Agronomy Research **7**(Special issue I), 548–554, 2009

Effect of crop management on the incidence of *Meligethes aeneus* Fab. and their larval parasitism rate in organic and conventional winter oilseed rape

E. Veromann, M. Saarniit, R. Kevväi and A. Luik

Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences, Kreutzwaldi 1, 51014 Tartu, Estonia; e-mail: eve.veromann@emu.ee

Abstract. The occurrence of *Meligethes aeneus* adults, larvae and larval parasitism rate was studied in organic and conventional winter oilseed rape fields in Estonia. No insecticides were used in fields with either management. In the conventional field, significantly more *M. aeneus* adults and larvae were found than in the organic field, whereas the larval parasitism rate was significantly greater in the organic winter rape field. This study showed that organic cropping system enhanced the occurrence of parasitoids and diminished the incidence of pest attack in winter oilseed rape.

Key words: organic and conventional cropping system, winter oilseed rape, *Meligethes aeneus*, larval parasitism

INTRODUCTION

Oilseed rape (*Brassica napus* L.) is an increasingly important crop throughout northern and central Europe, for its cooking oil, rapemeal and more recently for bioenergy. In Estonia, the area sown to the crop has increased 60-fold over the past 15 years (Statistics Board, 2009), which has resulted in an increase in the damage caused by various oilseed rape pests (Hokkanen, 2000; Cook & Denholm, 2008).

Among the insect pests, the pollen beetle *Meligethes aeneus* Fab. (Coleoptera, Nitidulidae) is the major pest throughout Europe in both winter and spring oilseed rape fields (Alford et al., 2003). In Estonia, *M. aeneus* is the most numerous crucifer-specialist insect in the oilseed rape crop (Veromann et al., 2006a,b). The adult beetles emerge in spring from hibernating sites when air temperatures exceed 12–15°C. They feed on pollen from most plants, but eggs are laid only in buds of brassicaceous plants (Alford et al., 2003). In Estonia, pollen beetles feed on different blooming plants before migrating to oilseed rape fields. Green bud stage of oilseed rape plants is the most susceptible period for causing yield-limiting damage by *M. aeneus* adults (Cook & Denholm, 2008). They bite holes in the small rape buds (most suitable buds are 3mm long) to reach pollen for feeding and thereby damage the plants. Females lay eggs into the buds where first instar larvae cause additional damage by feeding on pollen (Büchi, 2001; Cook et al., 2002; Alford et al., 2003). Second instar larvae feed on pollen from open flowers and do not cause significant loss of yield (Williams & Free, 1978).

Throughout Europe, the management of oilseed rape pests still relies greatly on chemical pesticides, often applied routinely and prophylactically, without assessing pest incidence on the fields (Williams, 2004). This has led to their over-use, reducing the economic competitiveness of the crop, threatening biological diversity and enhances the pyrethroid resistance development in the pollen beetle (Hansen, 2003; 2007; Heimbach et al., 2006; Nilsson & Ahman, 2006; Wegorek & Zamoyska, 2007). Pest resistance to insecticides develops more quickly than new insecticides can be brought to the market, while the need for them continues to increase (Veromann et al., 2008). Pesticides also kill natural agents of biological control (involving parasitoids) that represent a resource with a great value for farmers due to decreased insecticide use and for consumers wishing to choose healthier food (Alford, 2000; Nilsson, 2003; Walters et al., 2003). Parasitoids are essential natural enemies of many crop pests and may act as keystone species in ecosystems (Thies et al., 2003).

Organic farming is a system with harmonized interactions of all agroecological elements and it enhances the presence of biological control agents. Organic agriculture should achieve ecological balance through establishment of habitats for beneficial agents and maintenance of genetic, agricultural and landscape diversity. Therefore it is important to find out if and how the cropping system of oilseed rape impacts the abundance of main pest and its parasitism rate. The aim of this pilot study was to find out whether there are differences between organic and conventional winter oilseed rape (WOSR) fields in the abundance of *M.aeneus* adults, larvae and larval parasitism rates.

MATERIALS AND METHODS

This study was carried out on conventionally (Kulli 58º14´ latitude 26º15´ longitude) and organically (certificated organic Puki Farm – 58º28´ latitude 26º59´ longitude) grown crops of winter oilseed rape in Tartu County in 2006. WOSR cv. Banjo and turnip rape cv. Prisma was drilled on August 2005. The previous crops in conventional and organic field were winter wheat and clover, respectively. The conventional WOSR field was situated in an open landscape, bordered by roads on two sides and by barley on the other sides. The organic turnip rape field was located in a diverse landscape, between forests and hayfields. No insecticides were applied. Samples were taken from 5 randomly chosen plants at 24 different places in conventional and 20 in organic field; in total from 120 and 100 plants, respectively. To determine flight activity of adult *M. aeneus*, beetles were counted at green bud stage of plants (BBCH 51–53 (Meier, 2001)), for the estimation of oviposition activity of *M. aeneus*, at the end of flowering of main raceme (BBCH 67–69) all larvae were collected from the flowers. For the estimation of parasitisation level, second instar larvae of *M. aeneus* were dissected in the laboratory. Larvae and eggs of parasitoids were counted and the percentage of parasitism was calculated.

Statistical analysis was carried out using the SAS GENMOD procedure. Comparisons of the number of adults, larvae and parasitized larvae in different cropping systems were made by using generalized linear models, applying the Poisson distribution and the log link function (adults and larvae), Binormal distribution and logit function (parasitized larvae). If the model was overdispersed, the scale parameter was estimated by Pearson's chi-square divided by the degrees of freedom.

RESULTS AND DISCUSSION

During the green bud stage of plants, the occurrence of *M. aeneus* adults was significantly greater in the conventional than in the organic oilseed rape field (χ^2 = 13.80; *df* = 1; *P* = 0.0002) (Fig. 1). Nevertheless, the number of adults per plant was low and did not exceed the economic threshold level neither in the organic nor in conventional system. The influential factor in our pilot study was that we had different cultivars in comparable systems and turnip rape is more attractive for pollen beetles than oilseed rape (Cook et al., 2002; 2006; 2007). Regardless of the attractiveness of turnip rape to pollen beetles, the 9.17-fold greater number of adult beetles was found in WOSR, in conventional system. Thus, we can extrapolate our result to the landscape level and to the efficiency of host plant localisation of beetles. We postulate that adult beetles could locate their host plants (in their vulnerable stage) in the open landscape significantly more easily than in diverse scenery. In accordance to Thies et al. (2003) low plant damage caused by the *M. aeneus* and high beetle mortality due to parasitism could be found in structurally complex landscapes with a high percentage of non-crop area. In our study the organic field was situated in structured landscape.

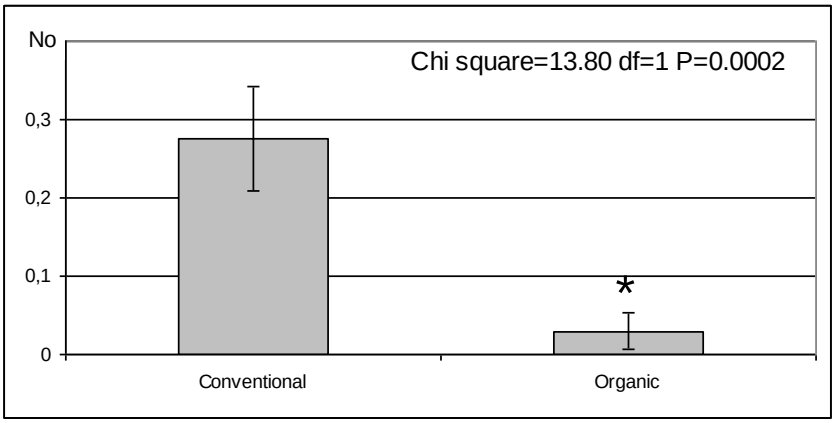

Fig. 1. Mean (±SE) number of *M. aeneus* adults per oilseed rape plant (during green bud stage, BBCH 51–53) in conventional and organic winter oilseed rape fields in Tartu County, Estonia, 2006 (asterisk indicates significant difference between cropping systems).

Similarly to adults, the mean number of *M. aeneus* larvae per plant was significantly greater (4.86 times) in the conventional oilseed rape field than in the organic field (χ^2 = 36.65; *df* = 1; *P* < 0.0001) (Fig. 2). It was anticipated because of the greater abundance of adult beetles in conventional field. However, the greater number of larvae in conventional system does not implicate more active oviposition of adults. Oviposition activity was 1.89 times greater in organic field when compared to conventional one. Therefore, pollen beetles which had located the organic oilseed rape plants laid eggs more actively into flowers than those in the conventional field. During host plant selection, firstly, the insect must be able to detect and locate it from distance and secondly, it has to decide whether or not to accept the plant (Städler, 1992; Borg, 1996).

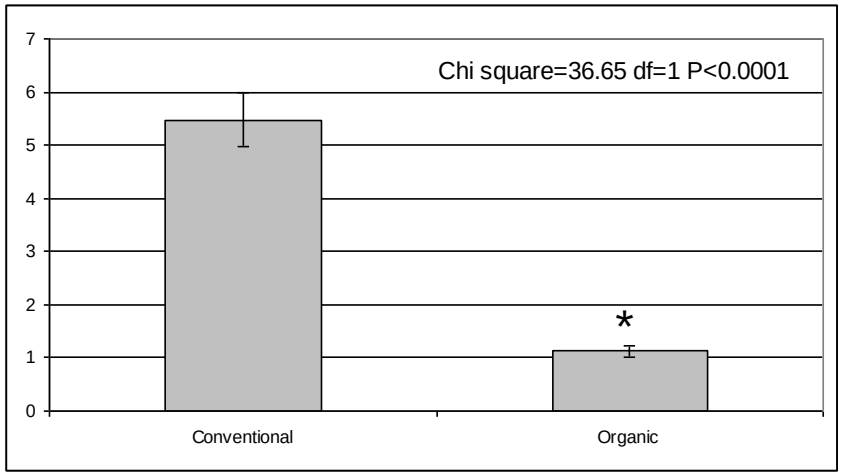

Fig. 2. Mean (±SE) number of *M. aeneus* larvae per oilseed rape plant in conventional and organic winter oilseed rape fields in Tartu County, Estonia, 2006 (asterisk indicates significant difference between cropping systems).

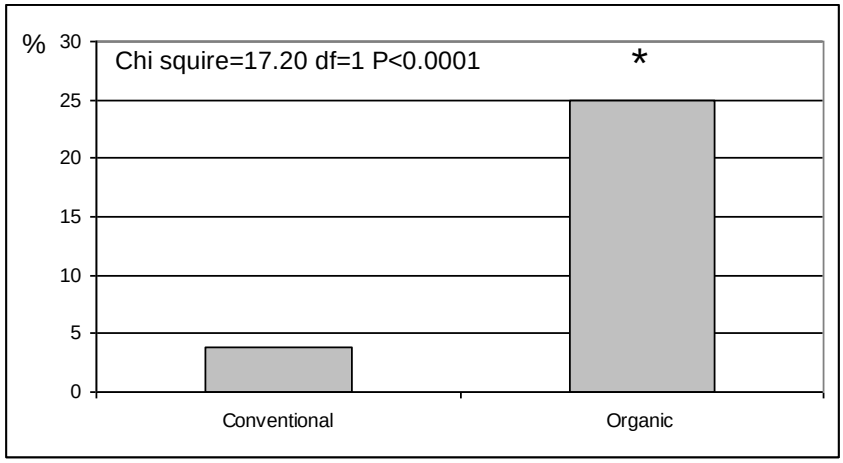

Fig. 3. Percentage of parasitized *M. aeneus* larvae per oilseed rape plant in conventional and organic winter oilseed rape fields in Tartu County, Estonia, 2006 (asterisk indicates significant difference between cropping systems).

If a plant is accepted or rejected depends on the sensory perception of the allelochemicals (external factors) and on the chemosensory coding of information (internal factors, such as motivation and degree of satisfaction) by the central nervous system (Courtney, et al., 1989; Borg, 1996).

Parasitism rate of *M. aeneus* larvae was significantly greater in the organic than in the conventional cropping system (χ^2 = 17.20; *df* = 1; *P* < 0.0001) (Fig. 3). The patterns of crop colonization by WOSR pests and their parasitoids and predators can be

explained by the presence of their overwintering sites in field boundaries and also by wind direction (Free & Williams, 1979; Ferguson, et al., 2003a,b; Warner, et al., 2000, 2003; Valantin-Morison, et al., 2007). Most families of insects tended to be concentrated around hedges, trees, bushes and stripes of woodland which provide a source of food, shed and shelter against the wind. In addition, complex landscapes support alternative host and host plants and may thereby enhance parasitoid populations (Thies, et al., 2003). Almost a 6-fold greater parasitism rate of the larvae from the organic oilseed rape proved that this crop management enhances the presence of parasitoids of *M. aeneus* and therefore reduces the number of pollen beetles.

CONCLUSIONS

Plain landscape without diverse field boundaries in the conventional crop management fostered infestation of oilseed rape by the pollen beetles and decreased the parasitism rate of *M. aeneus*. Greater parasitism rate in the organic system showed that this crop management system promotes the presence of parasitoids.

In Estonia, there is still no need for insecticide treatment against *M.aeneus* in winter oilseed rape, because they are poorly synchronized with phenological development of the winter crop.

ACKNOWLEDGEMENTS. We thank Marge and Madis Ajaots, (conventional Pilsu Farm) and Olev Pragi (Organic Puki Farm) for crop husbandry. This study was supported by the EU Framework 5 project MASTER: Integrated pest management strategies incorporating bio-control for European oilseed rape pests (QLK5-CT-2001-01447), Ministry of Agriculture of Estonia and Estonian Science Foundation grants Nr 5736 and 4993.

REFERENCES

Alford, D.V. 2000. Biological control of insect pests on oilseed rape in Europe. *Pesticide Outlook* **11**(5), 200–202.

Alford, D. V., Nilsson, C. & Ulber, B. 2003. Insect pests of oilseed rape crops. In Alford, D.V. (ed.): *Biocontrol of Oilseed Rape Pests*. Blackwell Science. Oxford, UK, 355 pp.

Borg, A. 1996. Oviposition behaviour of two pollen beetles (*Meligethes aeneus* and *M. viridescens*) on different host plants. Doctors dissertation. Swedish University of Agricultural Sciences, Upplala, 19 pp.

Büchi, R. 2002. Mortality of pollen beetle (*Meligethes* spp.) larvae due to predators and parasitoids in rape fields and the effect of conservation strips. *Agriculture, Ecosystems and Environment* **90**, 255–263.

Courtney, S., Chen, G.K. & Gardner, A. 1989. A general model for individual host selection. *Oikos* **55**, 55–65.

Cook, S.M., Bartlet, E., Murray, D.A. &Williams, I.H. 2002. The role of pollen odour in the attraction of pollen beetles to oilseed rape flowers. *Entomologia Experimentalis et Applicata* **104**, 43–50.

Cook, S.M. & Denholm, I. 2008. Ecological approaches to the control of pollen beetles in oilseed rape. *Bulletin OEPP/EPPO* **38**: 110–113.

Cook, S.M. Khan Z.R. & Pickett, J.A. 2007. The use of push-pull strategies in integrated pest management. *Annu. Rev. Entomol.* **52**, 375–400.

Cook, S.M., Smart, L.E., Martin, J.L., Murray, D.A., Watts, N.P. &Williams, I.H. 2006. Exploitation of host plant preferences in the pest management strategies for oilseed rape (*Brassica napus*). *Entomologia Experimentalis et Applicata* **119**, 221–229.

Cook, S.M., Smart, L.E., Potting, R.J.P, Bartlet, E., Martin, J.L., Murray, D.A., Watts, N.P. &Williams, I.H. 2002. Turnip rape (*Brassica rapa*) as a trap crop to protect oilseed rape (*Brassica napus*) from infestation by insect pests: potential and mechanisms of action. Proc. BCPC Conference – Pests & Diseases 2002, vol. **2**, 569–574.

Ferguson, A.W., Campbell, J. M., Warner, D.J., Watts, N.P., Schmidt, J.E.U. & Williams, I.H. 2003a. Spatio-temporal distributions of *Meligethes aeneus* and its parasitoids in an oilseed rape crop and their significance for crop protection. *11th International Rapeseed Congress, 6-10 July 2003, Copenhagen, Denmark*, 1057–1059.

Ferguson, A.W., Klukowski, Z., Walczak, B., Clark, S.J., Mugglestone, M.A., Perry, J.N. & Williams, I.H. 2003b. Spatial distribution of pest insects in oilseed rape: implications for integrated pest management. Agriculture, Ecosystems and Environment **95**, 509–521.

Free, J.B. & Williams, 1979.The distribution of insect pests on crops of oilseed rape (Brassica napus L.) and the damage they cause. – J. Agric. Sci., Cambridge **92,** 139–149.

Hansen L.M. 2003. Insecticide-resistant pollen beetles (*Meligethes aeneus* F) found in Danish oilseed rape (*Brassica napus* L.) fields. *Pest Management Science* **59** (9), 1057–1059.

Hansen, L.M. 2007. Occurence of insecticide resistant pollen beetles (*Meligethes aeneus* F.) in Danish oilseed rape (*Brassica napus* L.) crops. *Bulletin. OEPP/EPPO* **38**, 95–98.

Heimbach, U., Müller, A. & Thieme, T. 2006. First steps to analyse pyrethroid resistance of different oilseed rape pests in Germany. *Nachrichtenblatt des Deutschen Pflazenschutzdienstes* **58**, 1–5.

Hokkanen, H.M.T. 2000. The making of a pest: recruitment of *Meligethes aeneus* onto oilseed Brassicas. *Entomologia Experimentalis et Applicata* **95**, 241–249.

Meier, U. (ed.) 2001. Growth stages of mono- and dicotyledonous plants. 2nd ed. Updated 23 November 2005. Cited 12 April 2006.http://www.bba.de/veroeff/bbch/bbcheng.pdf

Nilsson, C. 2003. Parasitoids of Pollen Beetles. In Alford, D.V. (ed.): *Biocontrol of Oilseed Rape Pests*. Blackwell Science. Oxford, UK: 73–85.

Nilsson, C. & Ahman, B. 2006. Parasitoids of pollen beetles in Sweden – part of a strategy against pyrethroid resistance. *CD-ROM Proceedings International symposium on integrated pest management in oilseed rape, 3–5 April, 2006, Göttingen, Germany.*

Statistics Board 2009: Cited 17 Jan 2009. Updated 3 Apr. 2008. http://pub.stat.ee.

Städler, E. 1992. Behavioural responses of insects to plant secondary compounds. In: Herbivores: their infractions with secondary plant metabolites, 2E. Volume II: Evolutionary and ecological process. Academic press, 45–88.

Thies, C., Steffan-Dewenter, I. & Tscharntke, T. 2003. Effects of landscape context on herbivory and parasitism at different spatial scales. Oikos **101**, 18–25.

Valantin-Morison, M., Meynard, J-M. & Dore, T. 2007. Effects of crop management and surraounding field environment on insect incidence in organic winter oilseed rape (*Brassica napus* L.). *Crop protection* **26**, 1108–1120.

Veromann, E., Luik, A., Metspalu, L., & Williams, I. 2006a. Key pests and their parasitoids on spring and winter oilseed rape in Estonia. *Entomoogica. Fennica* **17**, 400–404.

Veromann, E., Tarang, T., Kevväi, R., Luik, A. & Williams, I.H. 2006b. Insect pest and their natural enemies on spring oilseed rape in Estonia: impact of cropping systems. *Agricultural and Food Science* **15**, 1–12.

Veromann, E., Kevväi, R., Luik, A. & Williams, I.H. 2008. Do cropping system and insecticide use in spring oilseed rape affect the abundance of pollen beetles (*Meligethes aeneus* Fab.) on the crop. *International Journal of Pest Management* **54**, 1–4.

Walters, K.F.A., Young, J.E.B., Kromp, B. & Cox, P.D. 2003. Management of Oilseed Rape Pests. In: Alford DV (ed.), Biocontrol of Oilseed Rape Pests. Blackwell Science, Oxford, UK: 43–71.

Warner, D.J., Allen-Williams, L.J., Ferguson, A.W. & Williams, I.H. 2000. Pest-predator spatial relationships in winter rape: implications for integrated crop management. *Pest Management Science* **56**, 977–982.

Warner, D.J., Allen-Williams, L.J., Warrington, S., Ferguson, A.W. & Williams, I.H. 2003. Mapping, characterisation, and comparision of spatio-temporal distribution of cabbage stem flea beetle (*Psylloides chrysocephala*), carabids and *Collembola* in a crop of winter oilseed rape (*Brassica napus*). *Entomologia Experimentalis et Applicata* **109**, 225–234.

Wegorek, P. & Zamoyska, J. 2007. Current status of resistance in pollen beetle (*Meligethes aeneus* F.) to selected active substances of insecticides in Poland. *Bulletin OEPP/EPPO* **38**: 91–94.

Williams, I.H. 2004. Advances in Insect Pest Management of Oilseed Rape in Europe. In: AR Horowitz & I. Ishaaya Insect (ed.): *Pest Management – Field and Protected Crops.* Springer-Verlag, Heidelberg, pp. 181–208.

Williams, I. H. & Free, J.B. 1979. Compensation of oilseed rape *Brassica napus* L. plants after damages to their buds and pods. *Journal of Agricultural Science, Cambridge* **92**, 53–59.