Assessment of the impact of actions in the vineyard and its surrounding environment on biodiversity in Rioja Alavesa (Spain)

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Keywords: Agroecology, biodiversity, habitat management, landscape ecology, vineyard.

Abstract

The aim of this study is to assess the impact of the implementation of cover crops, vegetational corridors, dry stone walls and biodiversity hotspots on arthropod populations. The work has been carried out in four vineyards in Rioja Alavesa (Spain) belonging to Ostatu winery, where these infrastructures were implemented in 2020. The presence and diversity of arthropods was studied by capturing them at spring at different distances from the infrastructure using pit-fall traps in the soil and yellow, white and blue chromatic traps at the canopy level. This is a preliminary study in which all adult arthropods were sorted to the taxonomic level of order and Coleoptera were classified to morphospecies**.** The results obtained show that there is a relationship between the basic characteristics of the vineyard and the arthropods captured, with a positive effect, although also dependent on the vineyard, of the presence of the infrastructures considered.

Introduction

Traditional viticulture areas have experienced in the last decades an intensification of field practices, linked to an increased use of fertilisers and phytosanitary products, and to a more intensive mechanization. This change in management has sometimes led to higher rates of soil erosion and loss of soil structure, fertility decline, groundwater contamination, and to an increased pressure of pests and diseases. Additionally, intensification usually leads to a simplification of landscapes, of particular concern in prestigious wine grape regions where the economical revenue encourages the conversion of land use from natural habitats to high value wine grape production. To revert this trend, it is necessary that growers implement actions that promote biodiversity in their vineyards. Cover crops and ecological infrastructures as vegetational corridors, dry stone walls and biodiversity hotspots had been proved to promote biodiversity since they provide alternate hosts and refuge for arthropods (Agrò, 2013; Altieri et al. 2005; Boller at al., 2004; Burgio et al. 2016; Nicholls et al. 2001; Nicholls et al, 2008; Rosas-Ramos et al. 2019).
Landscape composition and the diversity of vegetation surrounding the vineyards also influence the presence and diversity of arthropods (Isaia et al, 2006; Moth et al, 2021; Muneret et al 2018; Ponti et al 2005), as well as the management regime -organic or conventional- (Paiola et al. 2020; Puig-Montserrat et al. 2017) and ground cover use (Sáenz-Romo et al. 2019).
This paper aims to investigate the impact of the implementation of some ecological infrastructures (vegetational corridors, dry stone walls and vineyard biodiversity hotspots), and of cover crops on the abundance and diversity of arthropods, taking into consideration the incidence of vineyard characteristics (organic/conventional management and presence of surrounding vegetation in the vineyard perimeter).

Materials and methods

The study was established in 2020 in four rain-fed vineyards within the Rioja Alavesa area in Rioja appellation, Northern Spain. Three of those vineyards (Revillas, 1.11 ha, Valcabada: 3.02 ha, Zabala 4.63 ha) were grown organically, whereas the fourth one (Las Paules, 0.64 ha) was grown following integrated pest management regulations.

In the first three vineyards, some interventions were done in order to test their impact on arthropod abundance and diversity. Thus, in Revillas, a biodiversity hotspot that included a small water pond and wood and stone elements was implemented, in Valcabada a dry-stone wall was rebuilt in one of the margins and a spontaneous cover crop was established every two rows, and in Zabala a vegetational corridor crossing the whole plot was established, allowing connection with a forest area at its northern side. Las Paules did not have any ecological infrastructure, the soil was tilled and was used as a baseline.

In 2021, at flowering (May 25th) yellow, blue and white chromatic traps were placed at the canopy level to monitor diversity and abundance of the entomofauna in the four vineyards. These traps were placed at increasing distances from the ecological infrastructure. (Biodiversity hotspot: 5 and 10 m; vegetational corridor and dry-stone wall: 5, 15 and 25 m. In Las Paules, the vineyard used as a control baseline, where no ecological infrastructures had been implemented, traps were placed in the middle of the plot. Traps stayed in the field for two weeks, and then collected for arthropod population evaluation.

In the same sampling locations, pitfall traps of 9 cm diameter filled with 20 ml of propylene glycol 20% were used for collecting ground-active arthropods. Additionally, in Valcabada, pitfall traps were also placed in areas of the soil where spontaneous cover crop was maintained and in areas where soil had been mechanically tilled. For chromatic traps two replicates per sampling situation were considered, whereas for pitfall traps replicate number was three.

Arthropod individuals were sorted to order taxonomic level in chromatic traps, and to morphospecies in pit-fall traps. In both types of traps, the total number of individuals of each order or morphospecies was summed, and Shannon and Pielou indexes (Shannon, 1949; Pielou, 1977) were calculated.

Results and discussion

The implementation of elements that provide heterogeneity to the plots and food and shelter to arthropods have shown a trend to promote biodiversity, despite being results from a single year, in agreement with other works (Agrò, 2013; Altieri et al. 2005; Boller at al., 2004; Burgio et al. 2016; Nicholls et al. 2001; Nicholls et al, 2008; Rosas-Ramos et al. 2019). Thus, a trend of improvement in Shannon and Pielou biodiversity indexes was observed for arthropods captured in the chromatic traps within proximity to the ecological infrastructure (Table 1). In addition, a trend of biodiversity enhancement was observed in the pitfall traps under cover crop with respect to tillage (Table 2), as other authors previously found (Sáenz-Romo et al. 2019). This was reflected both in the biodiversity indexes and in the number of individuals and morphospecies present (Figures 1 and 2).

Contrarily to what was expected, lower biodiversity indexes were not observed in the vineyard used as a control baseline (Las Paules) compared to the organically managed ones (Table 1). Paiola et al. (2019) observed that biodiversity improvement in organic viticulture was dependent on the scale of the study, with less consistency at smaller scales. Here, we hypothesize that the ratio between vineyard area and length of vegetated perimeter could be affecting biodiversity indexes, as the edges of the plot may act as ecological compensation areas. This ratio ranges between 8 and 24%, having Las Paules the second best value due to the small size of the plot (Table 1). Our results seem to provide further evidence of the importance of the maintenance of the vegetated margins of the vineyard, as already highlighted by other authors (Muneret et al. 2019)

In addition to the presence of agroecological infrastructures, ground cover and integrated or organic management, another aspect that seems to be conditioning biodiversity is the surrounding landscape. Thus, in Zabala, the vineyard located closer to areas of forest vegetation, Hemiptera was the most represented order in the chromatic traps, while in the rest of the vineyards it was Diptera (Figure 1). In the pitfall traps, Coleoptera, specifically the family Carabidae (Figure 2), was the most represented order in Zabala, while in the rest of the plots it was the order Hymenoptera. The family Carabidae is considered an indicator of biodiversity (Rainio-Niemelä 2003). In relation to the closer proximity of Zabala to the forest, some authors suggest that carabids larger than 15 mm, such as those captured in this vineyard (Figure 2), are associated with less disturbed environments (Purtauf et al. 2005; Ribera et al. 2001).

It is important to underline that biodiversity indexes do not provide information on the ecology of the arthropods present, so higher indexes may include both species with potentially negative effects for the vineyard (pests or transmitters of viruses) and potentially beneficial species (parasitoids or predators of pests).

Since these are data from a single year, it is necessary to be cautious with the results obtained, since, as described by other authors, the effects of the introduction of ecological infrastructures and cover crops to improve arthropod biodiversity require long periods of time to observe changes in it (Álvarez et al. 2019).

Conclusion

Our results indicate that there could be a positive relationship between arthropod biodiversity and the presence of elements that add heterogeneity although it is necessary to be cautious, since the relationship between the proportion of vegetated perimeter and the area of the plot, as well as the characteristics of its environment may be affecting the diversity of arthropods. Further work is needed because, on the one hand, changes in arthropod biodiversity require long periods of time and, on the other hand, more detailed identification is required to classify the arthropods present according to their ecology.

Acknowledgements

This work has been developed as part of the VIÑADIVERSIDAD project carried out by Bodegas Ostatu. It has been funded by the Basque Government, within the 2020 call for aid for research, development, and innovation in the agricultural, forestry and fishery and aquaculture product sectors of the Basque Country.

Table 1. Biodiversity indexes according to distance to ecological infrastructure (Chromatic traps)

	Las Paules	**Revillas**		**Valcabada**			**Zabala**		
Distance to ecological Infrastructure		**5 m**	**10 m**	**5 m**	**15 m**	**25 m**	**5 m**	**15 m**	**25 m**
Shannon index	1,38	1,66	1,65	1,46	1,46	1,38	1,41	1,23	1,08
Pielou index	0,58	0,63	0,67	0,61	0,59	0,58	0,59	0,49	0,45
Ratio between plot area and length of vegetated edge	14,8	23,9		8,28			7,92		

Table 2. Biodiversity indexes according to ground cover management (Pitfall traps)

	Cover crop	**Tillage**
Shannon index	2,25	1,90
Pielou index	0,63	0,58

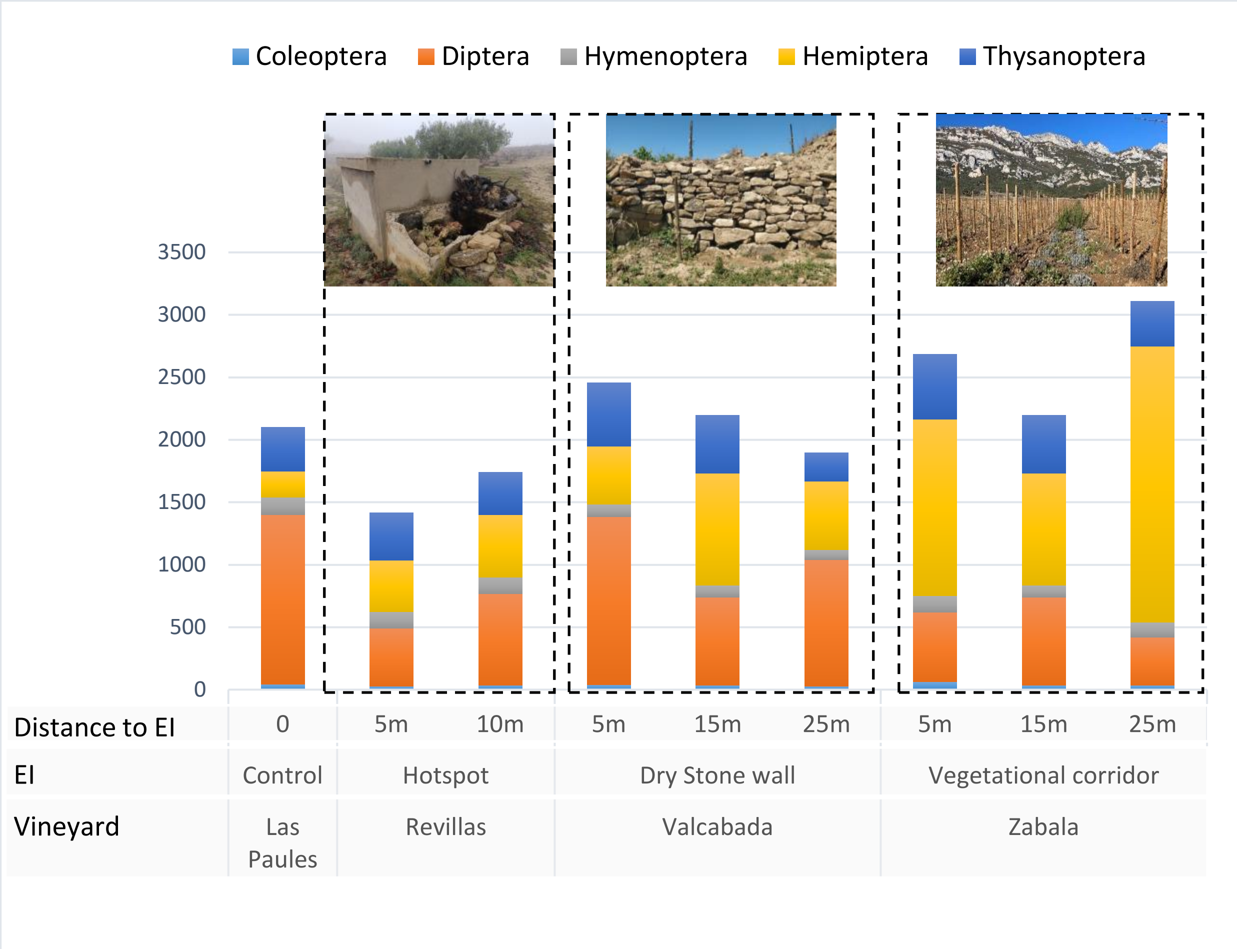

Figure 1. Total Number of individuals sorted to order in chromatic traps according to distance to ecological infrastructure (EI).

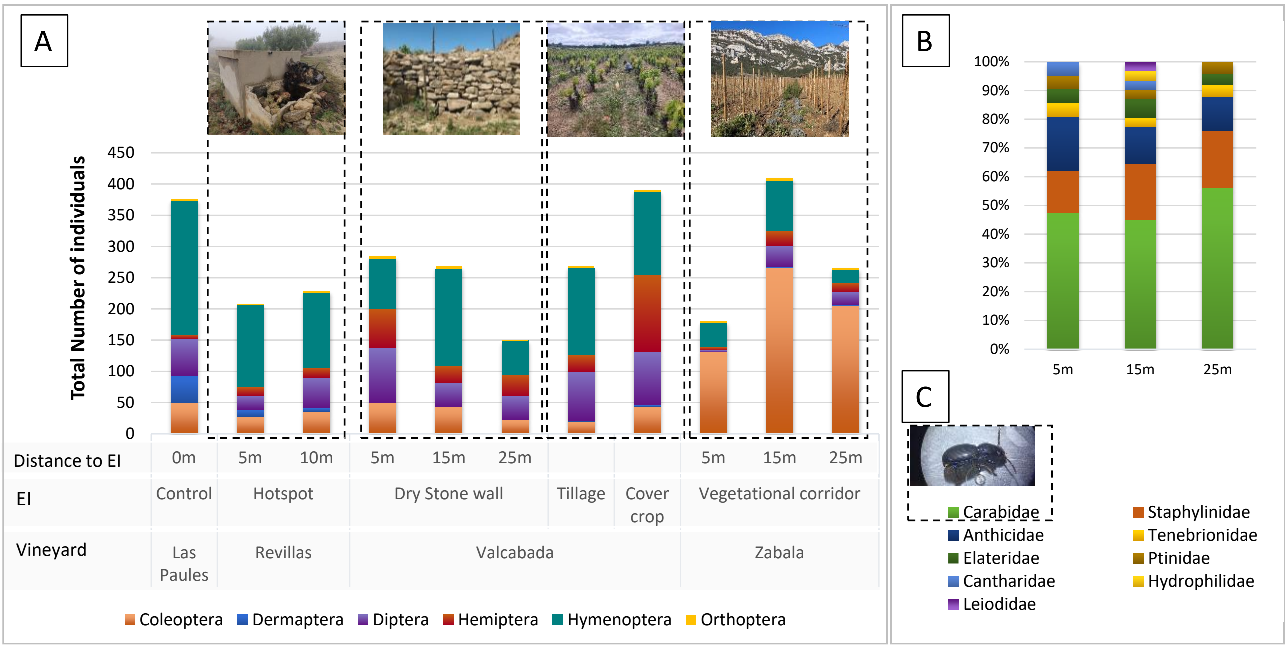

Figure 2. A: Number of individuals captured in pitfall traps according to distance to ecological infrastructure (EI). B: Percentage of Coleoptera families in Zabala. C: Carabid specie larger than 15mm captured in Zabala.

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