doi:http://dx.doi.org/10.15414/afz.2015.18.si.53-55

Biodiversity enhancement and utilization – Pest control in brassicas

Henryk Luka[*1,2], Guendalina Barloggio[1,2]

[1] *Research Institute of Organic Agriculture FiBL, Department of Crop Sciences, Frick, Switzerland*

[2] *University of Basel, Department of Environmental Sciences, Basel, Switzerland*

In cabbage fields parasitoid wasps (Hymenoptera) use the eggs or larvae of pest butterflies and moths for their own reproduction, ultimately killing them, playing an important role in the biological plant protection strategy. An efficient way to promote this parasitoids in the crop field is to provide them with flower strips as well as companion plants, e.g. cornflower (*Centaurea cyanus*), that will provide them with food (nectar) and shelter. Between 2007 and 2010 we conducted experiments to test the olfactory attractiveness of different flowers as well as the influence of their nectar on the regulation of the cabbage moth (*Mamestra brassicae*) as well as on the lifespan and parasitation performance of its antagonists (egg and larval parasitoids).

Keywords: functional biodiversity, cabbage, flowering plants, natural enemies

1 Introduction

Parasitic wasps (Hymenoptera) lay their eggs into the eggs or larvae of insect pests, ultimately killing them, playing therefore an important role in biological plant protection. In order to substantially contribute to pest regulation the parasitoids have to be specifically promoted and their population established (Pfiffner et al., 2005). This involves interactions between sown flowering strips (food source) and naturally occurring landscape elements, like e.g. field margins, hedgerows or extensive meadow, which serves the crop specific beneficial insects as a overwintering sites or as shelters after the harvest (Luka et al., 2012). The parasitation performance of the beneficials is influenced by the oviposition capacity and the longevity; both can be increased by providing a food source (Nectar) (Géneau et al., 2012). An efficient promotion of parasitic wasps in cabbage crops can be achieved by sowing flowering strips as well as nectar providing flowers, e.g. cornflowers (*Centaurea cyanus*) sown directly in the crop field (companion plant). Between 2007 and 2010 different experiment were conducted. We tested the effects of nectar providing flowers on the regulation of the cabbage moth (*Mamestra brassicae*) as well as on the longevity and parasitation performance of its antagonists (larval and egg parasitoids), in addition the attractiveness of different flowers towards these antagonists was tested (Luka et al., 2009; Géneau et al., 2012.; Belz et al., 2013; Balmer et al., 2013 & 2014).

2 Material and Methods

Research questions: Which flower species positively affect the oviposition capacity and longevity of the parasitic wasps? Which flower species composition guarantee a successful installation of a flowering strip? How big is the effect of companion plants in relationship to the distance from the flowering strip (near and far areas) on the parasitation of the eggs and larvae of the cabbage moth? How is the species and individual richness of ground beetles and spiders differing between the flowering strip and cabbage fields with or without companion plants?

[*] **Correspondence:** Henryk Luka, Research Institute of Organic Agriculture FiBL, Department of Crop Sciences, Ackerstrasse 113, Box 219, CH-5070 Frick, Switzerland. E-mail: henryk.luka@fibl.org

2.1 Flower selection

Under laboratory conditions the influence of different flowers as sources of floral and extra-floral nectar on the fecundity and longevity of the larval parasitoid *Microplitis mediator* as well as of the cabbage moth was tested (Géneau et al., 2012). The longevity was investigated as following. Each experimental unit was composed on a cage containing a flower species as well as one female and one male of *M. mediator*. The wasp mortality was daily checked. In order to determine the parasitation rate one *M. mediator* female was put in the cage together with 30 first instar *M. brassicae* larvae. The wasp was able to parasitize during one hour. After 24 hours the larvae were then dissected under binocular to determine the number of parasitized individuals. In this way were chosen the flowers that had the strongest impact on the longevity and fecundity of *M. mediator*.

2.2 Field experiments

The field trials were conducted in Switzerland in 2007, 2009 and 2010 for a total of 17 white cabbage field tested (Luka et al., 2009, Balmer et al., 2013 & 2014). In the experiments conducted in 2007 and 2010 the flowering strips were sown along cabbage fields: 2007 with three species (Buckwheat (*Fagopyrum esculentum*), Cornflower (*Centaurea cyanus*) and Common poppy (*Papaver rhoeas*)), 2010 with two additional species; the common vetch (*Vicia sativa*) and the bishop's weed (*Ammi majus*). The cornflower was used as companion plant to compare the pest regulation in plots with or without cornflowers. In order to record the predation and parasitation rate, laboratory reared cabbage moth eggs were exposed into field and then brought back in the laboratory to check for larvae hatching. To investigate the parasitation of the cabbage moth larvae, cabbage plants were searched for naturally occurring larvae. Parasitation was determined in the laboratory using molecular methods (multiplex PCR). Pitfall traps were used between end of June and the beginning of September to collect ground living spiders and ground beetles (Ditner et al., 2013).

3 Results

3.1 Flower selection

Laboratory experiments showed that in the presence of *F. esculentum, C. cyanus* und *V. sativa* females of *M. mediator* live longer and parasitized the highest number of cabbage moth larvae. On the contrary the cabbage moth did not benefit from the above cited flowers (Géneau et al., 2012).

3.2 Field experiments: parasitation and predation

The distance from the flowering strip had no effects on the egg predation and in 2010 also on the egg parasitation. In 2007 the parasitation of the exposed cabbage moth eggs was significantly higher near the flowering strip than in distant regions, where the naturally occurring egg parasitoid *Telenomus* sp. parasitized a higher number of eggs than the released and naturally occurring *Trichogramma* spp. (Luka et al., 2009; Balmer et al., 2013 & 2014). The companion plants had a significant influence on the predation of cabbage moth eggs as well as on the parasitation of *M. brassicae* larvae by *M. mediator*. In 2009 we found an increase, although not significant, of the parasitation in plots with companion plants, but in 2010 the parasitation in plots with companion plants was significantly higher compared to regions without companion plants (Luka et al., 2009; Balmer et al., 2013 & 2014).

3.3 Promotion of species diversity

In order to broader investigate the effects of the adopted measures on the biodiversity, in 2010 ground beetles and spiders present in the flowering strip as well as in plots with or without companion plants were recorded. The results showed that the flowering strips significantly increase the species and individual richness of ground beetles and spiders. Flowering strips provide a suitable habitat to many challenging and rare ground beetles' and spiders' species (Ditner et al., 2013).

3.4 Influence on the yield

The yield was recorded in 2009 and in 2010. In 2009 the cabbage heads were on average 18 % heavier in plots with companion plants than in plots without companion plants (cabbage field without flowering strip). In addition these cabbage heads reported also 41 % less damaged cabbage-head leaves, which had to be removed. In 2010 (cabbage field with flowering strips) we found no differences in the weight of the cabbage heads between plots with and without companion plants, but also compared to the insecticide treated plot (Balmer et al., 2009, Luka et al., 2010).

4 Conclusions

The impact of these measures is scientifically documented. For their efficacy is crucial to have in the proximity of the cabbage field, so in an environment placed at an accessible range for the beneficials, perennial habitats like extensive meadow, field margins and hedgerows to attract them after the overwintering period near the cabbage field. Therefore we are planning large scale field experiments to investigate the system by taking in consideration also the landscape composition. Until then we will develop agro-ecological optimizations to sown the flowering strip as well to mechanize the planting of the companion plants.

Acknowledgements

Funding: the Bristol-Foundation, the Federal Office for the Environment (BAFU), Coop Fonds für Nachhaltigkeit, the Ernst Göhner Foundation, the Parrotia-Foundation, Schöni Swissfresh AG, the Singenberg Foundation, the Bank Vontobel Charitable Foundation, the Dreiklang Foundation, the Werner Steiger Foundation and Stiftung zur internationalen Erhaltung der Pflanzenvielfalt.

Collaborations: all the farmers, Prof. Peter Nagel, PD Dr. Jan Beck, Prof. Mathias Kölliker, Prof. Walter Salzburger (University of Basel), Prof. Felix Wäckers (University of Lancaster), PD Dr. Michael Traugott (University of Innsbruck) as well as Dr. Werner Marggi and Dr. Hannes Baur (Natural History Museum Bern), Pius Andermatt and Oliver Kindler (Syngenta, Stein) and Johannes Burri (Fenaco).

FiBL collaborators (Department of Crop Sciences): Dr. Oliver Balmer, Dr. Elodie Belz, Dr. Céline Géneau, Dr. Lukas Pfiffner and Dr. Lucius Tamm. Master thesis: Nadine Ditner, Nadia Dürr, Ivan Juric, Andrea Leimgruber, Sebastian Moos, Johannes Schied, Bettina Weishaupt and Martin Willareth.

References

BALMER, O. et al.. (2009) *Nützlingsförderung im Kohl. Biodiversität mit Nutzen für Natur und Bauern*. *Zwischenbericht 2008-2009*. Frick.

BALMER, O. et al.. (2013) Noncrop flowering plants restore top-down herbivore control in agricultural fields. In *Ecology and Evolution*, vol. 3, no. 8, pp. 2634–2646.

BALMER, O. et al. (2014) Wildflower companion plants increase pest parasitation and yield in cabbage fields: Experimental demonstration and call for caution. In *Biological Control*, vol. 76, pp. 19–27.

BELZ, H., KÖLLIKER, M. and BALMER, O. (2013) Olfactory attractiveness of flowering plants to the parasitoid *Microplitis* mediator. In *BioControl,* vol. 58, pp. 163–173

DITNER, N. et al. (2013) Effects of experimentally planting non-crop flowers into cabbage fields on the abundance and diversity of predators. In *Biodivers Conserv*, vol. 22, pp. 1049–1061.

GENEAU, C. E. et al.. (2012) Selective flowers to enhance biological control of cabbage pests by parasitoids. In *Basic and Applied Ecology*, vol. 13, no.1, pp. 85–93.

LUKA, H. et al. (2009) Einfluss von Habitatmanagement auf die Reduktion von Schadlepidopteren im Kohl, pp. .288–291. In: MAYER, J *et al.* (Hrsg.) *Werte - Wege - Wirkungen: Biolandbau im Spannungsfeld zwischen Ernährungssicherung, Markt und Klimawandel*. Berlin: Dr.Köster.

LUKA, H. et al. (2010) *Nützlingsförderung im Kohl. Biodiversität mit Nutzen für Natur und Bauern*. Frick: Forschungsinstitut für biologischen Landbau (FiBL).

LUKA, H. et al. (2012) *Einführung von agronomisch und ökologisch wirkungsvollen Nützlingsblühstreifen in der Kulturlandschaft. Dossier Nützlingsblüstreifen*. Frick und Zürich: Forschungsinstitut für biologischen Landbau (FiBL) & Agroscope Reckenholz.

PFIFFNER, L., LUKA, H. and SCHLATTER C. (2005) Schädlingsregulation gezielt verbessern. In Ökologie & Landbau, vol. 134, no. 2, pp. 51–53.