Landscape effect of organic farming, semi-natural habitats and surrounding oilseed rape on multifunctionality in oilseed rape fields

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Résumé

Agroecology is an alternative to the conventional agricultural models that relies on ecological functions provided by biodiversity to achieve a balance between food production, farmers' profitability and reducing negative environmental externalities (Altieri, 1989; Gliessman, 2018). Understanding the conditions that promotes the simultaneous provision of multiple ecological functions that benefit to agricultural production is therefore required to design agroecological systems. However, antagonisms or synergies may arise in the expression of these functions (Garibaldi et al., 2018), hence the need to study the simultaneous provision of ecological functions, i.e. multifunctionality. Specifically considering dilution, dispersal, or barrier effects of the surrounding landscape on the distribution of beneficial organisms (Ragué et al., 2022; Couthouis et al., 2023).
In this study, we focus on three ecological functions related to crop production and examine how each of these functions and the multifunctionality, in oilseed rape fields vary with the amount of surrounding oilseed rape, grassland, hedgerows and organic farming in their surrounding landscapes. Ecological functions considered here are pollination (measured by the average number of seeds produced per oilseed rape branch), natural pest control (measured using sentinel cards with weed seeds or aphids as preys to estimate predation rates (Boetzl et al., 2020)) and organic matter recycling (estimated with the tea-bags index (Keuskamp et al., 2013)). These functions were measured in 108 oilseed rape fields between 2016 and 2022 (9 to 27 fields per year). The fields were selected to cover gradients of organic farming and semi-natural habitats.

To quantify the effects of each landscape variable on the level of multifunctionality in each field, we used the Siland method which simultaneously evaluates the effects of landscape variables and the distances of the effect by maximising the likelihood of the parameters (Carpentier and Martin, 2021). Because the magnitude of ecological functions and hence of multifunctionality vary with weather conditions, soil types and field size, we also account for these variables in our analysis. We found that the amount of oilseed rape within a 368 m radius buffer and the amount of grassland within a 378 m radius buffer around focal oilseed rape fields had a significant positive effect on multifunctionality. Conversely, the amount of hedgerows within a buffer of radius 734 m had a significant negative effect. No significant effect of the amount of organic farming was found on multifunctionality.
The function-by-function analysis will provide a deeper understanding of the ecological mechanisms that govern the provision of multifunctionality in agricultural environments.

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Mots-Clés: Agricultural landscape, Ecosystem functioning, Natural pest control, Pollination, Soil