The synergy of seed-eating carabids and crop rotation in weed regulation

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Abstract

Global population growth and increasing demand for food has resulted in unsustainable expansion and intensification of agriculture, and is one of the most pressing environmental challenge we face. It is widely recognized that agricultural production, and food security, depends strongly on ecosystem services such as pollination and pest management, but limited understanding of the drivers and processes involved in the provision of these services restricts our capability to manage and fully integrate their benefits into agricultural systems. Here we use advanced modelling approaches to analyse the effect of crop rotation and carabids on in-field weed regulation, revisiting data from the largest agricultural field experiment ever conducted in Great-Britain. The Farm Scale Evaluation (FSE) collected data on crop history, seed bank composition and amount, standing weed communities, seed rain and ground beetle communities in 257 conventionally managed fields over a 4-year period. Using structural equation modelling (SEM) approaches and food network analysis, we quantify the combined roles of crop rotation, management practices and biological control (via ground beetles: Carabidae) on in-field weed control and seed bank dynamics. In contrast to previous "piecemeal" analyses of the FSE data, our integrated approach based on causal inferences provides a mechanistic understanding that quantifies the impact of infield biodiversity on weed regulation. Our results show clearly a regulating effect of ground beetles on the composition and the density of weed seed in the seed bank. This study highlights the benefit of measures aimed at maintaining populations of ground-beetles and resilient food webs for integrated weed regulation in arable fields, contributing to both the maintenance of productivity and mitigating environmental impact of agriculture by reducing farmer-dependence on chemical pest management.

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