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CESAB
CENTRE FOR THE SYNTHESIS AND ANALYSIS OF BIODIVERSITY

Project summary

DISCO-WEED

Disentangling the role of anthropic disturbances and ecological processes on weed community assembly

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Start and finish: 2015-2019

Weeds are an important threat to crop production and management rules have been developed to regulate weeds in fields. However, intensive use of herbicides and inorganic fertilizers, large-scale simplification of crop sequences and repeated ploughing has caused considerable biodiversity loss in European agro-ecosystems; many weed species are currently threatened with extinction. Moreover, the drastic decline observed in weed diversity and abundance has highlighted the crucial functional role weeds play in agroecosystem food-webs; including in pollination, provision of habitat and biological control.

Context and objectives

The recognition of the need to better balance food production with other, non-provisioning ecosystem services, is reflected in the 2014-2020 reform of the Common Agricultural Policy which, for the first time includes 'greening measures' as a requirement for Pillar 1 payments that primarily support agricultural productivity. Assuring food security and conserving farmland biodiversity while reducing chemical inputs has also been the motivation for a number of National initiatives (e.g. French Ecophyto Plan, Campaign for the Farmed Environment in the UK). In this context, it is imperative that the consequences of agricultural management on weed abundance and crop production are investigated. The Disco-Weed project addressed these challenges using an interdisciplinary approach and aimed at filling the knowledge gap to reducing chemical inputs and understanding the effects of weeds on crop production.

Methods and approaches used for the project

We used weed community datasets based on standardized sampling schemes at French national scale (Biovigilance, Fried *et al.* 2008), in England and Scotland (Farm Scale Evaluations, Perry *et al.* 2003), in west of France (LTSER Zone Atelier "Plaine & Val de Sèvre", Bretagnolle *et al.* 2018) and in South East and South West of England (Farm4Bio, Holland *et al.* 2013) to analyse 'weed/crop/agricultural practices' relationship across various environmental conditions. Generalized-mixed, Bayesian hierarchical and simulation models have be used to take into account the intra and inter-farm variability over a biogeographic gradient to detect general trends in the effects of agronomic factors on the performance of weed species. For all analyses, we will combine spatial, community and functional ecology to assess the response of weeds to crop competition, agronomic practices, crop succession and landscape, as well as the effect of weed on crop yield.

Principal conclusions

Despite growing concern societal concerns about biodiversity decline and chemical pesticides, especially herbicides, the impact of weeds on crop yield as well as the processes that govern weed diversity in agroecosystems are poorly understood. By better questionning what makes a weed a weed, and how weed species are distributed along biogeographic gradients, Disco-Weed revealed that intensive agriculture has created a clearly delineated pool of plants that display a specific trait syndrome, the so-called arable weeds. The Disco-Weed project also demonstrated the strong contribution of crop competition and diversified crop sequences in reducing weed biomass, as well as the key role of dispersal in the persistance of weed diversity in farmlands. Finally, by combining data from surveys and experiments, we revealed that reducing dependence on weed management may not hamper cereal production in this system, and is economically profitable at the field level on the short term. Our project thus contributes to addressing key gaps in our knowledge on weed species assembly and weed-crop interaction, and gives hope for implementing win-win strategies for farmers and the environment.

Anticipated (or actual) impact of these results for science, society, and public and private decision making

There are still much to understand on weed species assembly and crop-weed interactions, however our results already suggest avenues to substantially reduced herbicide use and conserve weed biodiversity (and in turn farmland biodiversity)

while preserving both crop production and farmers' revenues.

At the field scale: Our results showed that crop competition is an efficient way to significantly reduce weed biomass (~65%) in arable fields and that reducing from 30 to 50% of herbicide use in the most intensively managed fields can enable maintaining crop production and quality and increase farmers' revenues.

At the succession scale: We showed that farmers may enhance arable weed diversity on a pluri-annual scale by sequentially sowing crop species that differ in their competitive ability and sowing date. They may also achieve a better control of weed abundance by increasing the diversity of crop sowing dates across the crop sequence.

At the landscape scale: Leaving field margins unmanaged or creating unsprayed strips of land away from sources of problematic weeds can not only provide a refuge for the beneficial plants we want to protect, but can also reduce the risk of the wrong

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