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Occurrence of aphid predator species in both organic and conventional corn and broad bean

Axel Vandereycken, Emilie Joie, Frédéric Francis, Eric Haubruge & François J. Verheggen

Université de Liège, Gembloux Agro-Bio Tech, Unité d'Entomologie fonctionnelle et évolutive, Passage des Déportés 2, B-5030 Gembloux (Belgium). E-mail : entomologie.gembloux@ulg.ac.be

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L'agriculture biologique permettrait d'augmenter l'abondance des espèces auxiliaires et d'accroitre la biodiversité dans les habitats agricoles. Dans cette étude, l'abondance des prédateurs de pucerons a été étudiée en cultures biologiques et conventionnelles pendant une période de deux ans. Une différence de diversité d'espèce n'a pu être mise en évidence entre les deux méthodes culturales. Cinq espèces prédatrices de pucerons ont été abondamment observées dans les cultures cultivées indépendament des pratiques culturales: *Coccinella septempunctata* L. 1758 (Coleoptera: Coccinellidae), *Propylea quatuordecimpunctata* (L. 1758) (Coleoptera: Coccinellidae), *Harmonia axyridis* Pallas 1773 (Coleoptera: Coccinellidae), *Chrysoperla carnea* (Stephens 1836) (Neuroptera: Chrysopidae) et *Episyrphus balteatus* (De Geer 1776) (Diptera: Syrphidae). Des différences d'abondances de prédateurs ont été observées entre les cultures conventionnelles et biologiques mais les densités observées n'étaient cependant pas majoritairement en faveur des cultures biologiques. L'abondance de ces 5 espèces variait selon différents paramètres tels que l'année d'inventaire, la culture inventoriée ou la pratique culturale utilisée. En conclusion, nous ne pouvons affirmer que les pratiques de l'agriculture biologique exercées en maïs et fève augmentent la diversité et l'abondance des auxiliaires.
Mots-clés : Coccinelle asiatique, *Harmonia axyridis*, pucerons, espèce invasive, interaction interspécifique, contrôle biologique, Coccinellidae

Organic farming has been suggested to enhance beneficial species abundance and diversity in agrosystem habitats. In this study, the abundance of aphid predators was compared in organic and conventional corn and broad bean fields during a two-year inventory. In both farming strategies, there were no differences between species diversity. Five aphid predator species were mainly observed: *Coccinella septempunctata* L. 1758 (Coleoptera: Coccinellidae), *Propylea quatuordecimpunctata* (L. 1758) (Coleoptera: Coccinellidae), *Harmonia axyridis* Pallas 1773 (Coleoptera: Coccinellidae), *Chrysoperla carnea* (Stephens 1836) (Neuroptera: Chrysopidae) and *Episyrphus balteatus* (De Geer 1776) (Diptera: Syrphidae). Differences in abundance of aphidophagous species between conventional and organic crop fields were observed even if not always in favour of the latter condition. The abundance of the five above-mentioned aphidophagous species varied for the most part according to almost all the observed parameters, including sampled year, crop and agricultural practices. In conclusion, our findings do not support organic practices in corn and broad bean as key options to increase the biodiversity and abundance of aphid natural enemies.
Keywords : Multi-coloured Asian ladybird, *Harmonia axyridis*, aphids, invasive species, interspecific interactions, biological control, Coccinellidae

1. INTRODUCTION

Most cultivated crops are situated in intensive agricultural area, where chemical biocides are used to control pest and plant diseases, with serious environmental consequences including loss of biodiversity (Ghorbani *et al.*, 2008). Organic farming has been proposed as an alternative in order to increase biodiversity in agricultural landscapes (Hole *et al.*, 2005). The use of organic manures, compost and crop residues and the set-up of mechanical weeding, minimum tillage, a prohibition/reduction of chemical pesticides, as well as hedgerow structures and ploughing modifications may contribute to favour biodiversity in agricultural areas (Kromp, 1999; Lampkin, 2000; Hole *et al.*, 2005). Worldwide organic production continues to rise, reaching 37.5 million hectares in 2009 and valued at more than 60 billon US dollars (Leu *et* *al.*, 2011; Raducuta & Doroftei, 2012). These specific management practices are either absent or rarely utilized in the majority of conventional farming (Gardner & Brown, 1998). The increase in abundance and/or species richness thanks to organic farming practices can touch a large range of taxa including mammals, invertebrates, flora, and birds (Hole *et al.*, 2005; Rundlöf *et al.*, 2010; Smith, 2010). Nevertheless, as shown in Hole *et al.* (2005), 32% of studies have either highlighted no difference between the two farming systems or a negative impact of organic farming on biodiversity, e.g., a negative impact of mechanical weeding on eggs and chicks of ground nesting bird species.

One of the most important components that could influence insect abundance in agroecosystems, and more particularly aphid natural enemies, is the use of insecticides in conventional farming that have shown different impacts on ladybirds: spinosad or indoxacarb induce stronger declines than chlorpyrifos, carbaryl, bifenthrin, and A-cyhalothrin (Galvan *et al.*, 2005). Pyrethrins are often used in organic farming (Isman, 2006) and although they leave no persistent toxins. Their toxicity for several beneficial arthropods has been confirmed in many previous works (e.g. Kraiss & Cullen, 2008). To reduce the impact on beneficial species, insecticide soaps are also used to control aphid populations (Karagounis *et al.*, 2006) as these products show less toxicity to important aphid predators, including *Harmonia axyridis* Pallas 1773 (Coleoptera: Coccinellidae), *Chrysoperla carnea* (Stephens 1836) (Neuroptera: Chrysopidae) and *Episyrphus balteatus* (De Geer 1776) (Diptera: Syrphidae) (Bigler & Waldburger, 1994; Pineda *et al.*, 2008).

In this study, the abundance of aphidophagous species in both broad bean and corn cultivated under organic and conventional farming systems was considered. We focused our attention on the multi-coloured Asian ladybird, *H. axyridis*, an invasive species (Brown *et al.*, 2008) and intraguild predator of native aphidophagous species (Brown *et al.*, 2011; Roy *et al.*, 2012).

2. MATERIAL AND METHODS

Study sites and sampling method

Aphidophagous insect populations were sampled in 2010 and 2011 in the southern region of Belgium, in an area of agricultural production named Hesbaye (individual sites are given in **Table 1**). Samplings were performed on two crops known for their abundance of aphidophagous predators: corn, *Zea mays* L. 1753 and broad bean, *Vicia faba* L. 1753 (Vandereycken *et al.*, 2010). The sampling period ran from mid-May to late September. The total surface of all conventional fields and organic fields was of 40 ha and 10 ha respectively. This difference of area was due to weak availability of organic fields compared to conventional ones. All fields were sampled once per week. Two different treatments were applied on each crop: a conventional treatment and an organic one. Fields of both farming systems were located in the same agricultural area. Fields of organic crops were separated from others by hedgerows composed of several tree species including *Acer* sp., *Crataegus* sp., *Viburnum* sp., *Ligustrum* sp., *Quercus* sp., *Betula* sp. and several herbs. The organic crops did not receive any synthetic manure, mechanically weeded, and received a minimum of tillage. A grass strip with flowers five meters wide was present around each crop field. Conventional farming fields were not surrounded by tree structures and were situated in an agro-intensive area in Hesbaye. In conventional cornfields, to prevent aphid damages, weeds were coated with insecticide (Thiamethoxam). In conventional broad bean, insecticides including pirimicarb and lambda-cyhalotrin were sprayed at the end of the flowering period to control aphids, thrips and bruchids. Fungicides including azoxystronbine and chlorothalonil were sprayed against anthracnose and botrytis.

The sampling method used to assess the numbers of aphidophagous predators and aphids consisted of visual whole-plant inspections using 1 m² quadrats. Visual sampling was conducted as it provides an easy and accurate method for the estimation of larval and adult densities of coccinellids in agroecosystems (Michels & Behle, 1992). Thirty-five quadrats for each crop were examined once per week in conventional and organic crops. Quadrats were located along transect lines across each field and spaced 20 meters apart. All leaves and stems within the quadrat were observed and all aphidophagous species at any stage were recorded. Aphid populations were also quantified on all leaves and stems. First instar and pupae were brought to the laboratory for rearing under laboratory conditions (T=24±1°C; HR=75±5%) for identification to the species level.

Table 1: Experimental sites (Belgium) where aphidophagous predators were surveyed from 2010 to 2011

Year	Site	Latitude	Longitude	Crops
2010	Walhain	4.735	50.616	Corn, broad bean, organic corn
	Perwez	4.813	50.645	Corn, broad bean
	Ramillies	4.866	50.624	Corn
	Rhisnes	4.830	50.500	Broad bean, organic corn, organic broad bean
	Gembloux	4.695	50.563	Broad bean
	Plancenoit	4.398	50.664	Corn, broad bean
	Nil-St-Vincent	4.689	50.646	Broad-bean
	Isnes	4.732	50.515	Broad bean
2011	Perwez	4.813	50.645	Corn, broad bean
	Gembloux	4.695	50.563	Corn, broad bean
	Plancenoit	4.398	50.664	Corn, broad bean
	Ligny	4.581	50.508	Broad bean
	Ramillies	4.866	50.624	Corn
	Rhisnes	4.830	50.500	Organic corn
	Walhain	4.735	50.616	Organic broad bean

Statistical analyses

As mean densities observed for 1 m² were low, these values were presented per 100 m² for better understanding. The evaluation of the most abundant species was realised for a specific developmental stage (larvae or adults), within crops and within treatments with an Analysis of Variance (ANOVA: General Linear Model, GLM) with species (n = 5) and month (n = 5) used as factors ($\alpha = 0.05$). The factor "month" was used in the GLM to decrease the impact of natural annual variations in predator densities. After this analysis, mean numbers of predators were compared using the Least Square Difference (LSD).
The mean numbers of aphidophagous species were compared between two treatments by an ANOVA: GLM with treatment (n = 2) and month (n = 5) used as factors ($\alpha = 0.05$). To explain the variations in predator abundances between two treatments, the mean species abundances within each crop were analysed by an Analysis of Covariance (ANCOVA: General Linear Model), with treatment (n = 2) and month (n = 5) used as factors (α = 0.05) and aphid densities as a co-variable.
Aphid densities were compared between two treatments by ANOVA: GLM with treatment (n = 2) and month (n = 5) used as factors ($\alpha = 0.05$).
The distribution of data (counting) was asymmetric and had to be $\log_{10}(x+1)$ transformed before analysis. Although the statistical analysis were performed on transformed data, untransformed data were presented in **Table 2**. Statistical analyses were performed using Minitab® 15.1.30.0 (State College, Pennsylvania, USA). When presenting the results, the "data point" term was used to refer to the density of one particular species at one developmental stage within one of the two crops during one specific year (**Table 3**).

Results

Five aphidophagous species were mainly observed in both crops and under both organic and conventional treatments: *C. septempunctata*, *Propylea quatuordecimpunctata* (L. 1758) (Coleoptera: Coccinellidae), *H. axyridis*, *C. carnea s.l.* and *E. balteatus* (**Table 2**). These five species represented 100% and 99% of all aphidophagous species observed in 2010 and 2011, respectively.

All aphid predator species were identified with the exception of the members of the *C. carnea* species complex, which were grouped together even if comprising three cryptic species: *Chrysoperla kolthoffi* Navas, *Chrysoperla lucasina* Lacroix and *C. carnea*, which can only be differentiated using molecular techniques (Bozsik *et al.*, 2003; Lourenço *et al.*, 2006).

1) Aphidophagous species abundance in conventional and organic farming

In 2010, the most abundant adult aphidophagous observed on either conventional or organic corn was *Coccinella septempunctata* L. 1758 ($P < 0.05$; LSD) (**Table 2**). In 2011, both *C. septempunctata* and *H. axyridis* numerically dominated the aphidophagous inventory on conventional corn ($P < 0.05$; LSD) while on organic corn, only *C. septempunctata* dominated ($P < 0.05$; LSD) (**Table 2**).

The most abundant larvae were, in 2010, *E. balteatus* on conventional corn and both *E. balteatus* and *H. axyridis* on organic corn. In 2011, only the larvae of *H. axyridis* dominated the aphidophagous guild on conventional corn ($P < 0.05$; LSD). No significant differences in larval densities were observed on organic corn.

In broad bean, *C. septempunctata* in 2010 and both *C. septempunctata* and *C. carnea s.l.* in 2011 were the two most frequently observed adult predators in both conventional and organic fields ($P < 0.05$; LSD) (**Table 2**).

There was no significant difference in larval densities observed on conventional broad bean in 2010, while *C. septempunctata* dominated on organic beans. In 2011, the most abundant larvae were those of *C. septempunctata* on conventional broad bean, while both *C. septempunctata* and *H. axyridis* were the most abundant on its organic counterpart ($P < 0.05$; LSD) (**Table 2**).

2) Organic versus conventional farming

The dominant aphidophagous species were mostly similar in both conventional and organic crops: in corn, *E. balteatus*, *H. axyridis* and *C. septempunctata* and in broad bean, *C. septempunctata*, *H. axyridis* and *C. carnea* (**Table 2**). However, densities differed between both kinds of treatment as well as from one year to another. Across the two crops and the two sampling years, 8 out of 20 data point (40%) and 11 of 20 data (55%) in 2010 and in 2011, respectively, showed a significant difference in predator abundance between the two treatments ($P_{treat.} < 0.05$; ANOVA) (**Table 3**). More precisely, a higher abundance in organic crops was observed than in conventional ones in 6 out of 20 data (30%) in 2010 and 5 out of 20 data point (25%) in 2011 (**Table 3**) ($P_{treat.} < 0.05$; ANOVA). In contrast, during these two years, 8 out of 40 data (20%) showed a lower abundance with organic farming than in conventional farming (**Table 3**).

A linear relation between aphid abundance and predator abundance was identified in 4 out of 40 data (10%) during the two sampling years ($P_{aphids} < 0.05$; ANCOVA). This correlation was highlighted for *C. septempunctata* larvae ($F_{1.404} = 11.29$) and *E. balteatus* adults ($F_{1.307} = 4.57$) in broad bean and for *E. balteatus* larvae ($F_{1.489} = 18.20$) and *H. axyridis* adults ($F_{1.339} = 7.16$) in corn (**Table 3**).

Differences in density between both two farming systems for *E. balteatus* larvae in corn in 2010 and *H. axyridis* adults in corn in 2011were shown ($P_{treat.} < 0.05$; ANOVA and $P_{treat./}$aphids > 0.05; ANCOVA).

No general conclusion can be made for the distribution of *H. axyridis*, the only alien aphidophagous species observed during our inventory. While adult densities were higher in organic corn than in conventional corn in 2010 ($F_{1,490} = 6.85$; $P = 0.009$), the opposite findings were recorded in 2011. In 2011, more adults were observed in conventional corn than in organic corn ($F_{1,340} = 6.70$; $P = 0.010$) (**Figure 1**). In 2010, results of larval density in corn showed no difference, while in 2011, higher densities of larvae were observed in conventional corn ($F_{1,340} = 27.8$; $P < 0.001$).

In broad bean, a difference in *H. axyridis* density between the two treatments was only found in 2011, where the numbers of predatory larvae in conventional broad bean were lower ($F_{1,308} = 10.1$; $P = 0.002$) (**Figure 1**).

Aphid abundances were also studied in both conventional and organic farming during the two years. No significant difference in aphid abundance was observed between conventional and organic treatments (**Figure 2**).

3. DISCUSSION

The present study explored differences in densities of aphidophagous species in relation to aphid abundance, between conventional and organic crop management, in both broad bean and corn crops. Both in 2010 and 2011, only five beneficial species were observed on the two crops, whether organically or conventionally farmed: *C. septempunctata*, *P. quatuordecimpunctata*, *H. axyridis*, *C. carnea s.l.* and *E. balteatus*. These five species have also been reported as predominant in previous works conducted in agroecosystems in Western Europe (Hodek & Honěk, 1996; Alhmedi *et al.*, 2007; Vandereycken *et al.*, 2010) and in other countries (Colunga-Garcia & Gage, 1998; Lucas *et al.*, 2007).

Only half the data (19 out of 40 data on the two crops during two years) showed a difference in terms of abundance of aphidophagous species between organic and conventional practices. Only ten percent of the data in corn and 35% in broad bean showed a higher abundance of aphidophagous species in organic than in conventional farming. Our findings are not in accordance with previous ones stating that densities of aphidophagous species are higher in organic farming than in conventional farming (Belfrage *et al.*, 2005; Wu *et al.*, 2006). In these studies, several parameters were proposed to increase biodiversity and abundance in organic farming, including management practices (mechanical weeding, minimum tillage, intercropping) (Sunderland & Samu, 2000; Hole *et al.*, 2005), hedgerow structures, and maintenance of nearby vegetation or plant corridors (Chamberlain & Wilson, 1999; Kromp, 1999). Hedgerows, containing alternative food sources and potentially used as shelters or overwintering sites and refuges following harvest, could be composed of different shrubs and herbaceous plants, providing continuous sources of food for preys and their natural enemies (Frieben & Kopke, 1995; Landis *et al.*, 2000). After feeding on alternative food, predators disperse into adjacent crops (Long *et al.*, 1998).

The low abundance and diversity of aphid predators observed on organic corn could be explained by the low growth of corn in 2011 due to the association of two factors: the drought during spring and the absence of chemical fertilizer. The drought affects more corn than broad bean because corn needs more water than the other. The corn growth deficiency, associated with a low aphid density, could have contributed to the low density of predators observed in 2011. Secondly, the absence of insecticide use in both conventional and organic corn farming decreases the variability between the two farming practices. Factors such as landscape structure and organic practices obviously did not increase the abundance of aphid predators. Additionally, aphid densities were found to directly impact the abundance of some aphid predators on corn, as suggested for *E. balteatus* (Leroy *et al.*, 2011a) and *H. axyridis* (Leroy *et al.*, 2011b).

Because of its status as an invasive and intraguild predator (Brown *et al.*, 2011; Roy *et al.*, 2012), our analysis focussed on *H. axyridis.* Excepting in organic farming in 2011, *H. axyridis* at the adult stage was found to be more abundant on corn than on broad bean, as suggested in previous works (Colunga-Garcia & Gage, 1998; Koch *et al.*, 2006; Lucas *et al.*, 2007). The architectural structure of a corn plant is comparable to that of a tree, i.e., a stiff trunk with many branches. *H. axyridis* is known to be a semiarboreal species (Hodek, 1973; LaMana & Miller, 1996). On the other hand, *C. septempunctata* prefers agroecosystem habitats (Maredia *et al.*, 1992; Alhmedi *et al.*, 2009; Gardiner *et al.*, 2009).

In conclusion, our findings do not support organic practices in corn and broad bean as key options to increase biodiversity and abundance of aphid natural enemies.

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(41 ref.)

Table 2: Abundance (mean and SE) of aphidophagous species (larvae and adults) in two crops (corn and broad bean) and two treatments (conventional and organic) in 2010 and 2011. Means within a developmental stage followed by the same letter are not significantly different. (P > 0.05; LSD test). *C. 7-punctata: Coccinella septempunctata; P. 14-punctata: Propylea quatuordecimpunctata*.

	Mean number of aphidophages /100 m²							
	Corn				Broad bean			
	Conventional		Organic		Conventional		Organic	
2010								
Larvae								
H. axyridis	14.2 ± 3.1	*b*	13.6 ± 5.8	*ab*	5.9 ± 2.4	/	15.7 ± 8.1	*b*
C. 7-punctata	8.7 ± 2.2	*b*	3.0 ± 1.5	*b*	15.8 ± 4.8	/	48.6 ± 23.0	*a*
P. 14-punctata	0.8 ± 0.5	*c*	0.5 ± 0.6	*b*	0	/	0	*b*
E. balteatus	42.0 ± 8.3	*a*	17.7 ± 4.1	*a*	5.2 ± 1.9	/	0	*b*
C. carnea s.l.	5.2 ± 1.3	*b*	0.5 ± 0.6	*b*	0.2 ± 0.3	/	4.3 ± 2.5	*b*
Adults								
H. axyridis	5.2 ± 1.6	*b*	10.1 ± 2.4	*b*	2.4 ± 0.8	*b*	2.9 ± 2.1	*b*
C. 7-punctata	13.9 ± 2.2	*a*	32.3 ± 5.2	*a*	12.0 ± 1.8	*a*	17.1 ± 5.8	*a*
P. 14-punctata	2.5 ± 0.9	*b*	8.6 ± 2.4	*bc*	0.7 ± 0.5	*b*	1.4 ± 1.5	*b*
E. balteatus	0	*b*	0	*c*	0	*b*	1.4 ± 1.5	*b*
C. carnea s.l.	5.7 ± 1.4	*b*	5.1 ± 1.9	*bc*	5.0 ± 1.2	*b*	1.4 ± 1.5	*b*
2011								
Larvae								
H. axyridis	37.4 ± 5.7	*a*	1.3 ± 1.3	/	33.1 ± 9.5	*b*	84.0 ± 34.3	*ab*
C. 7-punctata	20.9 ± 5.3	*b*	6.3 ± 3.8	/	171.1 ± 53.9	*a*	126.0 ± 34.5	a
P. 14-punctata	0.5 ± 0.4	*c*	0	/	0.3 ± 0.3	*b*	2.0 ± 2.0	*c*
E. balteatus	10.7 ± 1.9	*b*	0	/	3.0 ± 1.2	*b*	12.0 ± 4.7	*bc*
C. carnea s.l.	0.5 ± 0.4	*c*	3.8 ± 2.2	/	1.8 ± 0.8	*b*	0	*c*
Adults								
H. axyridis	18.7 ± 2.6	*ab*	7.5 ± 3.0	*b*	8.8 ± 2.3	*b*	12.0 ± 6.8	*b*
C. 7-punctata	23.0 ± 3.1	*a*	35.0 ± 7.4	*a*	45.9 ± 9.0	*a*	74.0 ± 22.1	*a*
P. 14-punctata	3.5 ± 1.3	*c*	3.8 ± 2.2	*b*	2.7 ± 0.9	*b*	2.0 ± 2.0	*b*
E. balteatus	1.1 ± 0.7	*c*	0	*b*	7.0 ± 1.8	*b*	48.0 ± 22.0	*b*
C. carnea s.l.	16.8 ± 2.6	*b*	6.3 ± 3.3	*b*	49.9 ± 6.8	*a*	82.0 ± 27.6	*a*

Table 3: ANOVA and ANCOVA summary of effects of aphid abundance and treatments (conventional, organic) on predator abundances at the adult and larval stages in corn and broad bean crops in 2010 and 2011 (P values come from GLM, *** P < 0.001, ** P < 0.01, * P < 0.05, ns = not significant P > 0.05; [a]analyzed by ANOVA , [b]analyzd by ANCOVA, [1] more predators in conventional crops, [2] more predators in organic crops; *H. a: Harmonia axyridis, C. 7: Coccinella septempunctata, P. 14: Propylea quatuordecimpunctata, E. b: Episyrphus balteatus, C. c: Chrysoperla carnea*)

	2010						2011					
	[a]*Treat.*		[b]*Treat./Aphids*		[b]*Aphids*		[a]*Treat.*		[b]*Treat./Aphids*		[b]*Aphids*	
	F	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*
Corn												
Larvae												
H. a	0.03	*ns*	0.02	*ns*	0.00	*ns*	27.84	***[1]	23.72	***	0.06	*ns*
C. 7	1.95	*ns*	1.77	*ns*	0.05	*ns*	4.97	*[1]	4.87	*	0.11	*ns*
P. 14	0.00	*ns*	0.01	*ns*	0.58	*ns*	0.33	*ns*	0.29	*ns*	0.00	*ns*
E. b	4.60	*[1]	1.86	*ns*	18.20	***	11.42	**[1]	12.44	***	1.05	*ns*
C. c	5.23	*[1]	5.22	*	0.04	*ns*	7.37	**[2]	5.78	*	0.18	*ns*
Adults												
H. a	6.85	**[2]	6.02	*	0.41	*ns*	6.70	*[1]	2.36	*ns*	7.16	**
C. 7	12.16	**[2]	11.31	**	0.12	*ns*	1.99	*ns*	3.67	*ns*	2.93	*ns*
P. 14	6.11	*[2]	6.13	*	0.07	*ns*	0.18	*ns*	0.12	*ns*	0.02	*ns*
E. b	/	/	/	/	/	/	0.70	*ns*	1.85	*ns*	2.76	*ns*
C. c	0.16	*ns*	0.21	*ns*	0.15	*ns*	8.06	**[1]	5.37	*	1.05	*ns*
Broad bean												
Larvae												
H. a	3.38	*ns*	2.74	*ns*	2.25	*ns*	10.11	**[2]	10.43	**	0.35	*ns*
C. 7	18.58	***[2]	15.76	***	11.29	**	6.60	*[1]	4.92	*	2.26	*ns*
P. 14	/	/	/	/	/	/	2.23	*ns*	2.40	*ns*	0.19	*ns*
E. b	1.47	*ns*	1.17	*ns*	1.31	*ns*	5.74	*[2]	4.78	*	0.62	*ns*
C. c	12.74	***[2]	12.03	**	0.51	*ns*	0.75	*ns*	0.74	*ns*	0.01	*ns*
Adults												
H. a	0.02	*ns*	0.10	*ns*	2.79	*ns*	0.07	*ns*	0.10	*ns*	0.07	*ns*
C. 7	0.84	*ns*	0.65	*ns*	0.89	*ns*	14.27	***[2]	12.77	***	0.37	*ns*
P. 14	1.40	*ns*	1.72	*ns*	1.48	*ns*	0.01	*ns*	0.03	*ns*	0.17	*ns*
E. b	5.58	*[2]	5.50	*	0.00	*ns*	33.87	***[2]	26.32	***	4.57	*
C. c	2.96	*ns*	2.55	*ns*	1.06	*ns*	2.16	*ns*	3.14	*ns*	2.66	*ns*

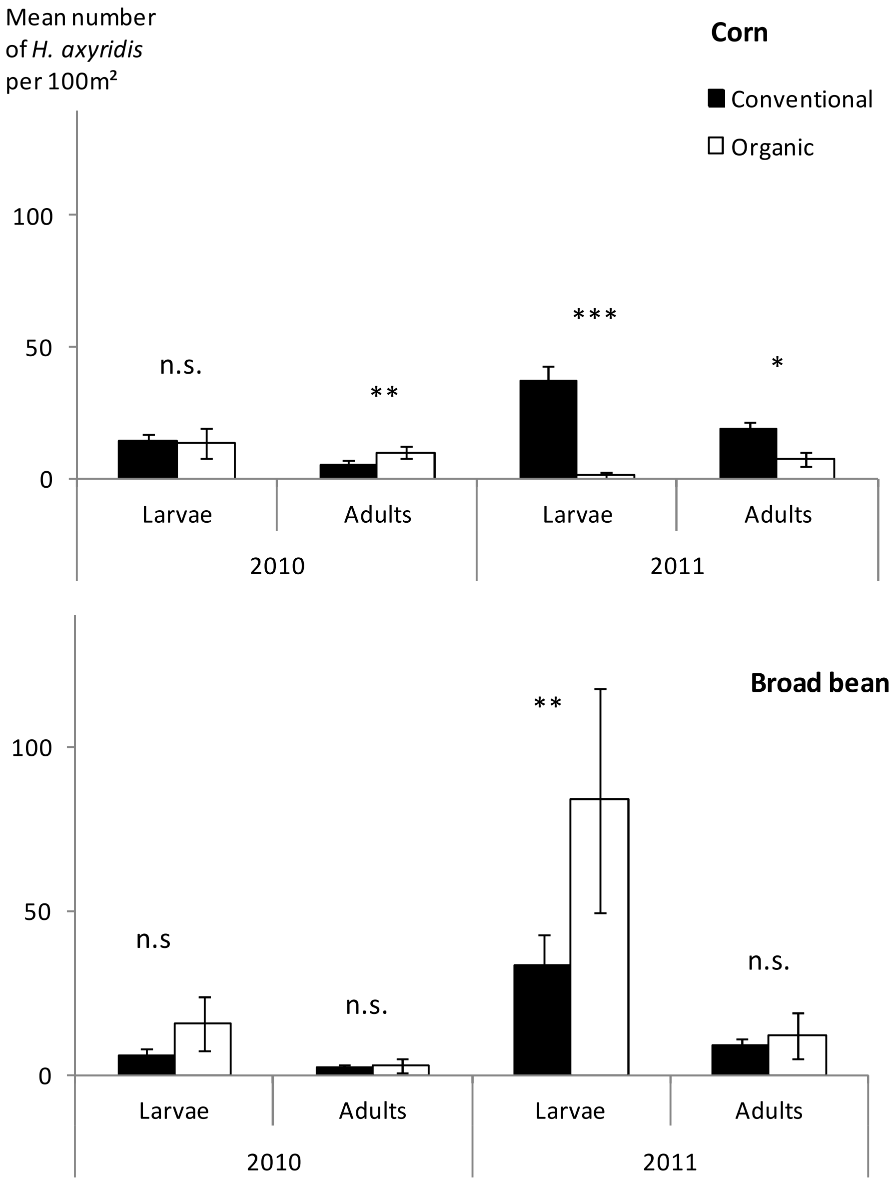

Figure 1: Mean numbers and SE of *H. axyridis* observed per 100 m² on corn and broad bean with conventional and organic treatment in 2010 and 2011. (P values come from GLM, *** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$, ns = not significant $P > 0.05$)

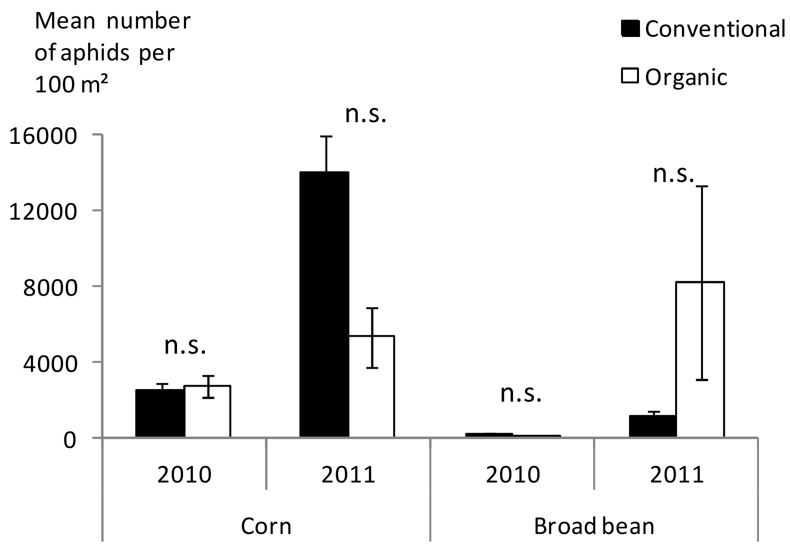

Figure 2: Mean numbers and SE of aphids observed per 100 m² on corn and on broad bean with conventional treatment and organic treatment in 2010 and 2011. (P values come from GLM, *** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$, ns = not significant $P > 0.05$)