

Trophic Networks and Ecosystem Services of Natural Regulation in Conservation Agriculture



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Social-economic context

One of the main challenge European agriculture is currently facing is its transition towards more sustainable systems supported by ecosystem services. Conservation agriculture is among production systems that aims to pursue responsible farming practices and develop biological control. Based on minimal soil disturbance and permanent soil cover, conservation agriculture is already expected to counterbalance soil erosion and improve soil quality and biodiversity, while still using pesticides. A major breakthrough for conservation systems would be to quantify ecosystem services of natural regulation provided by biodiversity and adapt chemical use to it.

Scientific context

Biodiversity have a general positive effect on biocontrol services, with complementary activities of auxiliaries species, such as predators or parasitoids. Carabid beetles are one of the most abundant family of ground-dwelling predators found in cereal crops. Most species are generalist predators and often have an opportunistic behaviour with a wide range of preys. That make them first class biocontrol agents as they have the possibility to feed on weed seeds and pests. However, importance of those preys in carabids diet, compared to other, potentially beneficial, agricultural organisms, remains unknown. For instance, intraguild predation (i.e. predator eating predator) can damped the regulation service provided by carabids. In addition, conservation farming practices affect agricultural communities, providing more alternative preys to carabids, and their effects on trophic interactions and natural regulation are yet to be demonstrated.

Objectives

The aim of this thesis is to study hints of carabids biological control, from indirect to direct measures, with increasingly precise tools and techniques:

(1) Assess biocontrol services in wheat fields in conservation agriculture.

Thanks to a two years fieldwork effort, communities of pests (aphids), weeds, natural enemies (carabids, spiders, parasitoids) and species of agricultural interest (earthworms, springtails) will be determined and compared between conventional and conservation systems. Their relationships with direct (parasitism) and indirect (predation rates on sentinel preys) measures of natural regulation will then be assessed.

(2) Estimate seasonal variations and compromise between services and disservices of carabids communities (see Preliminary results).

A first trophic network will be constructed in conventional agriculture thanks to a Multiplex PCR Diagnostic approach. Variations of predation on two pests (aphids, slugs), another natural enemy (spiders) and species of agricultural interest (springtails, earthworms) will be studied in carabid communities. The objective is to evaluate if carabid beetles are good biocontrol agents and if there is a shift in regulation as time goes by, while considering potential inconvenient predation on decomposers and intraguild predation.

(3) Make a topological analysis of trophic networks of carabids.

At last, the aim is to build a more exhaustive trophic network thanks to metabarcoding data on carabid regurgitates and machine learning. The influence of agricultural practices (conservation versus conventional) and seasons on the topology of the network will also be assessed.

Preliminary results

In 2018-2019, 1819 carabid beetles were collected in 5 French regions at 4 different times: in Fall, April, May and June. Their diet was studied thanks to a PCR Diagnostic approach with 5 target preys: aphids, slugs, spiders, earthworms and springtails.

78% of carabids were positive to at least one prey. The most eaten one was springtail (Figure 1-A), then it was earthworms, spiders and pests (aphids, slugs).

Pests do not seem to be a huge part of carabids diet, but their predation increases with time (Figure 1-B). The same phenomenon is observed for spiders in opposition to predation rates of springtails and earthworms that seem to decrease as time goes by.

One explanation for this result is that spiders population and pests infestations increase in the late seasons and that carabid beetles have indeed an opportunistic hunting behaviour, leading to predation rates dependent of preys density (still need to be verified).

Perspectives

A better appreciation of trophic networks and biocontrol services provided by carabid beetles could be an asset to create a decision support tool for assessing the necessity of chemical treatment.

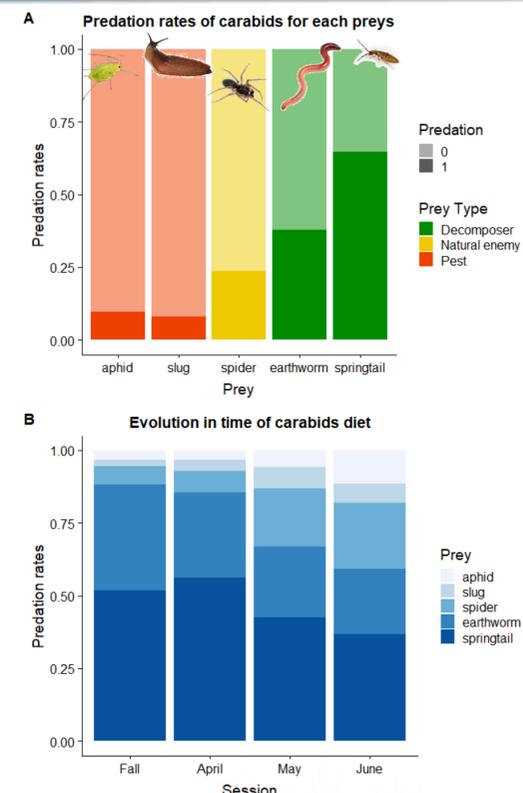


Figure 1: First description of carabids diet

