



# Potential of tomato colonisation by mirid bugs in Roussillon area (Southern France): effect of crop management and landscape features in crop surroundings

Amélie Lefevre, Stéphanie Aviron

## ► To cite this version:

Amélie Lefevre, Stéphanie Aviron. Potential of tomato colonisation by mirid bugs in Roussillon area (Southern France): effect of crop management and landscape features in crop surroundings. Colloque IOBC "Integrated control in protected crops, Mediterranean climate", Oct 2012, Catania, Italy. , 2012. hal-01458675

**HAL Id: hal-01458675**

**<https://hal.science/hal-01458675>**

Submitted on 3 Jun 2020

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## **Potential of tomato colonization by mirid bugs in Roussillon area (Southern France): effect of crop management and landscape features in crop surroundings**

**Amélie Lefèvre<sup>1</sup>, Stéphanie Aviron<sup>2</sup>**

<sup>1</sup>INRA, UE411 Domaine Expérimental Alénia Roussillon, F-66200 Alénia, France; <sup>2</sup>INRA, UR980 SAD-Paysage, 65 rue de St Briec, F-35042 Rennes Cedex, France  
e-mail: Amelie.Lefevre@supagro.inra.fr

**Abstract:** Enhancing insect pest control by their natural enemies is considered as a promising crop protection strategy to reduce pesticide use. In Mediterranean areas, native natural enemies such as mirid bugs (Heteroptera: Miridae) settle spontaneously in protected tomato crops and can play an important asset for pest regulation, which remains however hardly predictable. This present study aims at identifying key factors of colonization of crops by mirid bugs and more specifically agronomical practices and landscape features in the tomato crops surroundings. Data on land-uses proportions, crop management and mirids populations were collected for 34 tomato crops in Roussillon area (south of France) and analysed using multivariate methods. Exploratory analyses show correlations between crop management, proportions of certain land-uses and abundance of mirids in tomato. This is the first step of a whole study aiming to assess the potential of protected crop colonization by beneficials in order to manage crops and their surroundings and enhance this process.

**Key words:** conservation biological control, tomato colonization, Miridae, landscape, crop management

### **Introduction**

To reduce pesticide use in protected horticultural cropping systems, it seems necessary to design pests control strategies that account for technical and economical considerations, as well as agroecological context of crops. Integrated Pest Management (IPM) strategies that rely on augmentative biological control, i.e. based on release of reared beneficial organisms, can be successfully applied in greenhouses (van Lenteren, 2000). However, for producers involved in a more agroecological approach (Wezel *et al.*, 2009) and with few income capacity, naturally occurring beneficial organisms may provide a useful complementary tool in pests regulation strategies (Le Roux *et al.*, 2008).

In Mediterranean areas, polyphagous predatory mirids (Heteroptera: Miridae) can spontaneously colonize summer crops and contribute to control their main pests (Gabarra *et al.*, 1988; Alomar *et al.*, 1991). In tomato crops, the presence of arthropod predators and timing of colonisation can strongly vary according to crop management (e.g. intensity of pesticide use or deleafing practices; Yardim & Edwards, 1998; Gradish *et al.*, 2011) and presence of specific landscape features in the crop surroundings (Ingegno *et al.*, 2009; Gabarra *et al.*, 2004; Castañé *et al.*, 2004). Crop colonization by mirids especially seems to be enhanced by the presence, in the close vicinity of tomato greenhouses, of alternative food sources, reproduction or refuges sites with specific cultivated or uncultivated host plants (Lambion, 2011; Lykouressis *et al.*, 2008). However, there are still knowledge gaps about the ecology of mirids, the crops colonization processes and how to enhance mirid populations in horticultural systems (Perdikis *et al.*, 2011). The role of uncultivated elements as sources of

mirids for tomato crops is only explored at very small spatial scales (up to 75m to our knowledge), although these insects might disperse over longer distances. Moreover, little is known about the respective effects of the diverse cultural practices and landscape features in the crop surroundings on mirid occurrence in tomato crops. If these gaps were filled, IPM strategies could integrate the natural biological control potential with more reliability.

The present study is part of the project REGABRI, which aims at assessing the effects of cultural practices and landscape features in the crop surroundings, on colonization of protected tomato crops by mirids in Southern France. In the studied region, indigenous mirid bugs occurring in protected crops are *Macrolophus* and *Dicyphus* sp., as well as *Nesidiocoris tenuis* (Dicyphini). Based on the regional agronomic diagnosis method from Doré *et al.* (2007), a stratified sampling design is set up to build a diagnosis of protected vegetables production farms. The diagnosis is planned following two steps:

- (1) relate colonization performances of tomato crops by mirids to cultural practices and landscape features in the crops surroundings from 50 to 300m (2010 and 2011).
- (2) verify hypothesis stemmed from step one through a survey of mirids in uncultivated or cultivated elements identified as potential sources for mirids in previous step (2012).

The present article presents preliminary results from step one.

## Material and methods

### *Study site and sampled farms*

The study was carried out in the Roussillon plain (Pyrénées Orientales dept.) in Southern France. This area is a mosaic of various crops (orchards, vineyards, cereals, horticultural crops), semi-natural elements (hedges, herbaceous elements and fallow) and urban areas. Thirty four tomato crops located on 23 production farms were sampled in 2010 and 2011 (Table 1). Production farms were chosen to maximise the variability of the surface area covered by semi-natural uncultivated elements in the crop surroundings. Tomato crops were cultivated under tunnels or plastic greenhouses without insect-proof nets, in soil, and planted from mid-March to mid-April.

Table 1. Number of sampled crops and production farms in 2010 and 2011.

	Farming system		Total	
	Organic	Conventional	Crops	Farms
2010	11	3	14	10
2011	15	5	20 (5*)	20 (8**)
<b>Total crops</b>	26	8	34	-

\* crops / \*\* farms sampled both years

### *Evaluation of crop colonization and mirid population levels*

Observations of mirids were made weekly from tomato planting to end of July, on 24 plants evenly distributed in each tomato field. On each plant, adults of *Macrolophus* sp., *Dicyphus* sp., *Nesidiocoris* sp., and mirid larvae (all species pooled) were counted on 6 leaves without removing insects or destructing plants. Additionally, a dozen of individuals per genus were removed once in June in each tomato crop for morphological identification, to confirm the visual identification of mirids in the field.

### ***Determination of homogeneous crop management groups***

Data on technical cultural practices – mainly crop protection practices and plant management – were collected for each crop and farm in 2010 and 2011 by the mean of field observations and surveys with farmers. As the number of sampled crops was small in comparison with the number of agronomical variables (19 variables in 2011), an integrative variable was built. We established homogeneous crop management (HCM) groups using a multiple correspondence factor analysis (MCFA) and an ascending hierarchical clustering (AHC). Axes of the MCFA were built using data from 2011, whilst agronomical data from 2010 were used as supplementary. Then, AHC was performed on crops coordinates along axes 1 and 2 of the MCFA to identify HCM groups.

### ***Characterisation of landscape features in crop surroundings***

Landscape features were described in a 300m area around tomato crops using GIS software (gvSIG OADE). Land uses were digitized using aerial photographs (BD ORTHO<sup>®</sup> IGN 2009) and field controls, and categorised according to 24 classes. For the analyses, the 24 initial land use classes were grouped into 15 classes considered as more ecologically relevant for mirids (Table 2). The proportion (percent cover) of each land use was then calculated in buffers of different sizes (50m, 100m, 200m, 300m) to describe landscape composition in the crop surroundings.

Table 2. Land use classes considered in the analyses.

General land use type	Land use classes for analyses
Crops	Cereal, outdoor vegetable crop, protected horticultural crop, grassy orchard, orchard with bare soil, olive grove and vineyards
Uncultivated elements	Ditch, perenial herbaceous vegetation, fallow, woodlot, deciduous hedge, conifer hedge
Others	Element without vegetation (bare soil area, road, building), urban grassy area, water

### ***Exploratory analysis of the relationships between crop colonization by mirids, management type and landscape features***

Canonical redundancy analysis (RDA) was performed to explore the effects of crop management type (HCM groups) and landscape descriptors on mirids (average weekly abundances of each mirid genus for adults and for larvae) using Canoco software. RDA was first performed with each management and landscape variable separately to eliminate non significant variables. Correlations between significant variables were examined to eliminate the redundant variables which had the lowest correlations with RDA axes. The remaining, significant management and landscape variables at the different spatial scales were then integrated in a global RDA to examine their effects on mirids. Partial RDAs were finally performed to estimate the respective proportion of variance in mirids data explained by management type vs. landscape descriptors.

## Results and discussion

### *Mirid colonization*

First results show that tomato crops colonization by mirid bugs is a very heterogeneous process as illustrated particularly by the variability of the entrance timing, the average abundance per week, and total abundance on the studied period (Figure 1). The mirid species occurring on tomato crops were *Dicyphus errans*, *Macrolophus pygmaeus* and *Nesidiocoris tenuis*. This last species that appeared late in June, was scarce in 2010 and only detected in 5 crops in 2011.

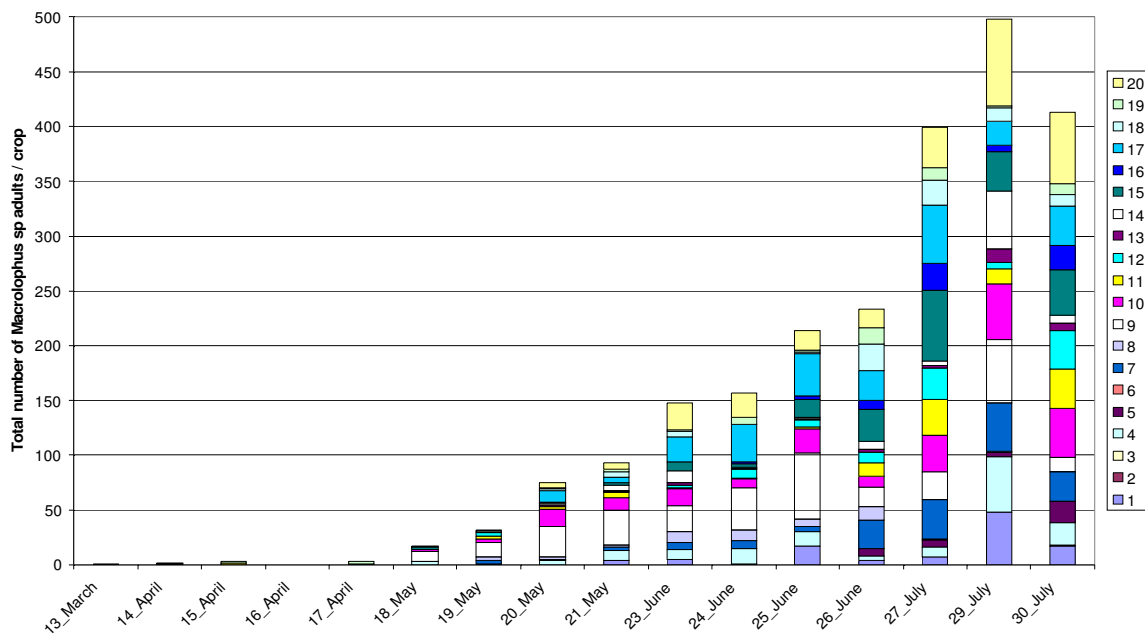


Figure 1: Abundance of adults of *Macrolophus sp.* per week in 2011

### *Management strategies of tomato crops*

The two first axes of the MCFA performed on agronomical data explained 37.4% of the total variance. The HCA performed on crop coordinates along the two first MCFA axes allowed to identify three contrasted management types of tomato crops. Four crops were managed with chemical insecticides and acaricides, spinosad use, and with intensive deleafing and disbudding ("chemical management" type). Other crops were managed under organic farming but differed according to the frequency of interventions: eight crops were characterised by frequent use of *Bacillus thuringiensis* (Bt), as well as beneficials releasing, companion plants using and deleafing ("organic – many interventions") contrary to the last eight crops with few Bt use, no deleafing nor insects release ("organic – few interventions").

### *Effects of management type and landscape descriptors*

Significant and non redundant management and landscape variables explained 54.6% of total variance in mirids data (RDA,  $p = 0.002$ ).

The results first confirm the strong negative impact of pesticide use on beneficial insects (Yardim & Edwards, 1998), as adults (*Macrolophus* and *Dicyphus sp.*) and larvae were

abundant in organic crops (whatever frequency of intervention) but rare in crops under chemical management (Figure 2).

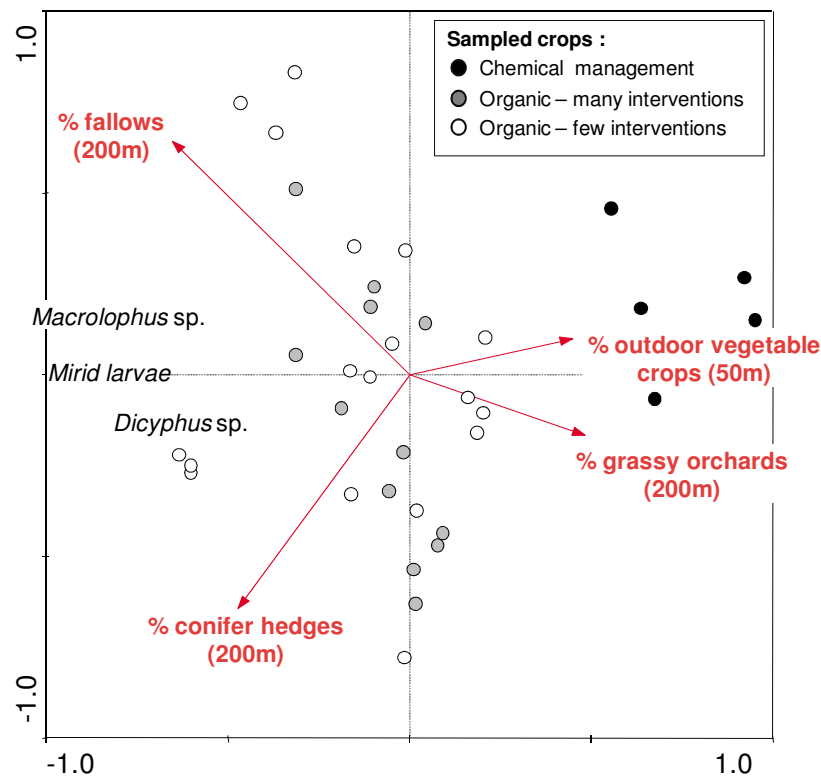


Figure 2. Ordination diagram of the RDA testing the effect of tomato crop management type and landscape features on mirid data (total variance explained 54.6%,  $P = 0.002$ ).

Mirid abundances in tomato crops varied also according to landscape features in the crops surroundings, at larger spatial scales (200m) than those investigated in previous studies. Mirids were abundant in crops surrounded by fallows (200m) (*Macrolophus* sp.) and/or conifer hedges (200m) (*Dicyphus* sp.) (Figure 2), which might reflect a functional role (habitats, refuges) of fallows or a windbreak effect of hedges for adult mirids. On the contrary, mirids were rare in crops surrounded by outdoor vegetable crops (50m) and/or grassy orchards (200m), which might be explained by dilution processes (Parsa *et al.*, 2011) in nearby outdoor crops or intensive pesticide spraying in orchards.

Partial RDAs show that management type and landscape features are important to understand the variability in tomato crop colonisation by mirids (16.8% and 20% of explained variance, respectively,  $p < 0.05$ ). However, their effects on mirids are not totally independent (17.8% explained by the interactions between landscape and management variables). This is explained by higher proportions of fallows and conifer hedges on organic production sites. In our study area, organic farmers demonstrate a stronger motivation than conventional ones to preserve uncultivated areas and manage them extensively. These different environmental considerations on organic and conventional production sites are likely to influence mirid population levels prior to tomato colonisation. Thus, the effects of management strategies by farmers and of landscape features in the crops' surroundings cannot be interpreted separately.

## Conclusions and perspectives

The preliminary results confirm the negative impact of chemical crop protection strategies on mirid bugs, but also bring insights about possible effects of specific landscape features in tomato crops surroundings at large spatial scales. Further analyses are however needed to explore the effects of other factors such as land-uses spatial configuration, or pest infestation levels on tomato crops.

The hypotheses stemmed from statistical correlations between mirid abundances and the presence of specific landscape features will be tested in the second step of the project in 2012: a survey of mirids and their host-plants will be realised in the uncultivated and cultivated elements identified in 2010-2011 as possible sources or sinks of mirids. In particular, this will allow to test whether fallows are functional habitats or refuges for mirid bugs on studied production sites.

## Acknowledgements

We thank the Catalan producers who give us such a warm reception every week, students (M. Perraudin, H. Skrzypczynski, Y. D. Varennes, R. Chadly, S. Redondo) and colleagues of INRA Alénya Roussillon for the field surveys and keybording of data. Thanks to J. C. Streito (INRA), C. Laisne (CBGP Unit) and F. Hamdi (IRD) for mirids identification. Funding was provided by the Intern Committee for Organic Farming of INRA and Interreg REDBIO (EFA 10/08).

## References

- Alomar, O., Castañé, C., Gabarra, R., Arno, J., Ariño, J., Albajes, R. 1991: Conservation of native mirid bugs for biological control in protected and outdoor tomato crops. IOBC-WPRS Bull. 14: 33-42.
- Doré, T., Clermont-Dauphin, C., Crozat, Y., David, C., Jeuffroy, M. H., Loyce, C., Makowski, D., Malézieux, E., Meynard, J. M., Valantin-Morison, M. 2007: Methodological progress in on-farm regional agronomic diagnosis. A review. Agron. Sustain. Dev. 28: 151-161.
- Castañé, C., Alomar, O., Goula, M., Gabarra, R. 2004: Colonization of tomato greenhouses by the predatory mirid bugs *Macrolophus caliginosus* and *Dicyphus tamaninii*. Biol. Cont. 30(3): 591-597.
- Gabarra, R., Castañé, C., Bordas, E., Albajes, R. 1988: *Dicyphus tamaninii* as a beneficial insect and pest in tomato crops in Catalonia, Spain. Entomophaga 33(2): 219-228.
- Gabarra, R., Alomar, O., Castañé, C., Goula, M., Albajes, R. 2004: Movement of greenhouse whitefly and its predators between in- and outside of Mediterranean greenhouses. Agric. Ecosyst. & Env. 102(3): 341-348.
- Gradish, A. E., Scott-Dupree, C. D., Shipp, L., Harris, C. R., Ferguson, G. 2011: Effect of reduced risk pesticides on greenhouse vegetable arthropod biological control agents. Pest Man. Sc. 67(1): 82-86.
- Ingegno, B. L., Pansa, M. G., Tavella, L. 2009: Tomato colonization by predatory bugs (Heteroptera: Miridae) in agroecosystems of NW Italy. IOBC-WPRS Bull. 49: 287-291.
- Lambion, J. 2011. Functional biodiversity in southern France: a method to enhance predatory mirid bug populations. Acta Hort. (ISHS) 915:165-170.

- Le Roux, X., Barbault, R., Baudry, J., Burel, F., Doussan, I., Garnier, E., Herzog, F., Lavorel, S., Lifran, R., Roger-Estrade, J., Sarthou, J. P., Trommetter, M. 2008: Agriculture et biodiversité. Valoriser les synergies. Ed. Quae, Versailles (FRA), 184 pp, Expertises Collectives.
- Lykouressis, D., Giatropoulos, A., Perdikis, D., Favas, C. 2008: Assessing the suitability of noncultivated plants and associated insect prey as food sources for the omnivorous predator *Macrolophus pygmaeus* (Hemiptera: Miridae). Biol. Cont. 44(2): 142-148.
- Parsa, S., Canto, R., Rosenheim, J. A. 2011: Resource concentration dilutes a key pest in indigenous potato agriculture. Ecol. Appl. 21: 539-546.
- Perdikis, D., Fantinou, A., Lykouressis, D. 2011: Enhancing pest control in annual crops by conservation of predatory Heteroptera. Biol. Control 59(1): 13-21.
- Van Lenteren, J. C. 2000: A greenhouse without pesticides: fact or fantasy? Crop Protection 19: 375-384.
- Wezel, A., Bellon, B., Doré, T., Francis, C., Vallod, D., David, C. 2009: Agroecology as a science, a movement and a practice. A review. Agron. Sustain. Dev. 29(4): 503-515.
- Yardim, E. N., Edwards, C. A. 1998: The influence of chemical management of pests, diseases and weeds on pest and predatory arthropods associated with tomatoes. Agric. Ecosys. & Env. 70(1): 31-48.



