Biological Control 54 (2010) 331–341

Contents lists available at ScienceDirect

Biological Control

journal homepage: www.elsevier.com/locate/ybcon

Mortality factors affecting the cabbage seedpod weevil, *Ceutorhynchus obstrictus* (Marsham), in its area of origin: A life table analysis

T. Haye [a,*], P.G. Mason [b], L.M. Dosdall [c], U. Kuhlmann [a]

[a] *CABI Europe-Switzerland, Rue des Grillons 1, 2800 Delémont, Switzerland*
[b] *Agriculture and Agri-Food Canada, Research Center, K.W. Neatby Building, Ottawa, ON, Canada K1A 0C6*
[c] *Department of Agricultural, Food and Nutritional Science, 4-10 Agriculture/Forestry Center, University of Alberta, Edmonton, AB, Canada T6G 2P5*

ARTICLE INFO

Article history:
Received 8 February 2010
Accepted 7 June 2010
Available online 11 June 2010

Keywords:
Ceutorhynchus obstrictus
Fecundity
Mortality factors
Life tables
Parasitoids
Predators
Invasive species
Trichomalus perfectus
Mesopolobus morys

ABSTRACT

The cabbage seedpod weevil, *Ceutorhynchus obstrictus* (Marsham) (Coleoptera: Curculionidae), is a widely distributed invasive pest of cruciferous crops in North America. Control measures rely mostly on the application of insecticides but alternative control strategies such as classical biological control are under evaluation. To investigate the impact of parasitoids and other mortality factors on *C. obstrictus* populations, life table studies were conducted between 2005 and 2007 in 13 winter oilseed rape fields in Switzerland, part of the native range. Under field conditions females only realized approximately 50% of their potential lifetime fecundity, varying between 96 and 631 eggs per individual. Total generational mortality was higher than 99.6% in each year. Overwintering mortality of adults was the major population limiting factor, contributing approximately 50% to the overall generational mortality of *C. obstrictus*, whereas factors acting on the immature stages were responsible for the remaining 50%. Among the mortality factors of the immature stages, egg, larval and pupal mortality contributed 9–12%, 25–28% and 4–6% to the generational mortality, respectively. Larval ecto-parasitism on its own accounted for 7–15% of the generational mortality. Comparison of life table data presented here with that from North America will be invaluable for elucidating the mortality factors that regulate *C. obstrictus* populations in Europe, the region of origin.

© 2010 Elsevier Inc. All rights reserved.

1. Introduction

The cabbage seedpod weevil, *Ceutorhynchus obstrictus* (Marsham) (syn. *C. assimilis* (Paykull), see Colonnelli, 1998) (Coleoptera: Curculionidae), is widely distributed in cruciferous crops in Europe (Alford et al., 2003), the United States (McCaffrey, 1992) and Canada (Kuhlmann et al., 2002). Introduced to North America from Europe (Laffin et al., 2005) about 80 years ago, it first became a pest in British Columbia (Canada) in 1931 (McLeod, 1962). In the mid 1940s, the weevil dispersed south into the US Pacific Northwest, and in the 1990s it was reported from California, the south-eastern US, and Alberta (Canada). With the beginning of the new millennium the weevil further spread into the Canadian canola[1], *Brassica napus* L. and *B. rapa* L. (Brassicaceae) growing areas of south-western Saskatchewan (2000), southern Quebec (2000), and Ontario (2001) (Brodeur et al., 2001; Cárcamo et al., 2001; Dosdall et al., 2002; Mason et al., 2004). Since its arrival in Canada, the weevil has caused substantial economic losses in canola crops in the Prairie Provinces of Saskatchewan and southern Alberta, where massive *C. obstrictus* outbreaks in 1999 resulted in crop losses of approximately Can$ one million (Kuhlmann et al., 2002). In eastern Canada, *C. obstrictus* is regarded as a threat to canola variety testing and seed production (Mason et al., 2004). In US, weevil larvae can cause 15–35% yield losses in winter canola fields not treated with insecticides (McCaffrey et al., 1986). In Europe, *C. obstrictus* is well controlled by natural enemies (Williams, 2003). However, it may become an indirect problem, when it co-occurs with another European oilseed rape pest, the brassica pod midge *Dasineura brassicae* (Winnertz) (Diptera: Cecidomyiidae), which oviposits mainly through feeding punctures, ovipositional or larval exit holes of *C. obstrictus* in the seed pod wall (Alford et al., 2003).

In Europe, reproductively immature adults overwinter in the leaf litter or soil in the proximity of oilseed rape fields. In spring, adults emerge from their overwintering sites and migrate to flowering winter oilseed rape fields (Dmoch, 1965). To develop their ovaries, female *C. obstrictus* must feed on buds, racemes, flowers or pods of its host plant for 2–3 weeks, depending on the daily mean temperatures (Kirchner, 1961; Dmoch, 1965; Ni et al., 1990). Reproductively mature, females usually oviposit single eggs into developing pods, which are then marked with a pheromone that deters repeated oviposition by themselves or other females

---

* Corresponding author. Fax: +41 32 421 4871.
E-mail address: t.haye@cabi.org (T. Haye).

[1] In North America, *Brassica napus* (+ *B. rapa*) are referred to as canola. In Europe, *B. napus* is referred to as oilseed rape. Thus, when referring to the crop in North America we use canola and when referring to the Europe crop we use oilseed rape.

1049-9644/$ - see front matter © 2010 Elsevier Inc. All rights reserved.
doi:10.1016/j.biocontrol.2010.06.004

(Ferguson et al., 1999). Significant damage to the crop is mainly caused by the larvae, each consuming about five to six seeds to complete its development (Dmoch, 1965; Gould, 1975). Fully grown larvae chew exit holes through the wall of the pod and drop to the ground to pupate below the soil surface. The new generation of univoltine adults emerges in mid to late summer and feeds on late maturing pods or flowers of secondary shoots.

In Europe, the high levels of parasitism of cabbage seedpod weevil larvae suggest that parasitoids play an important role in suppressing cabbage seedpod weevil populations, although their impact on the population dynamics of the weevil has been little studied (Williams, 2003). As part of an earlier biological control initiative in Canada, the most important biological control agents of the cabbage seedpod weevil in Europe, the larval ecto-parasitoids *Trichomalus perfectus* (Walker), *Mesopolobus morys* (Walker), and *Stenomalina gracilis* (Walker) (all Hymenoptera: Pteromalidae), were imported from England and released in British Columbia, Canada, in the 1940s (McLeod, 1962; Gibson et al., 2006). Until recently it was thought that these three species were present in North America. However, a review of North American voucher specimens showed that *T. perfectus* and *M. morys* were misidentifications of *Trichomalus lucidus* (Walker) and *Mesobolobus moryoides* Gibson (Hymenoptera: *Pteromalidae*), respectively (Gibson et al., 2005). Recent surveys for cabbage seedpod weevil parasitoids in the area where the European parasitoids were first released confirmed the presence of *S. gracilis* in British Columbia and demonstrated that *M. morys* and *T. perfectus* had not established (Gillespie et al., 2006).

Currently, control measures for the cabbage seedpod weevil in Canada rely on the application of broad-spectrum insecticides and new approaches are needed (Dosdall et al., 2001). Because *M. morys* and *T. perfectus* are absent in North America, implementing a classical biological control program for *C. obstrictus* to reconstruct its European natural enemy complex is being considered. The objective of this study was to quantify the impact of larval parasitoids and other mortality factors on the population dynamics of the cabbage seedpod weevil prior to potential releases in North America. To investigate the key mortality factors of *C. obstrictus*, life table studies were conducted between 2005 and 2007 in its area of origin in Europe, where weevil populations are well controlled by natural enemies and other natural forces.

2. Material and methods

2.1. Field sites

The study was carried out in 13 winter oilseed rape fields (*B. napus* L. [Brassicaceae]) in north-western Switzerland from 2005 to 2007. Experimental fields were located in the Swiss Cantons of Jura, Neuchâtel, and Bern (Table 1). Due to crop rotation, at none of the sites was oilseed rape planted in consecutive years and thus, each year, new fields were selected, preferably adjacent or close to fields sampled in previous years. Three of 13 fields selected were managed conventionally, whereas in the remaining fields no insecticides were applied. In the conventional fields, pesticides were applied primarily against the pollen beetle, *Meligethes aeneus* (Fab.) (Coleoptera: Nitidulidae), before the blooming stage and may have reduced numbers of overwintered seedpod weevils. However, the life table study was not initiated before the first pods were evident on the lower part of the racemes (BBCH growth stage 65, Lancashire et al., 1991), when *C. obstrictus* started laying eggs in this newly formed tissue that was not contaminated with previously applied insecticides.

Table 1
Experimental field sites in Switzerland 2005–2007.

Year	Loaction	Canton	Coordinates	Altitude (m)
2005	Delémont[a]	Jura	N 47°22.301 E 007°20.400	479
2005	Courtemaîche[a]	Jura	N 47°26.431 E 007°03.201	410
2005	Lordel	Neuchâtel	N 47°02.571 E 007°00.205	918
2005	Nods	Bern	N 47°06.009 E 007°03.772	820
2006	Alle	Jura	N 47°26.239 E 007°06.839	512
2006	Courtemaîche[a]	Jura	N 47°26.976 E 007°03.149	423
2006	Fahy	Jura	N 47°24.598 E 006°58.112	583
2006	Nods	Bern	N 47°06.030 E 007°03.919	808
2006	Lordel	Neuchâtel	N 47°04.195 E 007°01.083	912
2007	Alle	Jura	N 47°26.239 E 007°06.839	512
2007	Courcelon	Jura	N 47°22.237 E 007°24.559	552
2007	Nods	Bern	N 47°06.030 E 007°03.919	808
2007	Lordel	Neuchâtel	N 47°04.195 E 007°01.083	912

[a] Conventionally managed fields.

2.2. Estimates of C. obstrictus fecundity

Overwintered *C. obstrictus* adults were collected from organic winter oilseed rape fields at Alle (N 47°26.239′, E 007°06.839′) and Courtemaîche (N 47°26.976′, E 007°03.149′) (both in the Ajoie region, Canton Jura, Switzerland) during the second week of May 2006. At this time winter oilseed rape fields were in bloom (BBCH 63) and weevils were observed feeding on buds and flowers to assimilate nutrients for egg development. A subsample of 10 weevil females was dissected to determine their reproductive maturity. According to the three-level rating system of Bonnemaison (1957), all dissected beetles were in reproductive stage 2, in which maturing oocytes are present in the ovarioles, but not in the oviducts. As oilseed rape plants had not yet developed pods at the time of adult collection, and dissected adult females had not yet reached reproductive maturity, there was no possibility that weevils had already started oviposition in the field. Furthermore, field-collected weevils were preferentially used for experiments, because Ferguson and Williams (1993) reported that the oviposition performance of laboratory-overwintered weevils was significantly poorer than that of field-collected individuals.

Forty mating couples were separated and each pair kept individually in 1.2 L clear plastic containers and provided with fresh rape buds and flowers. Containers were maintained in the laboratory at 14 h light, constant 20 °C and 60% RH. After one week, when females were assumed to have reached reproductive maturity (stage 3; Bonnemaison, 1957), the experiments were begun.

To estimate the potential lifetime fecundity, individual *C. obstrictus* couples ($n = 22$) were transferred into clear, ventilated 1.2 L plastic cylinders containing one small *B. napus* shoot with buds and flowers as a food source and a second shoot with eight pods for oviposition. Each couple was provided with fresh food and pods every two days throughout their lifetime. Weevils were maintained at 14 h light, constant 20 °C and 60% RH. Exposed pods were removed after 48 h and dissected for eggs. The total number of eggs laid over the lifetime of each female was used to calculate the mean potential lifetime fecundity and length of the oviposition period of *C. obstrictus*.

To estimate the *realized lifetime fecundity* and length of the oviposition period of *C. obstrictus* under semi-natural conditions, 18 weevil couples were transferred to individual pot-grown plants (BBCH 65) placed in an outdoor screened cage (2 × 2 × 2 m; 0.5 mm mesh

Download English Version:

https://daneshyari.com/en/article/4504324

Download Persian Version:

https://daneshyari.com/article/4504324

Daneshyari.com