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Agricultural management reduces emergence of pollen beetle parasitoids

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ABSTRACT

Natural enemies such as predatory arthropods and parasitoids have the potential to suppress pest species and provide the ecosystem service biological control. When predicting the potential of biological control in agriculture it is important to give evidence on how agricultural management influence the abundance and functions of the natural enemies. In this study we examined whether managements practices as insecticide application and different tillage regimes, can influence biological control of a herbivorous pest on oilseed rape (*Brassica napus* L.). The endoparasitoids *Phradis interstitialis* Thomson and *Tersilochus heterocerus* Thomson were studied as they are important for the biological control of the pollen beetle (*Meligethes aeneus* F.) which is a common pest on oilseed rape in Europe. The number of emerging female parasitoids was quantified by capturing the parasitoids in emergence tents from fields where the oilseed rape plants were grown the previous year. The number of emerging *P. interstitialis* and *T. heterocerus* were significantly reduced in insecticide treated fields, but the tillage regimes had no effect on the number of emerging females of either parasitoid species. We conclude that when predicting the biological control potential by pollen beetle parasitoids in agricultural landscapes it is important to consider insecticide treatment of former oilseed rape fields as that can influence population densities at the landscape scale the following year.

1. Introduction

The concern about the impact caused by intensive agricultural management on the environment and human health calls for more sustainable farming practices that replace external inputs such as pesticides with management promoting organisms that deliver important ecosystem services at the landscape scale (Pretty, 2008; Bommarco et al., 2013). Natural enemies such as predatory arthropods and parasitoids have the potential to suppress pest species and provide the ecosystem service biological control (Barbosa, 1998; Bommarco et al., 2011). To better manage ecosystem services such as biological control it is important to increase the knowledge on factors influencing the distribution of natural enemy populations at the landscape scale (Rusch et al., 2012; Vinatier et al., 2012). It is well known that intensification of agriculture is one of the main causes behind the losses of natural enemies in agricultural landscapes (Hendrickx et al., 2007; Bianchi et al., 2010). However, there is a lack of understanding on what type of management that is causing these declines and to improve the knowledge base the effects of different management regimes need to be tested.

Oilseed rape (*Brassica napus* L.) is an economically important crop and one of its key pests is the pollen beetle (*Meligethes aeneus* F.) that damage flower buds and thus reduce yields (Williams and Free, 1978; Nilsson, 1987; Zaller et al., 2008). The primary method of controlling pollen beetles in agriculture is the applications of non-selective insecticides such as synthetic pyrethroids (Richardson, 2008; Richardson, 2008). Natural enemies, especially specialist ichneumonid larval endoparasitoids such as *Phradis interstitialis*, *Phradis morionellus* and *Tersilochus heterocerus* can suppress the pollen beetle populations by killing their hosts (Thies et al., 2008; Rusch et al., 2011). The pollen beetle parasitoids overwinter within the pupae of the host, in the soil of previous year oilseed rape fields, until the following spring when they emerge and disperse to new oilseed rape fields (Nilsson, 1985; Williams, 2006). However, evidence on how agricultural management influence the emergence of the parasitoids from the agricultural fields is lacking.

It has been suggested that pesticide treatments (Williams, 2006) and intensive soil management (Nilsson, 2010) may reduce

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the number of emerging pollen beetle parasitoids. Though there is a lack of replicated studies evaluating the effect of insecticides on pollen beetle parasitoids under field conditions. Insecticides are generally known to affect non target beneficial arthropods such as parasitoids (Theiling and Croft, 1988; Desneux et al., 2007), resulting in sublethal effects (Desneux et al., 2007) or direct mortality (Tillman and Mulrooney, 2000). In lab experiments the exposure of adult *P. interstitialis* and *P. morionellus* to recommended and lower dosages of pyrethroid compounds induced high mortality rates (Hokkanen et al., 1988; Jackowski et al., 2008) while evidence is lacking concerning effects on *T. heterocerus*. A reduced parasitoid emergence can also be due to the effect of pesticides on the host populations but it is unclear how this affects the parasitoids.

Soil management as tillage can negatively affect organisms such as parasitoids when hibernating in arable fields, through physical damage or burying of larvae or host pupae in the soil (Purvis and Fadl, 1996; Holland and Reynolds, 2003). Reduced tillage regimes are suggested to increase survival rates of pollen beetle parasitoids compared to more conventional tillage regimes, as ploughing (Nilsson, 2010; Rusch et al., 2011 Rusch et al., 2011). Despite a general lack of well-replicated studies, a few studies have tested the effect of reduced tillage on the emergence of pollen beetle parasitoids but so far no effects have been determined (Nilsson, 1985; Klingenberg and Ulber, 1994).

The focus of this study was to determine how the emergence rates of pollen beetle parasitoids are affected by insecticide applications and different tillage regimes. We hypothesized that the emergence of pollen beetle parasitoids would be reduced in insecticide treated fields and higher in fields with reduced tillage compared to fields with conventional tillage. Emerging parasitoids were collected from fields that were grown with winter oilseed rape the previous year and replicated across a region. This allowed a separation of the effects of tillage regimes and insecticide applications on parasitoids emergence from random variation between fields.

2. Material and methods

2.1. Study area and field selection

To test the effects of soil management and pesticide application on emerging parasitoids the study was designed to include fields that had oilseed rape the previous year, as the parasitoids overwinter before emergence. The parasitoids were sampled during spring and early summer in 2010 in Scania, south-western part of Sweden (55°42′N, 13°11′E). The region is agricultural and characterized by intensive crop production. The proportion of arable land within a radius of 1000 m around a study sites was 81.7% ± 1.9% (mean ± SE) and winter oilseed rape was cultivated on 17.2% ± 1.6% (mean ± SE) of the area of arable land (analysis made in Arc info GIS 9.3 using data from 2009 in the Integrated Administration and Control System (IACS) supplied by the Swedish Board of Agriculture).

Fields with winter oilseed rape, in 2009, were selected using map information from the IACS database and through interviews with farm owners or tenants about their tillage and pest management regimes, resulting in a final selection of 20 fields

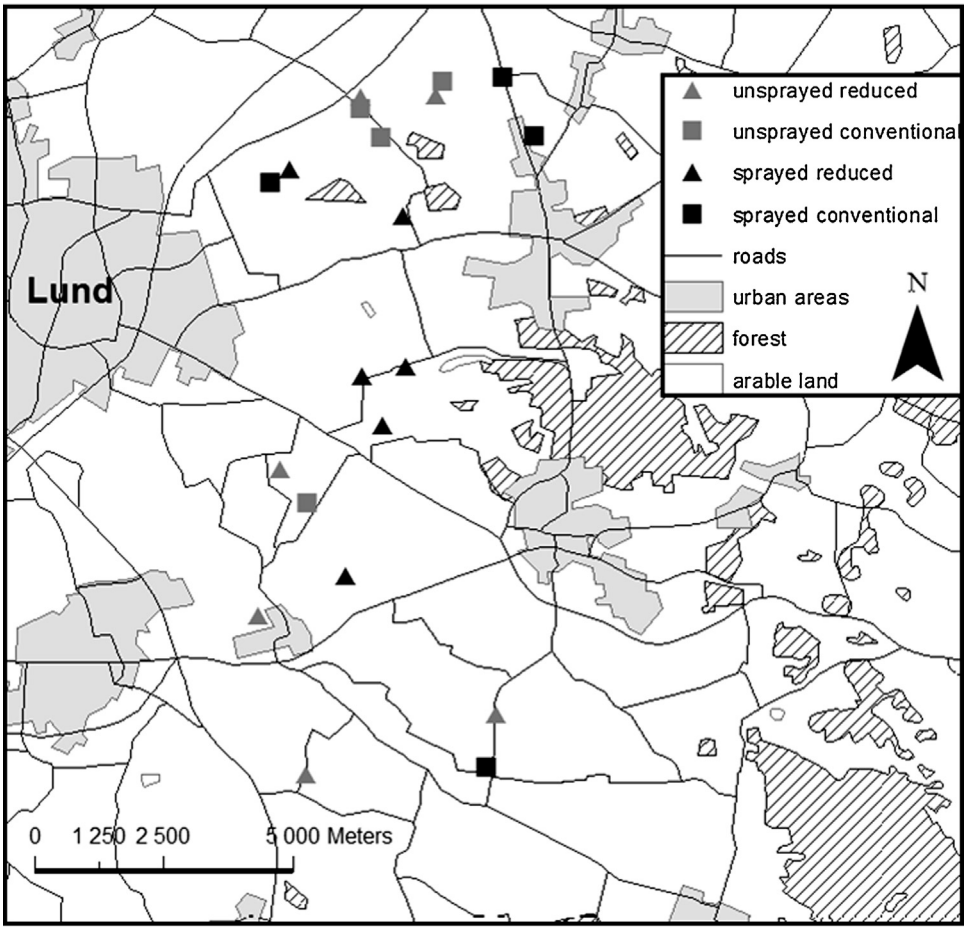

Fig. 1. Location of the study sites, that were situated close to the city of Lund (55°42′N, 13°11′E), south-western Sweden.