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Short communication

Fruit trees can also provide ecosystemic service in agroforestry systems

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Abstract

Trees are now widely considered as a powerful natural tool to provide multiple ecosystemic services (organic matter, shelter, biodiversity refuges, carbon storage, erosion limitation…). Additionnally to the fruit production as a main service, we aimed at assessing how far fruit trees in agroforestry systems may also provide service such as natural pest regulation on surrounding crops, vegetables in our case.

Under a 6-years project named Empusa, we try to quantify and localize how predation occurs in mixed plots, compared with orchards and vegetable fields in comparable situations.

To evaluate predation, we used two types of sentinel preys : plasticine caterpillars and moth eggs. Caterpillars show traces of birds activity, but also arthropods one such as spiders, ants, carabids… Egg preys rather show activity by generalist predators, mostly arthropods.

Sentinel preys were placed in 7 different farms at different periods between march and july, from 2019 to 2021. Plots include agroforestry systems, but also vegetable fields or orchards alone, as controls. Under agroforestry, they were placed in fruit trees and at different distances in vegetable rows.

Results from 5 sessions/year on 7 plots and 3 consecutive years (2019-2021) show heterogenous results concerning regulation. In most cases, natural regulation is shown to be higher in vegetables surrounded by fruit trees, although there might be no difference in some cases.

Eggs as sentinel preys appear to be a better and easier tool to be used. However, only predation rate is obtained, as no direct observation on taxa involved in predation is done. Improvements with a digital camera could bring significantly more information in the future.

Keywords : agroforestry, market gardening, forest garden, natural regulation

Introduction & objective

Agroforestry is defined as the association between trees and other crops or animals, and considered as more productive, and providing many different ecosystemic services. There is a functional complementarity between species, so that the productivity of ecosystems increases with biological diversity. Many experiments demonstrated that diversification has a positive effect on the produced biomass of an ecosystem (Hector et al. 1999, Tilman et al. 2001, Chen et al. 2018). A positive effect of the presence of trees on wind and water erosion of the soil has also been observed (Dupraz and Liagre 2008). Trees store more carbon as their biomass is important, and generate microclimates that maintain the soil moisture, which is a considerable advantage in the Mediterranean region (Quinkenstein et al. 2009). Finally, one of the major and indisputable benefits in associating trees and cultures is biodiversity preservation, especially for birds (Torralba et al. 2016) and butterflies (Varah et al. 2013). The trees form refuge areas for many species. They constitute corridors of movement, feeding, wintering or summering areas (Dupraz and Liagre 2008). The objective is then to favor the presence of beneficials, which will feed on pests.

The agroforestry systems of this study are forest gardens, which combine fruit trees and vegetables to optimize the use of plot space and therefore food production (Warlop and Fourrié

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2017). The form of forest gardens is not new but has known a recent revival of interest, particularly among neo-rural farmers. They are especially located in the South of France (Léger et al. 2018), where high temperatures can cause damage to crops, that tree shadows can mitigate.

We aimed at assessing the control of the natural enemies by auxiliaries in such an agroforestry system. This was done by measuring the predation and parasitism rates in space, both in trees and in vegetables. We also measured functional biodiversity movements by assessing predation according to the distance to the trees. Predation was expected to be higher when fruit trees are present in the system, since they can host many predators. For this reason, we also imagined that the regulation rates would have been higher in vegetable crops located closer to the trees than in those that are more distant.

Material & method

The study targeted apple and peach trees as well as all the vegetables grown near them. The potential pests of these crops are numerous, which is why we worked on generalist predators.

The experiments were carried out on three agroforestry farms, and on four control sites (orchard control, market gardening control, figure 1), for 4 to 5 sessions per year between March and July.

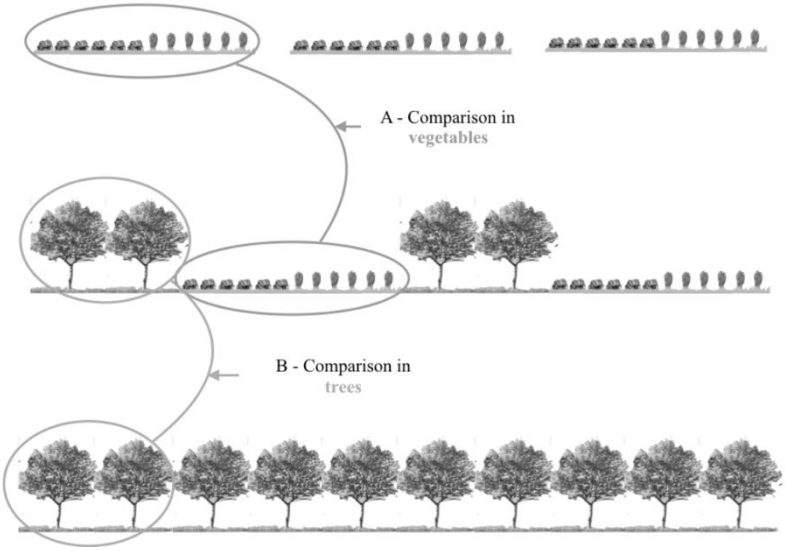

Figure 1 : comparison of predation rates between agroforestry and control plots

We used sentinel preys to assess predation in fields, in 2 different forms :

- Predation cards which are papers with laboratory eggs sticked on them (picture 1)
- Plasticine caterpillars as lures, sticked on branches or in vegetables (picture 2).

Picture 1 a/b : predation cards in vegetables and apple tree

picture 2 a/b : caterpillars on tree and vegetables

Predation cards and caterpillars were placed in the fields for 2 to 4 days according to the season, and predation rate was quantified in the lab afterwards.

Results

- For the predation cards

As shown on the figure 2 below, predation is higher in vegetables (market gardening) in agroforestry, whereas no difference could be seen in 2019 sessions.

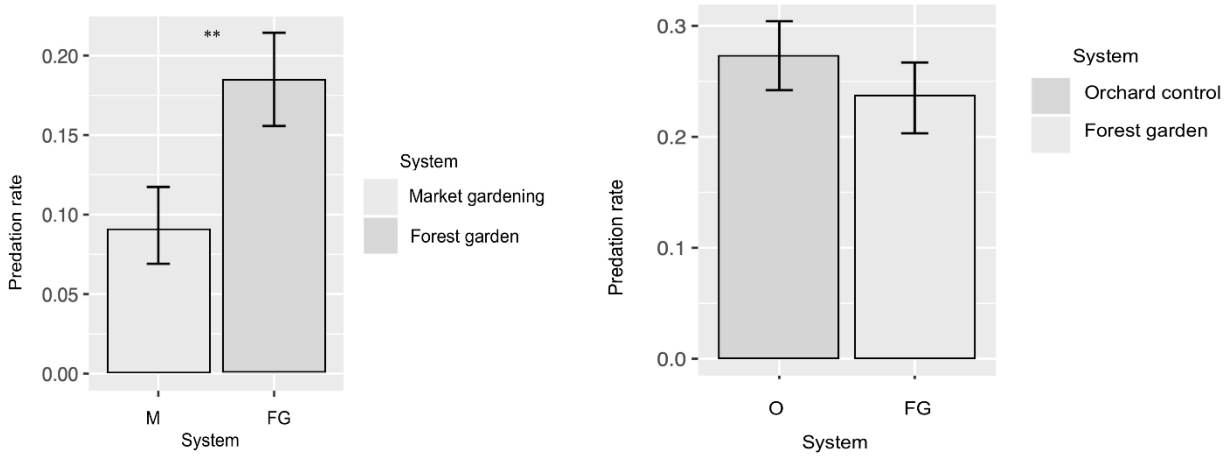

Figure 2 : Mean predation rates assessed in 2019 with the predation cards in the vegetables (left) and trees (right), for each system

Results get in 2020 and 2021 give the same trend with more activity in vegetables surrounded by fruit trees.

- For the caterpillars

The 2019 results give no difference in caterpillars predation between both systems, but one can observe a slight increase in forest garden (FG) systems without statistical difference

(figure 3). 2020 and 2021 gave the same overall results, although varying among sessions within a year.

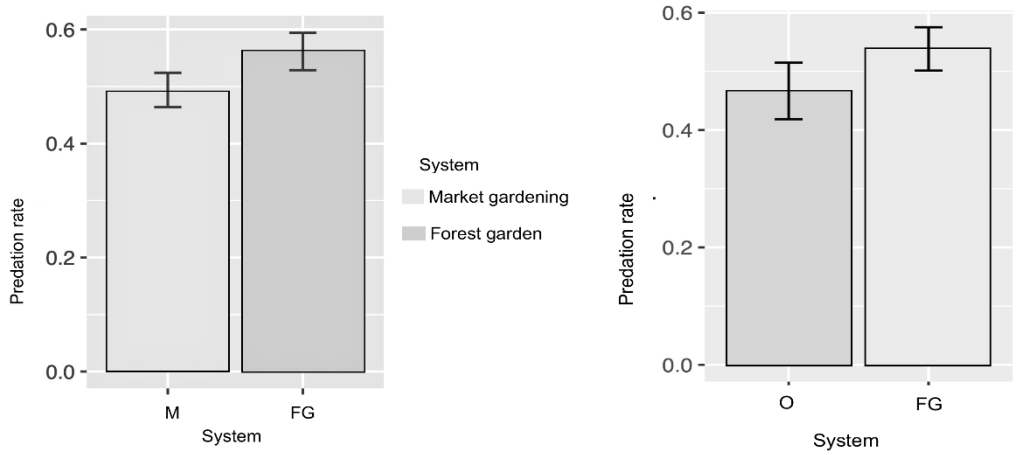

Figure 3 : Mean predation rates assessed with the artificial caterpillars in the vegetables (left) and in the trees (right), for each system

Discussion

Results obtained show the ecological role provided by fruit trees to vegetables, by hosting more beneficials that can increase natural regulation in the system.

Other services given by trees are described in literature, but we still miss research and accurate data to be able to better quantify these services.

Both methods used allowed a certain complementarity in the results. Predation cards use a living prey, therefore provides very realistic information on predation, but does not provide a complete overview of the predation pressure (Lövei and Ferrante 2017). In addition, this method does not provide any information on the identity of the predators, and must therefore be completed with camera traps pictures.

On the other hand, the caterpillar lures method uses artificial prey and makes it possible to search for a wider spectrum of predators (birds, micromammals and arthropods), distinguishing them thanks to the left traces.

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