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## Basis for implementing an integrated pest management program (IPM) in persimmon

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### **Abstract**

Persimmon has been traditionally considered a minor crop in Spain. However, during the last 20 years, persimmon production has exponentially increased mainly due to the commercialization of the fruit without astringency by a process of modified atmospheres. Due to this, a crop which had few important pests in the past, has become a crop in which some harmful organisms, such as mealybugs (Hemiptera: Pseudococcidae) or honeydew moths (Lepidoptera: Pyralidae), are becoming major pests. With the aim to develop an integrated pest management program (IPM) in persimmon, 5 pesticide-free persimmon orchards located in two production areas in the Valencian Community were chosen to study the presence and dynamics of the arthropods present in this crop (both phytophagous and natural enemies). Stems, leaves, flowers and fruit samples were taken every two weeks during three years (2014-2016). In parallel, persimmon pest species were hierarchized according to their economic impact. The information was used to develop an IPM program for persimmon and made available to the agricultural sector through the IVIA webpage (<http://gipcaqui.ivia.es>). In this IPM program, pests and natural enemies are identified and described. Sampling methods, economic injury levels and control methods for the main pests are also being developed. Biological control is prioritized as the preferred management method in this IPM program. In this respect, further research is needed to clarify the role of predatory mites (Acari: Phytoseiidae), which are very abundant in this crop.

**Keywords:** Sampling methods, phytophagous and natural enemy dynamics

### **INTRODUCTION**

Persimmon has traditionally been considered a minor crop in the Mediterranean Basin, but in the last 20-25 years a remarkable increase in production and economic importance has occurred, especially in Spain and particularly in the Valencian Community (Perucho, 2015). This situation has been possible to the commercialization of the cultivar "Rojo Brillante" (original from La Ribera Alta-Comunidad Valenciana) and the development of a post-harvest technique which eliminates the astringency of the fruit by subjecting them to an atmosphere saturated with CO<sub>2</sub>.

Traditionally, the cultivation of persimmon in Spain was not attacked by many phytophagous arthropod pests (Tena et al, 2015). The most problematic organism was the Mediterranean fruit fly or medfly, *Ceratitis capitata* (Wiedemann), which attacks the fruit

when it is ripe on the tree. However, with the new production system and the increase in the cultivation area, some phytophagous arthropods which were at low levels in the past and others that are being described for the first time, are recently becoming important pest in this crop.

Tena et al. (2015) pointed out that the most important pests nowadays were two mealybug species: *Planococcus citri* (Risso) and *Pseudococcus viburni* Signoret. Mealybugs cause premature ripening and fruit fall, as well as the proliferation of other pests such as honeydew moths. Furthermore, these authors highlighted the incidence of the medfly as a phytosanitary problem of decreasing significance. New pests such as whiteflies have recently been associated with this persimmon. However, there is a lack of accurate information on all these phytophagous pests of persimmon. Information on the population dynamics of each pest, the level of economic damage, and the presence of natural enemies on this crop remains largely unknown. Therefore, getting all this information is necessary as a first step to develop an integrated pest management program in persimmon.

In this work, the first results of the development of an integrated pest management in persimmon in the Valencian Community are presented. In addition, from a holistic point of view, we also present the web page "gipcaqui.ivia.es" as a means of diffusion and transfer to the persimmon sector of the results that are being generated.

## MATERIAL AND METHODS

To identify and monitor the arthropod fauna (phytophagous and natural enemies) in persimmon, 5 pesticide-free orchards of persimmon were selected. These orchards were located in two production areas of the Valencian Community: two orchards in the region of Plana Baixa, in the town of Almenara (province of Castellón), and the other three orchards in Ribera Alta region, in the localities of L'Alcudia and Carlet (province of Valencia).

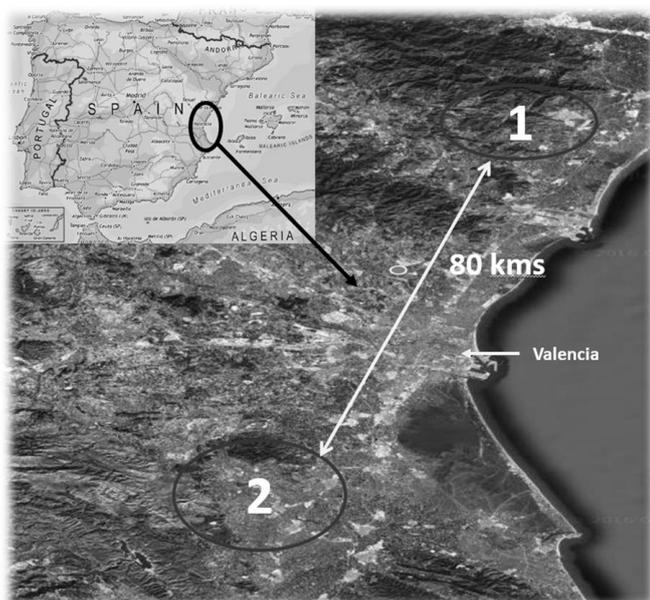


Fig 1 – Map with the 2 persimmon production areas sampled in the Valencian Community in this work: Plana Baixa (1) and Ribera Alta (2).

The sampling plan was designed for the 3 calendar years of 2014, 2015 and 2016. Samples were collected fortnightly in all orchards between March and December every year. Each sample consisted of 1 shoot at least 20 cm in length and 5 leaves, with 2 flowers (from

March to mid-May), and with 1 fruit (from end-May to December). A total of 20 samples were collected per orchard on each sampling date.

The samples were inspected under the binocular microscope (x40) in the laboratory and all arthropods present were identified and assigned to the organ of the plant on which they were found. In parallel, the persimmon website was created and published at <http://gipcaqui.ivia.es>.

## RESULTS

Until the end of 2015, we have identified nine different groups of arthropods. The most prevalent group was mealybugs, with 32% abundance, followed by mites with 25%. This second group was mainly composed by *Lorryia formosa* Cooreman, a saprophyte species, without economic incidence in this crop. The rest of phytophagous groups have been found with less than 10% of abundance: coccids (8%), thrips (4%), aphids (2%), honeydew moths (2%) and whiteflies (1%). The two main groups of beneficial insects detected on persimmon were phytoseid mites (20%) and chrysopids (1%).

These results confirm the current importance of mealybugs as the main problem on persimmon in the Valencian Community. Surprisingly, the abundance of honeydew moths and whiteflies has been relatively low in spite of the damages that have been attributed to them in these last two seasons.

### Mealybugs

Four different mealybug species on persimmon have been detected in the Valencian Community. *Delotococcus aberiae* De Lotto, was only present in the northern region (la Plana Baixa), and the other three in the southern region (La Ribera Alta), *Planococcus citri* (Risso), *Pseudococcus viburni* Signoret and *Pseudococcus longispinus* Targioni Tozzetti (Fig. 2). *D. aberiae* was recently detected for the first time in Spain, as a citrus pest (Tena et al., 2016), and our finding is the first mention of its presence on persimmon as a pest.

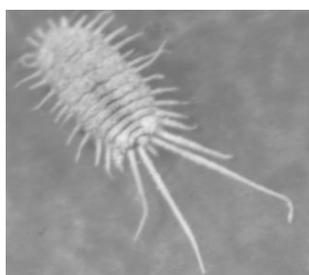
All nymphal instars of the four mealybug species can be detected on stems, leaves, flowers and fruits. However, the highest population levels are mainly found on fruit at the end of the season when their mere presence produces downgraded fruit.



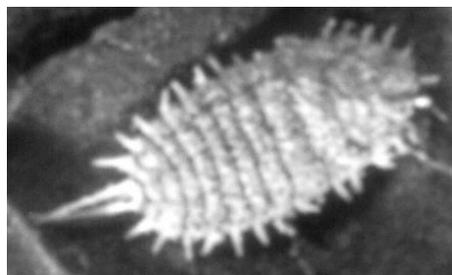
*Delotococcus aberiae*



*Planococcus citri*



*Pseudococcus longispinus*



*Pseudococcus viburni*

Fig 2- Species of mealybugs found on persimmon in the Valencian Community.

### Moths

Two species of moths have been detected in both regions (Fig 3): a piralid, the honeydew moth *Cryptoblabes gnidiella* (Millière), a Mediterranean species, and a cosmopterigid, the Florida pink scavenger *Anatrachyntis badia* (Hodges), a species native to the American continent. Initially it seemed that *C. gnidiella* had a higher incidence on the crop but the damage caused by *A. badia* has increased recently. The pest incidence and level of damage caused by each moth species must be carefully explored (Fig 4).



Fig 3- Adults of moth species found on persimmon: left, *Cryptoblabes gnidiella*, and right *Anatrachyntis badia*



Fig 4- Damage of honeydew moths on persimmon fruit

### Whiteflies

In 2015, the presence of whitefly populations attacking persimmon trees has been detected. Damage is not directly attributed to the insect feeding on leaves, but is mainly due to the development of sooty mold (fumagine) on the fruits from the honeydew excretion of nymphal instars.

Two species have been identified (Fig 5): the citrus whitefly *Dialeurodes citri* Ashmead and the nesting whitefly *Paraleyrodes minei* Iaccarino. Both species are well known as citrus pests (García-Marí, 2012; Urbaneja et al., 2016).

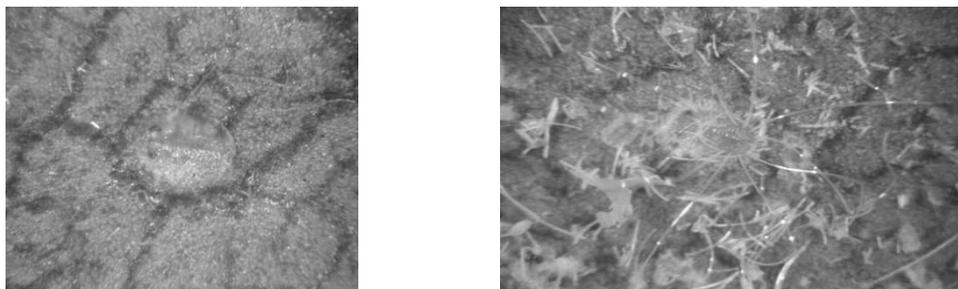


Fig 5- Whiteflies species found on persimmon: *D. citri* (left) and *P. minei* (right)

### **Phytoseid mites**

Four species of phytoseid mites (predatory mites) have been identified: *Euseius stipulatus* (Athias-Henriot), *Amblyseius andersoni* (Chant), *Typhlodromus phialatus* Athias-Henriot and *Paraseiulus talbii* (Athias-Henriot).

### **Persimmon IPM website**

The persimmon IPM website (<http://gipcaqui.ivia.es/>) has been designed and is actively running (Pérez-Hedo et al., 2016). Information about pests and diseases of persimmon has been included in four main sections: Identification, Sampling methods, Economic injury levels and Management measures. In addition, a mailing list of subscribers has been created to enable weekly dissemination of important news regarding IPM in persimmon. Until now, the web page receives an average of around 200 visits per day and 1500 subscribers have been added to the mailing list.

### **DISCUSSION**

To date we have been able to determine the importance of phytophagous and natural enemies in persimmon orchards that have not received any chemical treatment. It seems evident that the importance of some phytophagous is less in natural situations than commercial persimmon orchards where pesticides are applied. An example is the low incidence whiteflies and honeydew moths in the unsprayed orchards in this study. We hypothesize the low incidence is a result of natural control from larger populations of natural enemies. This natural control does not exist in the commercial fields where chemical treatments have been frequently carried out disrupting biological control in the past seasons. In this respect, the population level of predatory mites per leaf is really high in our study. Phytoseiid mites could prey on young nymphal instars of whiteflies and hence regulate whitefly populations. Nevertheless, further research is urgently needed to confirm this hypothesis.

Two species of honeydew moths were detected. Growers and technicians have to date attributed all honeydew damage to *C. gnidiella*. However, the two species will coexist in the crop and can produce significant damage to persimmon; hence a correct identification will be necessary to improve their control. Until now, the real status as pests of both species is not clear. García-Martínez et al. (2016) give preliminary guidelines for the correct identification of both moths: *C. gnidiella* and *A. badia*.

An IPM program is not fixed and must evolve according to what happens in our environment. The persimmon IPM program is a good example of this dynamism. As issues in crop protection emerge, technical specialists need to be available to undertake research and generate new knowledge, as well as support the adoption by industry of IPM strategies. In line with this transfer of information to the persimmon industry of the Region of Valencia, IVIA launched the website "INTEGRATED PEST AND DISEASE MANAGEMENT IN PERSIMMON" (<http://gipcaqui.ivia.es/>) as a support for decision making within an IPM program. The website has great value as a consultation tool, as it has different sections in which to obtain information on all pests and diseases that attack persimmon. Indeed, our goal is to continue updating the web page as new information is obtained, such as sampling methods and control measures.

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