Agriculture, Ecosystems and Environment 241 (2017) 150–159

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

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

Meteorological and landscape influences on pollen beetle immigration into oilseed rape crops

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ARTICLE INFO

Article history:
Received 18 October 2016
Received in revised form 24 February 2017
Accepted 8 March 2017
Available online 23 March 2017

Keywords:
Brassicogethes
Decision support systems
Insecticide resistance
Integrated pest management
Meligethes aeneus
Monitoring trap
Sustainable intensification

ABSTRACT

Heavy reliance on pesticide inputs to maintain crop yields has been an important aspect of agricultural intensification. Insecticide use has had detrimental impacts on pollinators and natural pest control agents, contributing to a decline in associated ecosystem services, and has also led to resistance development in pest populations. Throughout Europe, in oilseed rape (*Brassica napus* L.) crops, prophylactic use of insecticides against pollen beetles (*Meligethes aeneus* F. also known as *Brassicogethes aeneus*) has led to such issues, and there is an urgent need to develop more sustainable pest management practices for the crop. Although advice is available to oilseed rape growers regarding control thresholds, it may not be adhered to due to the expense of pollen beetle monitoring relative to the inexpensive cost of pyrethroid insecticides. Thus, the key to reducing prophylactic insecticide applications may lie with improved, less labour intensive methods of pollen beetle monitoring. For these to be realized, a better understanding is needed of the effects of agri-landscape features and meteorological conditions on pollen beetle immigration into the crop. In this study, based on data from four years of pollen beetle monitoring on a total of 41 field sites, we model the effects of meteorological (wind speed and direction, rainfall and accumulated temperature) and landscape (areas of woodland, residential gardens, the current and previous seasons' oilseed rape crops, and lengths of hedgerows and treelines) variables on directional sticky trap catches, at both the single trap and field scales. Meteorological variables, particularly accumulated temperature and wind speed were more important than landscape variables in predicting the abundance of pollen beetles immigrating into OSR fields. Sticky traps that were facing downwind caught more beetles than those that were facing across-wind or upwind; this is the first study to show at a landscape-scale, direct evidence for use of upwind anemotaxis by pollen beetles at the point of entry during immigration into the crop. At the field scale, the area of oilseed rape grown in the previous season was found to be positively related to trap catch, but no relationships with other landscape variables were found. Optimally-placed monitoring traps could complement existing decision support systems to reduce pollen beetle monitoring effort and encourage use of insecticides only when control thresholds are breached, thus enhancing the sustainability of oilseed rape production. Knowledge of the area of oilseed rape crops grown during the previous season in the surrounding landscape could contribute to risk assessment of potential pest pressure for individual OSR crops.

1. Introduction

The heavy reliance on pesticide inputs associated with post-WW2 agricultural intensification, along with habitat loss and a reduction in cropping diversity, has contributed to environmental degradation and declining biodiversity within farmed landscapes (Stoate et al., 2001; Robinson and Sutherland, 2002). In particular, the impact of pesticides on pollinators and natural pest control agents has played a role in the deterioration of associated ecosystem services which are vital for sustainable food production (Goulson, 2013; Vanbergen, 2013; Roubos et al., 2014). Furthermore, sustained use or overuse of insecticides has frequently led to development of resistance (Heckel, 2012), threatening the sustainability of existing pest management practices and

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http://dx.doi.org/10.1016/j.agee.2017.03.008

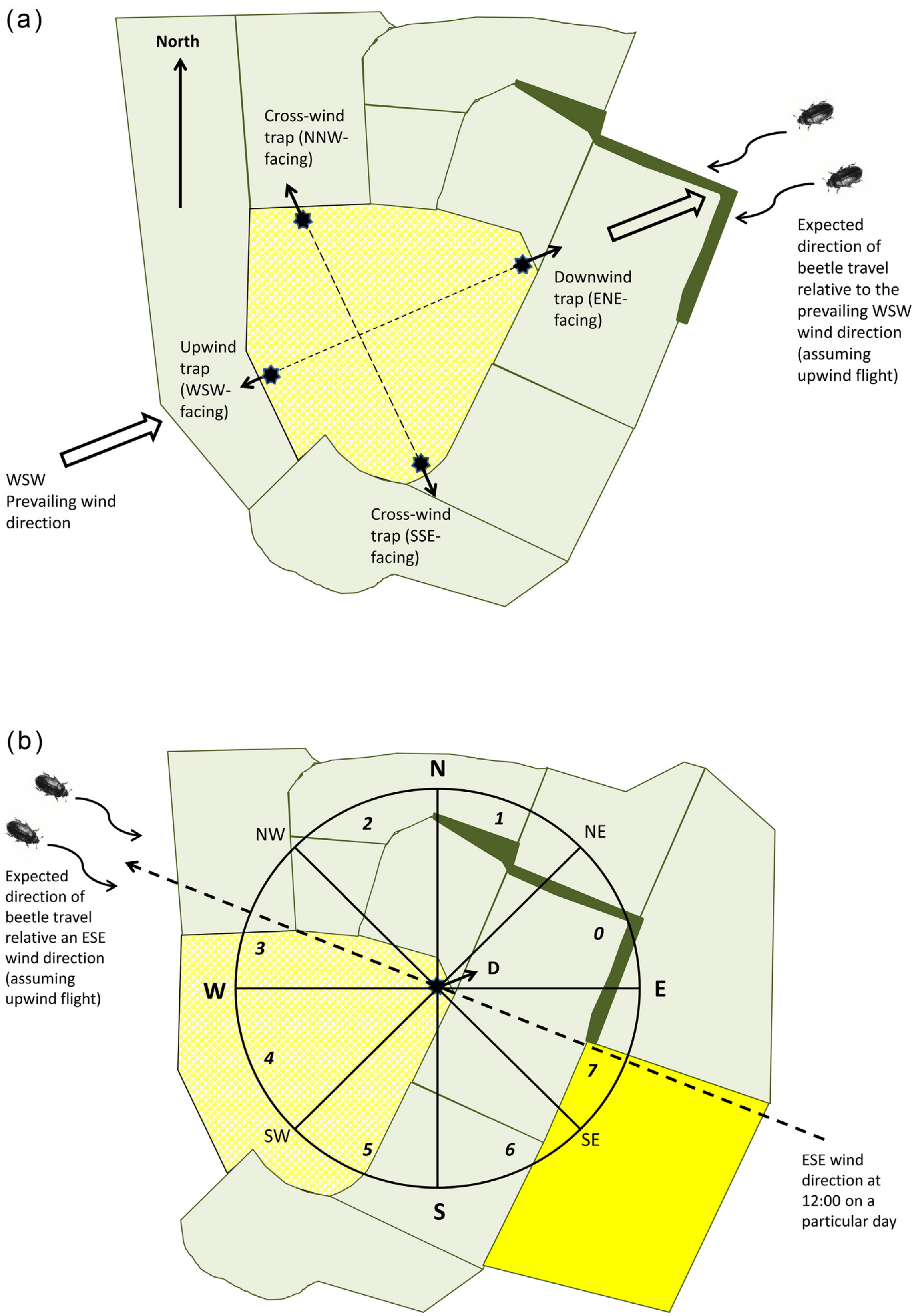

Fig. 1. (a) Typical site layout showing directional sticky trap placement in oilseed rape crops relative to an assumed WSW prevailing wind direction (hollow arrows) and the boundaries of a sampled field (textured shading). Upwind (WSW-facing) and downwind (ENE-facing) traps (black stars with arrows to indicate facing direction) were placed 3 m into the crop on opposite sides of the field, along the plane of the WSW-to-ENE prevailing wind direction (short-dashed line). Fifteen of the sites had additional NNW- and SSE-facing cross-wind traps, placed on a NNW–SSE plane (long-dashed line), perpendicular to that of the prevailing wind. When the wind is from the prevailing WSW direction, pollen beetles flying upwind are expected to enter the crop from the ENE. (b) Landscape mapping zones and assignment of wind and trap directions to specific directional segments or 'octants'. The circular area represents the 1000 m-radius zone within which landscape features were mapped in relation to a downwind trap (D; ENE-facing), and is divided into directional octants (labelled *0–7*). Traps were assigned to the octant corresponding to the direction that they were facing (in the case of the