Spatial organization of organic and conventional farming in agricultural landscapes: impacts on beneficial insects

Camille Puech, Stéphanie Aviron, Jacques Baudry

Proceedings of the 4th International Symposium on Biological Control of Arthropods, Pucón, Chile.
Peter G. Mason, David R. Gillespie & Charles Vincent Eds. (2013)
p209-211

Spatial organization of organic and conventional farming in agricultural landscapes: impacts on beneficial insects

Camille Puech[1], Stéphanie Aviron[1], Jacques Baudry[1]

[1]*INRA, Unité SAD-Paysage, F-35000 Rennes, France, camille.puech@rennes.inra.fr*

Given the current decline of biodiversity, modern agriculture is facing a new challenge: ensuring food supply to an increasingly large human population whilst maintaining the ecological balance of agro-ecosystems to preserve their sustainability. Because of a strong reduction of chemical inputs, organic farming is considered as a promising solution to promote communities of natural enemies and ensure crop protection thanks to biological control. Indeed, this ecological service seems to be an interesting alternative to chemical control but its functioning is not well understood.

Numerous studies have investigated the effect of organic *vs*. conventional farming on biodiversity at the field or farm scale. Overall, they show a positive effect of organic practices on the diversity or abundance of natural enemies, but there are also contradictory results (Bengtsson *et al.* 2005). This might be explained by the dichotomy generally made between organic and conventional farming, which does not always make sense because of the large diversity of practices occurring in each farming type (Laurens unpublished results). The effect of organic farming on natural enemies and biological control was also shown to vary according to landscape heterogeneity or complexity (usually described by the amount of semi-natural elements) (Rundlöf & Smith 2006, Holzschuh *et al.* 2010), which is recognized as a key driver of biodiversity. Furthermore, recent studies suggest that biodiversity is enhanced in landscapes with large areas of organic farming (Gabriel *et al.* 2010). However, the effects of the diversity and spatial organization of organic and conventional farming practices remain unexplored.

The present study aims at measuring the influence of the diversity and spatial organization of organic and conventional farming practices on aphids and their natural enemies (ladybirds, predatory carabid beetles and parasitoids) in winter wheat. Higher abundances of beneficial insects were expected in organic fields and “organic landscapes” but with important variations due to practices diversity. Moreover, fields directly surrounded by extensive practices, either organic or conventional, were expected to present high abundance of natural enemies.

Twenty, 1 km² landscapes were selected in Brittany (Western France). These landscapes were characterized by similar coverage of semi-natural elements, farmland, built areas and water, but different amount of organic fields (from 6 to 37%). In each landscape, ladybirds, carabid beetles, parasitoids and aphids communities were sampled from April to July 2012 in one pair of organic and conventional winter wheat fields. In each of the 40 fields, data on vegetation height, density, and weeds cover were also collected as descriptors of abiotic conditions. Interviews of farmers were conducted to describe agricultural practices (crop management sequence, seeding, winter cover, previous crop and crop rotation) on sampled and surrounding fields.

The results presented here concern ladybirds and include data on diversity of farming practices at the field scale only. At the field scale, the analysis of agricultural practices on wheat fields was made thanks to Correspondence Analysis. Fields

coordinates along the first three CA axes were used in linear models as descriptors of farming practices. Only field coordinates along the first axis had an effect on ladybirds. This axis was mostly related to farming type, with a distinction of organic (no inputs, frequent tillage and organic fertilization, long rotations) *vs.* conventional practices (chemical inputs, low tillage and organic fertilization, short rotations). However, there was a diversity of practices among interviewed farmers of each farming type (Figure 1a). Ladybirds were more abundant in fields with practices close to organic farming. This is consistent with studies which found direct or indirect lethal effects of chemical pesticides on ladybirds (Obrycki & Kring 1998). On the contrary, ladybirds are positively affected by frequent tillage and organic fertilization. Tillage is unlikely to affect ladybirds as they are absent in fields when most interventions are done (autumn), but some studies demonstrate a positive effect of organic fertilization on natural enemies (Holland & Luff 2000, Garratt *et al.* 2011). In addition, organic fields were characterized by dense weed cover compared to conventional fields. It might result from the practices previously mentioned, and explain their positive effect on ladybirds. Indeed, weeds create favorable and attractive microclimatic conditions thanks to vegetation structure (Ali & Reagan 1985). No effect of aphids abundance was found, probably because there were not enough individuals this year.

At the landscape scale, the proportion of the boundary of studied fields with organic fields had a strong positive effect on the abundance of ladybirds (Figure 1b). At larger scale, ladybirds were positively impacted by the amount of organic farming in 250m buffers (Figure 1c). This is consistent with Gabriel *et al.* (2010), which demonstrate a positive effect of organic farming in 10 km² landscapes. This suggests that farming practices may impact insects beyond the field scale. In fact, it is shown that pesticides can widely disperse in the environment (Wittich & Siebers 2002). Furthermore, ladybirds are known to move frequently between habitats (Evans 2003) and can consequently be affected by practices at landscape scale. However, ladybirds were not influenced by landscape characteristics in 500m buffers, probably because the coverage of organic farming amongst sites varies less than in 250m buffers.

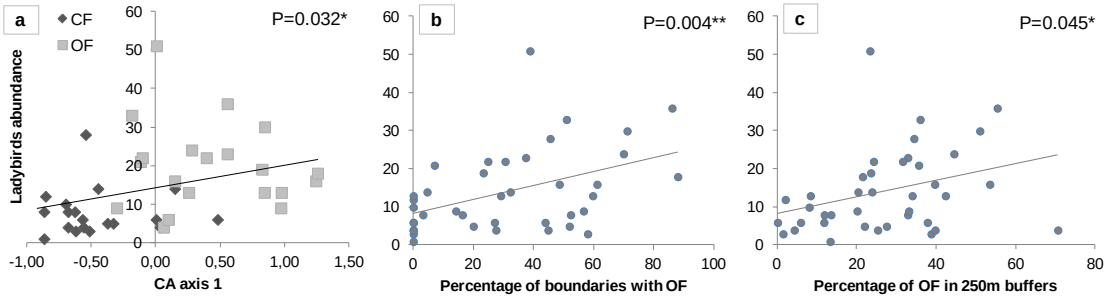

Figure 1. Effect on ladybirds abundance of a) the first CA axis (CF: Conventional Farming ; OF: Organic Farming) b) the percentage of boundaries between the study fields and organic fields c) the percentage of organic fields in 250m buffers. N=40.

To conclude, these results demonstrate that even if organic and conventional farming systems are basically different, there is a wide diversity of practices within each farming type that should be taken into account. Moreover, the strong effects of agricultural practices on ladybirds at field and landscape scales suggest that practices effects on natural enemies should be taken into account at different spatial scales to improve biological control efficiency.

Further analysis will be done to evaluate the effect of the detailed agricultural practices at landscape scale on ladybirds. Comparison with results for parasitoids and ground beetles will also provide additional information about the biological control potential.

Ali, A. D., and T. E. Reagan. 1985. Vegetation manipulation impact on predator and prey populations in Louisiana sugarcane ecosystems. J.Econ.Entomol. 78: 1409-1414.

Bengtsson, J., J. Ahnström, and A.-C. Weibull. 2005. The effects of organic agriculture on biodiversity and abundance: a meta-analysis. J. Appl. Ecol. 42: 261-269.

Evans, E. W. 2003. Searching and reproductive behaviour of female aphidophagous ladybirds (Coleoptera: Coccinellidae): a review. Eur. J. Entomol. 100: 1-10.

Gabriel, D., S. M. Sait, J. A. Hodgson, U. Schmutz, W. E. Kunin, and T. G. Benton. 2010. Scale matters: the impact of organic farming on biodiversity at different spatial scales. Ecol. Lett. 13: 858-869.

Garratt, M. P. D., D. J. Wright, and S. R. Leather. 2011. The effects of farming system and fertilisers on pests and natural enemies: A synthesis of current research. Agr. Ecosyst. Environ. 141: 261-270.

Holland, J. M., and M. L. Luff. 2000. The effects of agricultural practices on Carabidae in temperate agroecosystems. Integrated Pest Management Reviews 5: 109-129.

Holzschuh, A., I. Steffan-Dewenter, and T. Tscharntke. 2010. How do landscape composition and configuration, organic farming and fallow strips affect the diversity of bees, wasps and their parasitoids? J. Anim. Ecol. 79: 491-500.

Laurens, E. 2012. Etude des pratiques en blé dans les exploitations bretonnes. Unpublished.

Obrycki, J. J., and T. J. Kring. 1998. Predaceous coccinellidae in biological control. Ann. Rev. Entomol. 43: 295-321.

Rundlöf, M., and H. G. Smith. 2006. The effect of organic farming on butterfly diversity depends on landscape context. J. Appl. Ecol. 43: 1121-1127.

Wittich, K. P., and J. Siebers. 2002. Aerial short-range dispersion of volatilized pesticides from an area source. Int. J. Biometeorol. 46: 126-135.