recorded on June 9 (BBCH 81-83) when the weather became hot and dry. The emergence period of the second generation imagines was 14 days.

The number of emerged imagines was found to be much lower than the number of larvae reaching soil. The total number of emerged imagines in tents was 1995.9/m², or 1.5% of the total number of larvae (131,904.0/m²) in tents. The low number of emerged second generation imagines in the late host phenophase (BBCH 76-78 to BBCH 81-83) did not cause any significant damage to oilseed rape in our survey. In the absence of oilseed rape as a host, larvae of *D. brassicae* are able to develop in weeds of the cabbage family, and then get into soil to overwinter (Kazda et al., 2005).

Low numbers of emerged second generation adults are likely to be the species' survival strategy under different weather conditions. Emergence of adults may be scarce or completely stop, especially in dry years (Nilsson et al., 2004), as recorded during the warm and dry summer of 2011. Besides, low rates of imagines emergence can be conditioned by possible effects of their natural enemies, both predators (Büchs & Alford, 2003; Williams et al., 2010) and parasitoids (Ferguson et al., 2010; Williams & Ferguson, 2010).

Our examination of tents in the summer of 2011, and during the development period of wheat until harvest in the following 2012, showed no flight activity of midges, which indicates that their diapause may last longer than a year, sometimes up to five years (Williams et al., 1987; Alford et al., 2003; Nilsson et al., 2004; Williams & Cook, 2010; Williams, 2010).

Table 1. Mean number of larvae in funnels per m² and mean number of imagines of *D. brassicae* in emergence cages per m² over the period April, 27-June 21, 2011 (BBCH 67-69 - BBCH 87-88)

OSR phenophase	Funnel traps - Mean number of larvae/m ²	Emergence cages - Mean number of imagines/m ²
BBCH 67-69 (April 27 2011)	0.0	0.0
BBCH 71-73 (May 3 2011)	13.5	0.0
BBCH 73-75 (May 9 2011)	288	0.0
BBCH 76-78 (May 26 2011)	946.5	49.4
BBCH 79-80 (June 5 2011)	11116.5	177.0
BBCH 81-83 (June 9 2011)	3420.0	23.1
BBCH 83-85 (June 16 2011)	582.0	0.0
BBCH 87-88 (June 21 2011)	121.5	0.0

Damage symptoms and harmfulness

Females of *D. brassicae* lay eggs into pods where larvae develop (Figure 3) feeding on inner tissue but not damaging the seeds. Due to larval feeding, pods change their colour from yellow to brown, often deforming, drying and cracking (Figure 4). Seeds drop out of their damaged pods prematurely, significantly reducing the yield at harvest. During our checking of 773 pods on May 3 (BBCH 71-73), 51.5 pods/plant were recorded, including 6 damaged pods which represented 11.6% of damaged pods. The mean number of 26.3 and maximum of 61 larvae were found per pod. Various percents of pod damage had been reported from other countries, such as Romania (Bucur & Rosca, 2011), Croatia (Maceljski et al., 1980), Germany (Büchs & Katur, 2004), while the heaviest damage of 86% was recorded in the Czech Republic (Pavela et al., 2007). Since pod damage of 21% causes yield loss of 34% (Bracken, 1987 cited by Aljmlj, 2007), chemical pest control is often recommended (Kazda et al., 2005; Pavela et al., 2007; Vaitelyte et al., 2011).

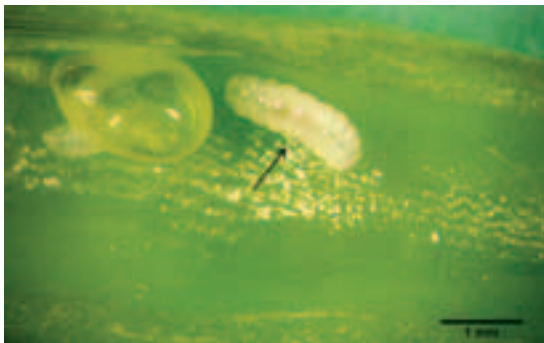


Figure 3. A larva in a pod feeding on inner tissue without damaging the seeds



Figure 4. Damaged pods of oilseed rape change their colour, often deforming, drying and cracking

During our examination of infested pods, special attention was paid to detecting damage caused by the cabbage pod weevil *Ceutorhynchus assimilis*, (syn. *C. obstrictus*), which is important for infestation intensity of *D. brassicae*. In this study, damage caused by that weevil species was not observed. A single larva of *C. assimilis* was found in the total of 773 examined pods, so the correlation between these two species was not determined. Similar observations had been reported in the Czech Republic (Kazda et al., 2005), while other literature data show that the midge uses openings made by *C. assimilis* for oviposition (Åhman, 1987; Pavela et al., 2007; Aljmlj, 2007; Williams, 2010).

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REFERENCES

- Alford, D.V., Nilsson C. & Ulber, B. (2003). Insect pests of oilseed rape crops. In D. V. Alford (Ed.) *Biocontrol of Oilseed Rape Pests* (pp. 9-42). Oxford, UK: Blackwell. doi:10.1002/9780470750988.ch2
- Åhman, I. (1987). Oviposition site characteristics of *Dasineura brassicae* Winn. (Dipt., Cecidomyiidae). *Journal of Applied Entomology*, 104(1-5), 85-91. doi:10.1111/j.1439-0418.1987.tb00501.x
- Aljmlj, F. (2007). *Classification of oilseed rape visiting insects in relation to sulphur supply*. Braunschweig, Germany: Technischen Universität Braunschweig. Doctoral thesis.
- Axelsen, J.A. (1992). The population dynamics and mortalities of the pod gall midge (*Dasineura brassicae* Winn.) (Dipt., Cecidomyiidae) in winter rape and spring rape (*Brassica napus* L.) in Denmark. *Journal of Applied Entomology*, 114(1-5), 463-471. doi:10.1111/j.1439-0418.1992.tb01152.x
- Büchs, W. & Alford, D. (2003). Predators of oilseed rape pests. In D.V. Alford (Ed.), *Biocontrol of Oilseed Rape Pests*, (pp. 181-199). Oxford, UK: Blackwell. doi: 10.1002/9780470750988.ch12
- Büchs, W. & Katur, K. (2004). Cultivation techniques as means to control pests in organic oilseed rape production. *IOBC/WPRS Bulletin*, 27(10), 225-236.
- Büchs, W. & Katur, K. (2005). Regulierung von Schadinsekten durch pflanzenbauliche Maßnahmen im ökologischen Rapsanbau. In *Entomologie im Pflanzen- und Vorratsschutz*. Sektion 8 (p 221).

- Bucur, A. & Rosca, I. (2011). Research regarding biology of rape pests. *Scientific Papers, Series A* (Bucharest), 54, 356-359.
- Ferguson, A.W., Campbell, J. M., Warner, D.J., Watts, N.P., Schmidt, J.E.U. & Williams, I.H. (2004). Phenology and spatial distributions of *Dasineura brassicae* and its parasitoids in a crop of winter oilseed rape: Implications for integrated pest management. *IOBC/WPRS Bulletin*, 27(10), 243-252.
- Ferguson, A.W., Williams, I.H., Castle, L.M. & Skellern, M. (2010). Key parasitoids of the pests of oilseed rape in Europe: A guide to their identification. In I.H. Williams (ed.), *Biocontrol-Based Integrated Management of Oilseed Rape Pests* (pp. 77-114). Dordrecht, Netherlands: Springer. doi: 10.1007/978-90-481-3983-5
- Grantiņa, I. (2012). *Brassica stem and pod weevil (Ceutorhynchus spp.) and brassica pod midge (Dasineura brassicae) biology, ecology and economical importance in Latvia*. Jelgava, Latvia: Latvia University of Agriculture. Doctoral thesis.
- Kazda, J., Baranyk, P. & Nerad, D. (2005). Bionomic and economic meaning of brassica pod midge (*Dasineura brassicae* Winnertz) in new technologies of winter rape cultivation. *Scientia Agriculturae Bohemica*, 36(4), 121-133.
- Maceljski, M., Balarin, I. & Danon, V. (1980). Rezultati vešegodišnjih proučavanja pojave i štetnosti insekata na uljanoj repici (The results of investigations of the appearance and noxiousness of insects on rape in Yugoslavia). *Zaštita bilja/Plant Protection*, 31(4), 317–324.
- Milovanović, P. (2007). Štetni insekti na uljanoj repici u Srbiji (Harmful insects affecting oil-seed rape crops in Serbia). *Zaštita bilja/Plant Protection*, 58, 25-53.
- Nilsson, C., Vimarlund, L. & Gustafsson, G. (2004). Long term survival of Brassica pod midge (*Dasineura brassicae*) populations. *IOBC/WPRS Bulletin*, 27(10), 299-305.
- Pavela, R., Kazda, J. & Herda, G. (2007). Influence of application term on effectiveness of some insecticides against brassica pod midge (*Dasineura brassicae* Winn.). *Plant Protection Science*, 43, 57-62.
- Simova-Tošić, D., Skuhrava, M. & Skuhravy, V. (2000). Gall midges (Diptera: Cecidomyiidae) of Serbia. *Acta Entomologica Serbica*, 5(1/2), 47-93.
- Vaitelyte, B., Petraitiene, E., Šmatas, R. & Brazauskienė, I. (2011). Control of *Meligethes aeneus*, *Ceutorhynchus assimilis* and *Dasineura brassicae* in winter oilseed rape (*Brassica napus* L.). *Žemdirbyste-Agriculture*, 98(2), 175-182.
- Weber, E. & Bleiholder, H. (1990). Erläuterungen zu den BBCH-Dezimal - Codes für die Entwicklungsstadien von Mais, Raps, Faba-Bohne, Sonnenblume und Erbse – mit Abbildungen. *Gesunde Pflanzen*, 42, 308-321.
- Williams, I.H. (2010). The major insect pests of oilseed rape in Europe and their management: an overview. In I. Williams (ed.) *Biocontrol-Based Integrated Management of Oilseed Rape Pests* (pp. 1-45). Dordrecht, Netherlands: Springer. doi: 10.1007/978-90-481-3983-5
- Williams, I.H. & Cook, S.M. (2010). Crop location by oilseed rape pests and host location by their parasitoids. In I. Williams. (Ed.) *Biocontrol-Based Integrated Management of Oilseed Rape Pests* (pp. 215-244). Dordrecht, Netherlands: Springer. doi: 10.1007/978-90-481-3983-5
- Williams, I.H. & Ferguson, A.W. (2010). Spatio-temporal distributions of pests and their parasitoids on the oilseed rape crop. In I. Williams. (Ed.), *Biocontrol-Based Integrated Management of Oilseed Rape Pests* (pp. 245–271). Dordrecht, Netherlands: Springer. doi: 10.1007/978-90-481-3983-5
- Williams, I.H., Ferguson, A.W., Kruus, M., Veromann, E. & Warner, D.J. (2010). Ground beetles as predators of oilseed rape pests: Incidence, spatio-temporal distributions and feeding. In I. Williams. (Ed.), *Biocontrol-Based Integrated Management of Oilseed Rape Pests*, (pp. 115-149). Dordrecht, Netherlands: Springer. doi: 10.1007/978-90-481-3983-5
- Williams, I.H., Martin, A.P. & Kelm, M. (1987). The phenology of the emergence of brassica pod midge (*Dasineura brassicae* Winn.) and its infestation of winter oil-seed rape (*Brassica napus* L.). *Journal of Agricultural Science*, 108(3), 579-589. doi:10.1017/s0021859600079983

Biologija i štetnost mušice kupusne ljuske (*Dasineura brassicae* Winn.) na ozimnoj uljanoj repici

REZIME

Mušica kupusne ljuske, *D. brassicae* (Winn.) (Diptera: Cecidomyiidae), je značajna štetočina uljane repice (*Brassica napus* L.). Tokom 2011. godine, na uljanoj repici, na lokalitetu Stari Žednik, kao i 2011/12. godine, na ozimjoj pšenici koja je u plodoredu sa uljanom repicom, praćena je biologija i štetnost ove vrste. U toku godine *D. brassicae* razvija dve generacije, a prezimljava kao larva u kokonu u zemljištu. Imigracija imaga prve generacije je dosta razvučena i traje od početka aprila do kraja maja. Dug period imigracije uslovio je prisustvo larvi u ljuskama od sredine aprila do sredine juna. Infestirane mahune se deformišu i pucaju, semenke ispadaju, što ima za posledicu smanjenje prinosa uljane repice. Oštećenost ljuški iznosi 11,6%. Eklozija imaga druge generacije je registrovana krajem maja i u prvoj dekadi juna. Tokom istraživanja utvrđeno je *D. brassicae* polaže jaja u zdrave mahune i da nema korelacije sa *Ceutorhynchus assimilis* Payk.

Ključne reči: Mušica kupusne ljuske; Uljana repica; Životni ciklus