Article

Bioprospecting of beneficial insects in agroecological and organic production systems in San Luis Potosí

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Abstract

Insect bioprospecting was carried out in two horticultural production units, an organic one called Casa Garambullo located in Villa de Hidalgo and an agroecological one called Granja Doña Mary located in Soledad de Graciano Sánchez, both in the state of San Luis Potosí. The diversity of insect species, beneficial or not, present in these localities was determined. To this end, horticultural production units were compared through the number of insect species over four weeks, using entomological net, water traps and yellow sticky traps. From these captures, a count of individuals was made, and they were classified by order and family. It was found that the largest number of specimens of beneficial insects was collected in the water traps. In the crops of corn in development, corn in postharvest, squash in development, squash in postharvest and chard of Casa Garambullo and Granja Doña Mary, 8 families of beneficial insects were identified: Vespidae, Apidae, Syrphidae, Eulophidae, Crabronidae, Formicidae, Cynipidae, Coccinellidae. Despite the homogeneity in the orders, the collection of arthropods in the organic production system 'Casa Garambullo' located in Villa de Hidalgo showed a greater number of beneficial insects compared to the agroecological production system Doña Mary in Soledad de Graciano Sánchez, in terms of diversity, the dominance of species and specific biodiversity in both localities was low; however, the diversity of species in the localities studied was high.

Keywords: agroecosystems, diversity, dominance, entomofauna, vegetables.

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Introduction

Conventional agriculture is considered one of the main causes of the simplification of the environment due to the strong impact produced on the environment. The expansion of monocultures has led to the homogenization of agricultural landscapes and the development of unfavorable agricultural practices for many species (Puech *et al*., 2014). The use of synthetic products for soil fertilization, insect control, the control of weeds and diseases compromise the health and well-being of the farmer, in addition to deteriorating the structure and biodiversity of the soil (Ortega, 2009), at the same time compromises the quality of foods, exacerbating the presence of toxic agricultural chemicals (Nicholls and Altieri, 2006) and negatively impacting the entomofauna of agricultural areas (Sánchez and Wyckhuys, 2019), mainly in pollinators that generate invaluable agroecosystem values (Devine *et al*., 2008).

Agroecological science promotes comprehensive environmental analysis, generating new theoretical-practical approaches to production, which has been configured from complex and systemic thinking (León, 2009). Organic agriculture is characterized by using agroecological management practices that promote soil biodiversity and beneficial ecological interactions to offset the need for synthetic inputs such as inorganic fertilizers and biocides (Blundell *et al*., 2020). Organic management practices also regulate undesirable insect populations and generate metabolomic reactions in plants to pest damage (Lichtenberg *et al*., 2017; Hernández, 2021). Likewise, it differs from agroecological production in the market by having the guarantee of a legal certification (Jarquin *et al*., 2013).

Long-term decline in insect pests on organic farms has been largely attributed to practices that limit their dominance, increase biodiversity, and increase the number of beneficial insects (Muneret *et al*., 2018). Within the agroecological and organic production systems, the preservation of beneficial entomofauna for biological control by conservation is important, being considered a requirement in the case of the Mexican Organic Certification published in the Official Journal of the Federation (DOF, for its acronym in Spanish) modified in 2020. Insects are the most diverse and abundant living beings in agroecosystems, with a direct link in terms of plant survival (Bautista *et al*., 2011).

Bioprospecting is defined as the collection and identification of biological samples (plants, animals, microorganisms, insects, macroscopic fungi, among the most important) and the accumulation of indigenous knowledge to help discover genetic or biochemical resources found in biodiversity. In an agricultural context, insect bioprospecting is grouped into beneficial and non-beneficial. The first group includes pollinators, as well as entomophagues and parasitoids of pest insects (Srivastava, 2017).

The need to achieve efficient pest control in the different crops has led to the search for more efficient ecological and economic alternatives for control and monitoring (Bravo *et al*., 2020). Stability in the agroecosystem is not only related to the number of species present, but rather to the functional connections between them. In general, the more diverse agroecosystems, the more stable and resilient they tend to be (Nicholls *et al*., 2015). Biodiversity must be maintained or promoted to preserve the self-regulating capacity of agroecosystems. The latter involves a thorough knowledge of existing species to promote survival.

Insect trapping is a useful tool for estimating the size of populations and the diversity of species existing in a specific location (Altieri and Nicholls, 2013). This is relevant since, because of modern agriculture, there is a loss in the landscape, and it has been suggested that large-scale conversion to organic agriculture could partly improve this loss (Benton *et al*., 2003).

Organic farming methods generally improve biodiversity, operationally defined as species richness in a variety of groups of organisms (Bengtsson *et al*., 2005). The richness and abundance of insects are defined by biotic and abiotic factors; climatic adversity is another factor that conditions the appearance or decline of insects, rather than the production of plants (Ruggiero, 2001). The objective of the present study was the population quantification (abundance) and diversity (species reported as beneficial and harmful) of insects using the Shannon-Weaver and Simpson indices in two different conditions, one organic and one agroecological in the state of San Luis Potosí.

Materials and methods

Study sites

The study was carried out in two production systems in the state of San Luis Potosí, the first considered organic as it is duly certified through an officially recognized organization for this purpose (DOF, 2020), called Casa Garambullo (CG), located in Peotillos, municipality of Villa Hidalgo (22° 29’54, 22488” north latitude and 100° 36’37, 36656” west latitude), at an altitude of 1 527 masl and the second characterized as an agroecological system, in the process of certification, located in La Virgin neighborhood in the municipality of Soledad de Graciano Sánchez, called Doña Mary (DM), of the Plantifor company (22° 11’27, 591” north latitude and 100° 57’2, 71368” west latitude) at an altitude of 1 853 masl. Both systems carry out the same practices (use of organic fertilizers, crop rotation, use of live barriers, maintenance of biodiversity, use of free pollination seeds, among others). The difference between the two is that in the organic system these practices have been carried out for more than three years, in contrast to the agroecological one.

Sampling of entomofauna in associated crops

The collection methods used were active and passive; the active method was by using an entomological net consisting of a metal ring of 0.3 m in diameter, handle of 1.5 m and using a white tulle-type fabric as material for the conical bottom bag and in the passive traps, water traps and sticky traps, which consisted respectively of a yellow plastic container with a capacity of 3 L with water, using 50 g of liquid soap to break the surface tension and increase the collection, and yellow plastic boxes of 0.25 x 0.25 m, fastened on two wooden poles previously installed on the ground at a height of 1.4 m (Ramírez *et al*., 2014).

The capture of insects was carried out in lots cultivated with chard (*Beta vulgaris*) in development, squash (*Cucurbita maxima*) and corn (*Zea mays*), the latter two in conditions of development and postharvest, from mid-September to the first week of October 2019. The collections considered several points within the productive lots as shown in Figure 1. Due to logistical limitations, only four collections with an entomological net were carried out on September 11, 18, 25 and October 2, 2019, between 10:00 and 13:00 respectively, making 3 hits with the net on the vegetation, crossing the sowing bed according to the recommendations of Coronado *et al*. (2015).

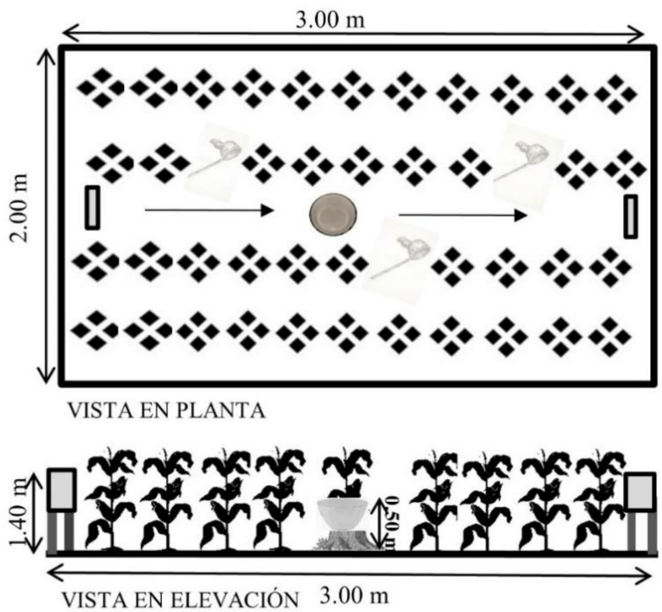

Figure 1. Graphic representation of the delimitation made in the crops of chard, corn and squash, with the passive and active methods of capturing insects.

Likewise, three collections with water traps were carried out following the methodology proposed by Morón and Terrón (1988), these traps were placed in the center of the polygons drawn for the evaluation of each crop; and finally the sticky traps were installed, from September 18 and 25 and October 2, to which vegetable oil was applied and, prior to the penultimate collection, synthetic oil was used (Mujica *et al*., 2007; Ruiz, 2010), this type of trap is based on chromatic attraction and is considered for the monitoring of certain pests, whose color used is attractive to aphids and whiteflies (Qiu and Ren, 2006). The insects captured by the net method were placed in airtight bags that contained a piece of cotton with formaldehyde. Those insects captured in the water traps were placed in glass containers with water and sealed.

The sticky traps removed in each collection were placed in airtight bags and were subsequently transferred to the entomology laboratory of the Faculty of Agronomy and Veterinary Medicine of the Autonomous University of San Luis Potosí, along with the specimens captured in the other two methods for their taxonomic identification by stereoscope and using the taxonomic keys by order and family (Gibb *et al*., 2006; Alonso, 2015; Aguirre and Barranco, 2015; Carles, 2015; García *et al*., 2015; Fernández and Pujade, 2015), reported as beneficial or not, then placed in falcon tubes of 50 ml with 70% alcohol for their conservation, with the respective date and identification of the farm. For the identification, all insects collected in conditions to be observed were used.

Data analysis

Shannon and Simpson indexes

Once the count and subsequent identification of insects by order and families was made, the specific biodiversity was calculated through the Shannon-Weaver index, (1964) and the richness of organisms was measured based on the Simpson diversity index. For the calculation of the Shannon index, the following formula was used: $H' = -\sum_{i=1}^{s} p_i \log_2 p_i$. Where: s= number of species (species richness); p_i= proportion of individuals of species; i= with respect to the total number of individuals (i.e., the relative abundance of species i); ni/N. Where: ni= number of individuals of species i; N= number of all individuals of all species.

The Shannon index, also considered an equity index, correlates abundance and richness of species and expresses the uniformity of abundance values across all species in the sample. It reaches values between 0, when there is a single species, and the Napierian logarithm of S, when all species are represented by the same number of individuals (Cámara and Díaz, 2013). For the calculation of the Simpson index, the following formula was used: $1-\sum_{i=1}^{s} p_i^2$. Where: s= is the number of species; p_i= is the relative abundance of species I; p_i= ni/Σni. Where: ni= number of individuals. $D = \Sigma pi^2$ (dominance).

The distinction of the species with the highest value of importance without evaluating the contribution of the rest is considered based on the Simpson index (1949). It indicates the relationship between the richness or number of species and the abundance or number of individuals per species anywhere. The importance of the most dominant species is being strongly influenced in its calculation. Values close to 1 indicate the predominance of one or some species over others. As its value is inverse to equity, diversity can be calculated as diversity ($D= 1- \lambda$), which tells us that the closer to the value of 1, the greater the equity (Cámara and Díaz, 2013).

Statistical data

The field data collected were sorted based on each trapping method. For the results of insect capture methods through entomological net, water traps and sticky traps, a two-way analysis of variance (Anova) with one replica was performed, followed by multiple comparisons with the Tukey test to test for significant differences ($p< 0.05$) between the type of traps used in both localities and the number of insects captured. For statistical analysis and graphical representation, the software Minitab19 and GraphPad Prism 9.0 were used respectively.

Climate data

Data on maximum, minimum temperatures and precipitation, but not relative humidity, were recorded in both localities during the time the study lasted through the application MeteoRed (version 6.8.3-free) in order to compare the behavior of the different insect populations based on climate information.

Results and discussion

Insect capture

In the organic production unit CG, by means of an entomological net, 95 insects were captured in the selected crops, likewise, 84 insects were captured in the production unit DM, with the order Hymenoptera (Figure 2) being the most frequently collected in both localities. Based on the total number of individuals captured, the largest number of insects was collected in the chard crop with 32.60% and 44.05% in CG and DM respectively, with the family Formicidae being the one with the highest number of individuals. This type of sampling demonstrated efficiency in capturing adult insects.

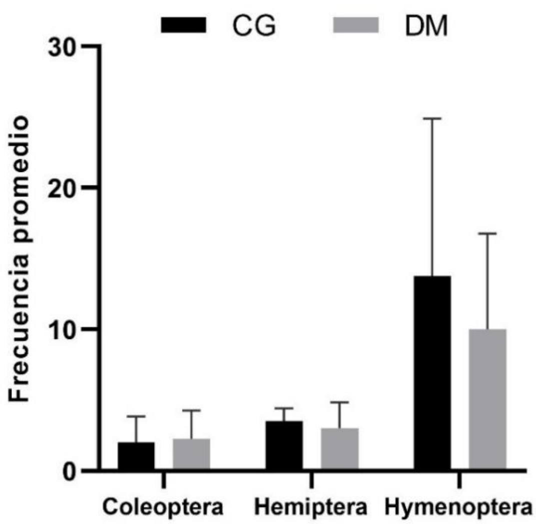

Figure 2. Orders of insects most frequently captured by the entomological net method in Casa Garambullo and Doña Mary. A comparison of means between localities was made and a greater presence of insects of the order Hymenoptera was observed; there are no significant differences (*p*> 0.05) in the capture of this order in both farms. Error bars indicate a 95% confidence interval (CI).

None of the crops sampled during the development of the study showed damages of economic importance in the two production units analyzed. Duarte and Almirall (2020) identified a high abundance of the family Formicidae (of the order Hymenoptera) through the association of crops that included chard, and mention that, although this family of insects presents a contribution as a biological controller, it must be taken into consideration that a high population of these insects could become a pest. On the other hand, Campo *et al*. (2014) mention that chard tends to present a high variety of insects, in addition to the fact that if this crop is associated, there would be a high diversity of natural enemies present in its environment.

The greatest capture of insects was achieved with the method of water traps, obtaining 1 202 in Casa Garambullo and 761 in Granja Doña Mary during the four weeks of study, being again the order Hymenoptera (Figure 3) the one that was most frequently observed in both farms. Of the total individuals, 39.6% and 33.51% were captured in the crops of corn in production and squash in postharvest in CG and DM, respectively. In both places, the family Vespidae was found in greater quantity. This method of collection is mostly used for flying insects (Hudson *et al*., 2020).

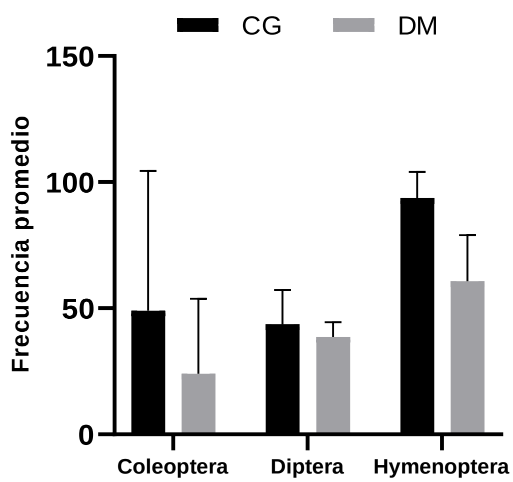

Figure 3. Orders of insects most frequently captured by the method of water traps in Casa Garambullo and Doña Mary. A comparison of means in the collection of insects between localities was made and it was confirmed that there are significant differences (*p*< 0.05) in the capture of the order Hymenoptera in both farms. Error bars indicate a 95% confidence interval (CI).

Within an agroecosystem, the presence of the family Vespidae has special relevance for the natural control of non-beneficial insects. Lopez *et al*. (2013) mention that this family acts as a natural controller of insects considered as a pest in corn; this arthropod acts as a controller of insects of the families Chrysomelidae, Cicadelidae, Noctuidae, Acrididae, found in a representative way in both study sites. In the same way, the family Vespidae can be associated as pollinators and predators of different pests in cucurbit crops (Dalló *et al*., 2018).

By means of the method of yellow sticky traps, during the three samples in the farm Casa Garambullo and Granja Doña Mary, 460 and 373 individuals were collected respectively, with the orders Hemiptera and Thysanoptera being the most frequently found in both farms (Figure 4). In the postharvest squash crop, in both farms, the largest number of captured insects was found with 36.96% and 37.27% in CG and DM respectively, with the families Aleyrodidae, Aphididae, Thripidae and Aeolothripidae being observed most frequently in both farms.

In a study conducted by Díaz *et al*. (2020) in squash, the efficacy of yellow sticky traps in the control of *Bemisa tabaci* belonging to the family Aleyrodidae, vector of the squash curly leaf virus (SLCV), was reported. Likewise, Corrales (1995) mentions that several species of Thysanoptera have been found in vegetables, including squash; however, within biological control, to keep a low population of these pest insects, it can be done with the presence of the family Eulophidae of the order Hymenoptera as mentioned by Loomans *et al*. (1997), which were identified at both study sites.

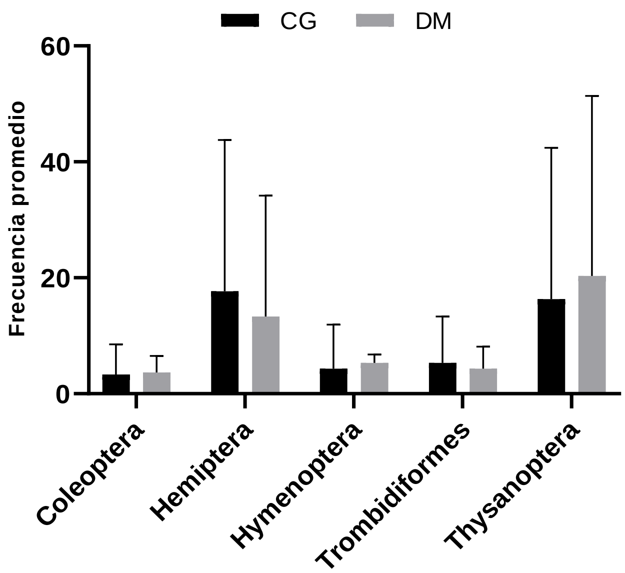

Figure 4. Orders of insects captured with sticky traps in Casa Garambullo and Doña Mary. Through the comparison of means, a greater presence is observed in the capture of non-beneficial insects of the order Hemiptera and Thysanoptera, there are no significant differences in the capture of these orders (p> 0.05) in both farms. Error bars indicate a 95% confidence interval.

As for the total number of insects captured in the organic CG and agroecological DM production units, it was found that, with the captures with entomological net, it was possible to collect 58.95% and 57.14% of beneficial insects respectively; likewise, from the water traps, despite the fact that a greater number of insects were captured, only 52.83% and 54.27% were identified as beneficial in both organic and agroecological production units respectively, finally through the sticky traps, 16.09% and 15.55% insects considered beneficial were captured in CG and DM (Table 1).

Table 1. Total number of insects captured/total beneficial insects in the crops analyzed.

Type of trap	Organic production unit	Agroecological production unit
Net	95/56	84/48
Water	1202/635	761/413
Sticky	460/74	373/58

Organic agriculture is a driver of the abundance of species of natural enemies as stated by Muneret *et al*. (2019) and it could be inferred that, based on the data obtained in the capture of beneficial insects with water traps and entomological net, their abundance is inversely proportional to the non-beneficial insects captured in both farms (organic and agroecological).

Species diversity in both production units

The Shannon-Weaver index has been the most used to measure the diversity of entomofauna. In ecology, diversity refers to the diversity of species, expressing the number of populations and their relative abundances (Segnini, 1995). For its part, from the Simpson index, the relationship between richness or number of species and the abundance or number of individuals per species anywhere is indicated (Moreno, 2001).

Considering the total number of insects captured through the three established collection techniques, the following orders of beneficial insects were identified: Hymenoptera, Coleoptera, Hemiptera and Diptera in Casa Garambullo and Doña Mary, being the families Vespidae, Apidae, Syrphidae, Eulophidae, Crabronidae, Formicidae, Cynipidae and Coccinellidae the ones identified in greater quantity in both farms.

As for the indices of specific biodiversity, these were low H': 1.33 and 1.26 in the organic and agroecological production units respectively (Table 2), considering a high range of specific biodiversity when they oscillate between 2 and 3 as stated by Pla (2006) and Gelambi (2018).

Table 2. Simpson's index calculated for organic and agroecological production units.

Order	Casa Garambullo			Order	Granja Doña Mary		
	Quantity	Relative abundance (pi)	pi^2		Quantity	Relative abundance (pi)	pi^2
Araneae	3	0.001707456	2.91541E-06	Coleoptera	178	0.14614122	0.0213572548
Coleoptera	303	0.172453045	0.029740053	Dermaptera	1	0.00082102	0.0000006741
Diptera	296	0.168468981	0.028381798	Diptera	282	0.23152709	0.0536047951
Hemiptera	210	0.119521912	0.014285488	Hemiptera	153	0.12561576	0.0157793201
Hymenoptera	710	0.404097894	0.163295108	Hymenoptera	367	0.30131363	0.090789903
Lepidoptera	4	0.002276608	5.18294E-06	Lepidoptera	4	0.00328407	0.0000107851
Orthoptera	3	0.001707456	2.91541E-06	Orthoptera	6	0.00492611	0.0000242665
Thysanoptera	197	0.112122937	0.012571553	Thysanoptera	210	0.17241379	0.0297265161
Trombidiformes	31	0.017643711	0.000311301	Trombidiformes	17	0.01395731	0.0001948064
Total	1757			Total	1218		
		D	0.25			D	0.21
		1-D	0.75			1-D	0.79

In the calculations made from the Simpson index, a low dominance among insect species was obtained in the Casa Garambullo and Doña Mary farms (D= 0.25 and D= 0.21 respectively), however, there was a high diversity of species in both farms 1 - D= 0.75 and 0.79 respectively (Tables 3 and 4). If the diversity of species is 1 or close to 1, it is considered high, as mentioned by Brito *et al*. (2007). The latter could be linked to changes in temperature and precipitation (Figures 5 and 6) since climate is an element that affects insect populations. Climatic variables influence the survival and duration of insect life cycles, causing variations in the number of individuals captured (Hodgson *et al*., 2011).

Table 3. Calculation of the Shannon index in the locality of Villa de Hidalgo.

Order	Family	#	pi	log pi	pi x log pi
Araneae	Araneidae	3	0.002	-2.77	-0.005
Coleoptera	Chrysomelidae	1	0.001	-3.24	-0.002
Coleoptera	Coccinellidae	28	0.016	-1.8	-0.029
Coleoptera	Curculionidae	101	0.057	-1.24	-0.071
Coleoptera	Dermestidae	58	0.033	-1.48	-0.049
Coleoptera	Meloidae	1	0.001	-3.24	-0.002
Coleoptera	Mordellidae	82	0.047	-1.33	-0.062
Coleoptera	Nitidulidae	13	0.007	-2.13	-0.016
Coleoptera	Scabareidae	4	0.002	-2.64	-0.006
Coleoptera	Tenebrionidae	15	0.009	-2.07	-0.018
Diptera	Calliphoridae	14	0.008	-2.1	-0.017
Diptera	Crabronidae	32	0.018	-1.74	-0.032
Diptera	Culicidae	57	0.032	-1.49	-0.048
Diptera	Dolichopodidae	18	0.01	-1.99	-0.02
Diptera	Empididae	13	0.007	-2.13	-0.016
Diptera	Eulophidae	11	0.006	-2.2	-0.014
Diptera	Muscidae	82	0.047	-1.33	-0.062
Diptera	Sepsidae	18	0.01	-1.99	-0.02
Diptera	Syrphidae	46	0.026	-1.58	-0.041
Diptera	Tachinidae	5	0.003	-2.55	-0.007
Hemiptera	Aleyrodidae	15	0.009	-2.07	-0.018
Hemiptera	Aphididae	135	0.077	-1.11	-0.086
Hemiptera	Cicadellidae	55	0.031	-1.5	-0.047
Hemiptera	Pentatomidae	5	0.003	-2.55	-0.007
Hymenoptera	Aphelinidae	20	0.011	-1.94	-0.022
Hymenoptera	Apidae	107	0.061	-1.22	-0.074
Hymenoptera	Brachonidae	6	0.003	-2.47	-0.008
Hymenoptera	Crabronidae	21	0.012	-1.92	-0.023
Hymenoptera	Cynipidae	37	0.021	-1.68	-0.035
Hymenoptera	Eulophidae	64	0.036	-1.44	-0.052
Hymenoptera	Formicidae	190	0.108	-0.97	-0.104
Hymenoptera	Scoliidae	36	0.02	-1.69	-0.035
Hymenoptera	Vespidae	229	0.13	-0.88	-0.115
Lepidoptera	Noctuidae	4	0.002	-2.64	-0.006
Orthoptera	Acrididae	3	0.002	-2.77	-0.005
Thysanoptera	Aeolothripidae	176	0.1	-1	-0.1
Thysanoptera	Thripidae	21	0.012	-1.92	-0.023
Trombidiformes	Tetranychidae	31	0.018	-1.75	-0.031
	Sum	1 757			-1.329
				H	1.33

Table 4. Calculation of the Shannon index in the locality of Soledad de Graciano Sánchez.

Order	Family	#	pi	log pi	pi x log pi
Coleoptera	Coccinellidae	20	0.016	-1.785	-0.029
Coleoptera	Curculionidae	73	0.06	-1.222	-0.073
Coleoptera	Dermestidae	13	0.011	-1.972	-0.021
Coleoptera	Eulophidae	11	0.009	-2.044	-0.018
Coleoptera	Mordellidae	55	0.045	-1.345	-0.061
Coleoptera	Nitidulidae	6	0.005	-2.307	-0.011
Dermaptera	Forficulidae	1	0.001	-3.086	-0.003
Diptera	Bombyllidae	1	0.001	-3.086	-0.003
Diptera	Crabronidae	11	0.009	-2.044	-0.018
Diptera	Culicidae	42	0.034	-1.462	-0.05
Diptera	Dolichopodidae	10	0.008	-2.086	-0.017
Diptera	Eulophidae	109	0.089	-1.048	-0.094
Diptera	Muscidae	81	0.067	-1.177	-0.078
Diptera	Syrphidae	28	0.023	-1.638	-0.038
Hemiptera	Cicadellidae	34	0.028	-1.554	-0.043
Hemiptera	Aleyrodidae	3	0.002	-2.609	-0.006
Hemiptera	Aphididae	102	0.084	-1.077	-0.09
Hemiptera	Coccinellidae	8	0.007	-2.183	-0.014
Hemiptera	Coreidae	1	0.001	-3.086	-0.003
Hemiptera	Lygaeoidea	1	0.001	-3.086	-0.003
Hemiptera	Pentatomidae	3	0.002	-2.609	-0.006
Hemiptera	Pyrrhocoridae	1	0.001	-3.086	-0.003
Hymenoptera	Apidae	56	0.046	-1.337	-0.061
Hymenoptera	Aphididae	27	0.022	-1.654	-0.037
Hymenoptera	Crabronidae	8	0.007	-2.183	-0.014
Hymenoptera	Cynipidae	23	0.019	-1.724	-0.033
Hymenoptera	Eulophidae	11	0.009	-2.044	-0.018
Hymenoptera	Formicidae	107	0.088	-1.056	-0.093
Hymenoptera	Muscidae	9	0.007	-2.131	-0.016
Hymenoptera	Vespidae	126	0.103	-0.985	-0.102
Lepidoptera	Noctuidae	4	0.003	-2.484	-0.008
Orthoptera	Acrididae	6	0.005	-2.307	-0.011
Thysanoptera	Aeolothripidae	187	0.154	-0.814	-0.125
Thysanoptera	Thripidae	23	0.019	-1.724	-0.033
Trombidiformes	Tetranychidae	17	0.014	-1.855	-0.026
	Sum	1 218			-1.26
				H	1.26

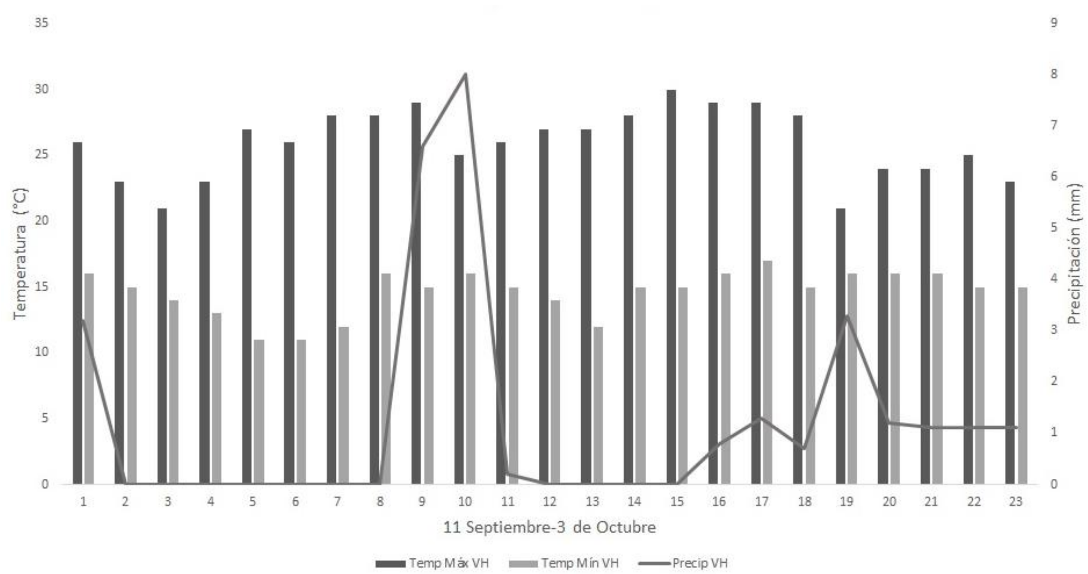

Figure 5. Climograph of the municipality of Villa de Hidalgo where the maximum temperature 30 °C, minimum temperature 11 °C and precipitation from September 11 to October 3, 2019, are indicated.

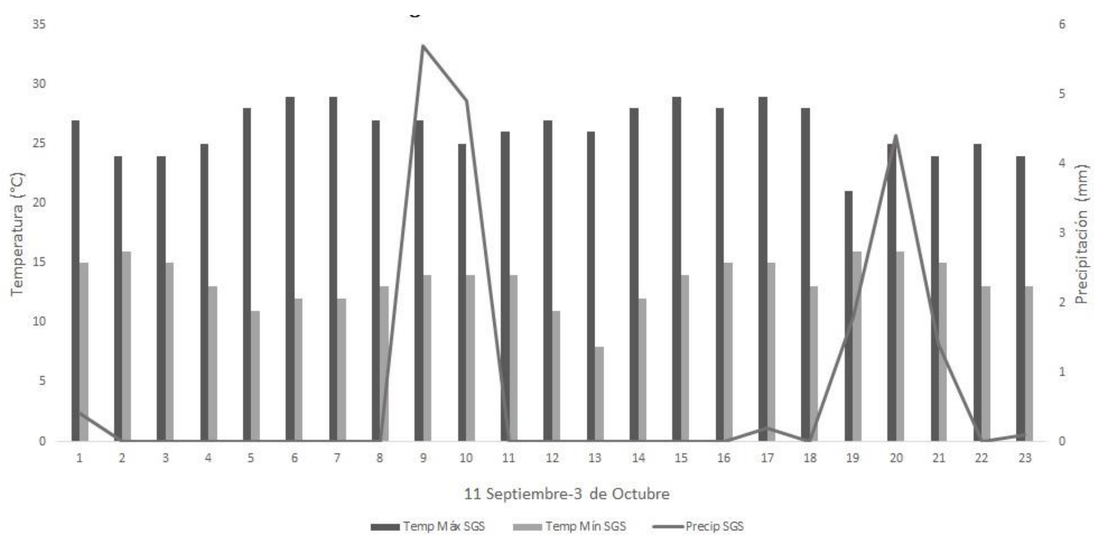

Figure 6. Climograph of the municipality of Soledad de Graciano Sánchez where the maximum temperature 29 °C, minimum temperature 8 °C and precipitation from September 11 to October 03, 2019, are indicated.

The richness and diversity of insects is directly linked to biotic and abiotic factors. Although the offspring is high, arthropod mortality is high and variable, some authors emphasize that biodiversity is being affected by habitat and climate (Fox, 2013).

Conclusions

The largest number of insects was captured in the organic production unit Casa Garambullo, attributable to its greater diversity of crops per unit area compared to the agroecological production system Granja Doña Mary, the main families of beneficial insects found in both production units were: Vespidae, Apidae, Syrphidae, Eulophidae, Crabronidae, Formicidae, Cynipidae and Coccinellidae. Regarding the indices of diversity of insects found in both production areas, in all the crops in which the diversity of insects was evaluated, it was found that there is a low dominance among insect species; however, diversity is high in both localities; specific biodiversity indices were low in both farms.

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