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The impact of semi-natural habitats on the abundance of pollen beetle adults on winter oilseed rape fields

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Abstract: Pollen beetle dispersal in the field depends on several different factors, such as the phenological stage of the crop, its odour and yellow colour during flowering are especially attractive to pollen beetles. The dispersal of the scent depends on wind direction and pollen beetles' dispersal follows upwind anemotaxis.

This experiment was conducted to investigate the effect of different semi-natural habitats (woody linear, woody areal, herbaceous linear and herbaceous areal) surrounding winter oilseed rape fields on the abundance of the pollen beetle. Beetles were counted from oilseed rape plants using the beating method. The results showed higher number of pollen beetles on fields bordered with herbaceous linear elements than with other studied semi-natural habitat elements.

Key words: *Meligethes*, oilseed rape, semi-natural habitat, dispersal

Introduction

Oilseed rape is the third most widely cultivated crop in Europe (FAO, 2013), the sowing area has also increased rapidly in Estonia. One of the main challenges in its production is the control of insect pests. The most widespread species causing yield losses throughout Europe is the pollen beetle (*Meligethes aeneus* Fab. Coleoptera: Nitidulidae) (Alford *et al*., 2003).

Several aspects of pollen beetle oviposition and feeding preferences, overwintering and crop location have been intensively studied (Free & Williams, 1978; Borg, 1996; Giamoustaris & Mithen, 1996; Alford *et al*., 2003; Ferguson *et al*., 2003; Veromann *et al*., 2006, 2009, 2012, 2013; Williams *et al*., 2007; Williams, 2010; Williams & Cook, 2010), but the influence of landscape elements on the dispersal of the pollen beetle is less studied. Rusch *et al.* (2012) have found that overwintering habitats of the pollen beetle are influenced by the characteristics of the local habitat. Nevertheless, the impact of specific landscape elements such as semi-natural habitats on pollen beetle dispersal remains unknown.

The aim of the study was to determine the impact of different commonly occurring semi-natural habitats to pollen beetles' dispersal in field conditions.

Material and methods

The study was carried out in 2013 on commercial winter oilseed rape fields in Estonia. The effect of four different semi-natural habitats (SNH): woody area (Wa), woody linear (Wl), herbaceous area (Ha) and herbaceous linear (Hl) was studied. To determine SNH as 'areal' or 'linear', the length and width of elements were taken into consideration. The length of a linear element was at least 150 m and the width did not exceed 12.5 m: the measurements of areal elements were at least 60 x 60 meters. Oilseed rape fields were selected based on the surrounding landscape; only fields directly boarded with the mentioned SNH-s were selected. In total, the abundance of the pollen beetle was studied in 12 sample points on oilseed rape fields bordered by 3 Wa, 3 Wl, 3 Ha and 3 Hl.

Pollen beetles were counted from 10 randomly chosen oilseed rape plants 2 meters and 20 meters from the edge of the oilseed rape field bordered by each selected SHN type using the plant beating into a tray method (Cooper & Lane, 1991).

Statistical analyses were carried out using programs Statistica and MS Excel. The effect of semi-natural habitat type was measured using Kruskal-Wallis ANOVA, the differences between SNH-s were found using post-hoc Duncan test.

Results and discussion

The bordering semi-natural habitat had a significant effect on the abundance of the pollen beetle ($H(3, 1200) = 47.93$, $P < 0.0001$). The greatest abundance of pollen beetles was recorded on sites bordered by Hl elements, significantly more than all other tested landscape elements ($P < 0.0001$, Duncan test).

The largest number of beetles was found next to the most simple landscape element, Hl. This result concurs with Thies and Tscharntke (1999), who found the complexity of landscape to reduce the damage caused by pollen beetles. This is probably caused by the wind and plant cover concurrence as pollen beetles fly upwind towards suitable food source (Evans & Allen-Williams, 1994; Moser *et al.*, 2009; Williams *et al.*, 2007) which is located using volatile cues provided by food-plants (Evans & Allen-Williams, 1994; Blight & Smart, 1999; Smart & Blight, 2000; Cook *et al.*, 2002). As non-host plants can mask the host plant odours and reduce pest detection and therefore damage (Root, 1973; Pimentel, 1961) larger and more diverse habitats are more likely to provide more odour cues and therefore confuse pest colonization to the crop. Since the perception of the scent as well as its dispersal depends on wind speed (Finch, 1980; Schoonhoven *et al*., 2005) and several semi-natural landscape elements can act as wind barriers, the landscape composition affects the dispersal of insects. Wind is considered to be the most important parameter affecting the detection of odour plume by insects (Beyaert & Hilker, 2013) and therefore influencing their dispersal. For example, several studies have shown that hedgerows reduce the dispersal of insects (Lewis, 1969; Bowden & Dean, 1977; Fry, 1994; Mauremooto *et al*., 1995). This is also confirmed in the current study as significantly less beetles could locate the suitable food source next to woody landscape elements (Wl and Wa) compared to the element which due to its dimensions could not hide the attractive attributes of oilseed rape from the pollen beetle.

Also the width of the area seems to be a relevant factor, as more pollen beetles were found beside Hl elements compared to Ha. This is likely that the height and composition of the vegetation layer has an effect on the host location of pollen beetles. As mentioned before, they rely on chemical cues provided by plants. Specialist herbivores use plant-specific odour clues to locate suitable host plants (Hare, 2011; Pare & Tumlingson, 1999) but plant odour can change over time and distance (Helming *et al.*, 2004). Therefore the increased distance between the release point of the scent in concurrence with the vegetation composition on that trail decreases the probability to reach the source.

In the current study, the Ha element therefore reduces the likelihood to reach the oilseed rape field by confusing the pollen beetle as Wa and Wl have a hindering impact on the wind flow and therefore prevent the spreading of odour.

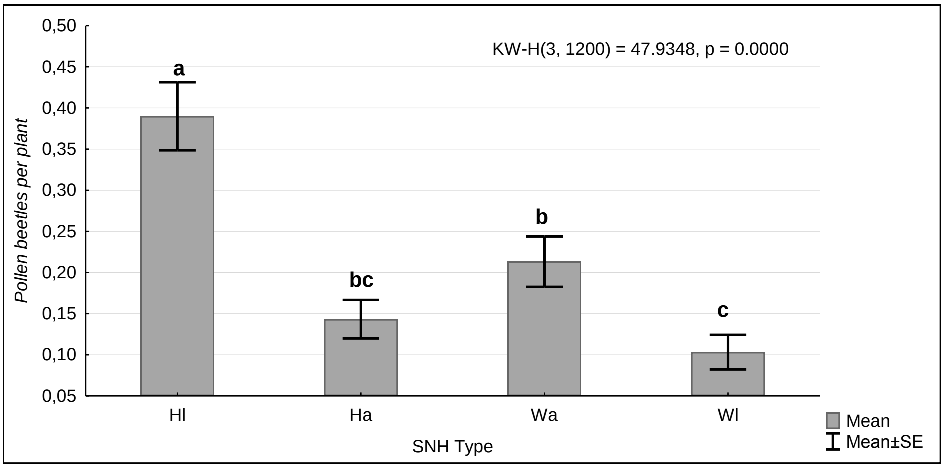

Figure 1. Abundance of pollen beetles on oilseed rape fields boarded by different semi-natural habitats (Hl – herbaceous linear; Ha – herbaceous areal; Wa – woody areal; Wl – woody linear). Different letters indicate significant differences between variables $p < 0.05$; Duncan test.

To conclude, our results demonstrate the importance of commonly occurring landscape elements on the dispersal of the pollen beetle.

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