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Citrus aphids in Italy: historical review

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Abstract. Aphids occurring on citrus in Italy have been studied since the second half of the XIX century. Most of the previous papers on the aphids of the Italian citrus groves concerned faunistic and morphological traits whereas the main aspects investigated in the last decades focused on their potential as virus vectors and on tools and strategies used for their control. Eleven are the aphid species reported on citrus in Italy, although most of them can be found only occasionally.

The following review takes also into account the works by Authors who have described some aspects relating to the morphology, biology, control, etc. of one or of several citrus aphid species in Italy.

Keywords. Aphids – Citrus – *Citrus tristeza virus* – Italy – Virus vectors.

Les pucerons des agrumes en Italie: bref historique

Résumé. *Les pucerons qui infestent les agrumes en Italie ont été étudiés à partir de la deuxième moitié du XIXe siècle. Au début, la plupart des travaux consacrés aux pucerons dans les vergers agrumicoles italiens étaient des études faunistiques ou des études sur les caractéristiques morphologiques alors que, dans les dernières décennies, l'attention s'est concentrée davantage sur leur potentiel en tant que vecteurs de virus et sur les outils et stratégies employés dans la lutte. Il existe onze espèces de pucerons connues sur les agrumes en Italie bien que, pour la plupart, elles ne soient signalées qu'occasionnellement. Ce travail prend aussi en consideration les travaux des auteurs qui ont décrit certains aspects de la morphologie, de la biologie, de la lutte d'une ou plusieurs espèces de pucerons des agrumes en Italie.*

Mots-clés. *Pucerons, agrumes – Virus de la tristeza des agrumes – Italie – Vecteurs de virus.*

I – Fauna

Among the scientists who, since the last decades of the XIX century, have reported the presence of aphid species (Hemiptera Aphididae) on some *Citrus*, apart from many other plant hosts, mention shall be made of Passerini (1863), Ferrari (1872), Del Guercio (1900) and Ribaga (1901). In 1917, Del Guercio published the description of some citrus aphid species thought to be new for science. Following review by various aphidologists highlighted that these new species had already been described before. Other contributions on aphid species that can be found also on the citrus were published by Silvestri (1939) and Roberti (1945). In the second half of the XX century, more specific contributions were published on the citrus aphids. The first paper on citrus aphids in Sicily was published by Barbagallo in 1965; the Author reports essential data on *Toxoptera aurantii* (Boyer de Fonscolombe), *A. spiraecola* Patch and *A. gossypii* Glover, and underlines the first finding of *Aphis spiraecola* on the island and its higher harmfulness versus other specific aphid species. In 1966, the same Author (Barbagallo, 1966b) published the first comprehensive review on the citrus aphids concerning only Sicily. The Author reports five more species of Aphididae in the Sicilian citrus-growing areas: *A. craccivora* Koch, *A. fabae* Scopoli, *Macrosiphum euphorbiae* (Thomas), *Myzus* (*Nectarosiphon*) *persicae* (Sulzer) and *Rhopalosiphum maidis* (Fitch). The most frequent species in the Sicilian citrus groves are, in decreasing order, *T. aurantii, A. spiraecola* and *A. gossypii.* The other species mentioned above are less relevant or occasional (as is the case for *R. maidis* usually associated with graminae) and their detection may be ascribed to the presence

of other wild or cultivated plants in the citrus grove hosting the same aphids (Barbagallo, 1966b; Patti, 1985). With the exception of *A. fabae*, the above mentioned species were also reported from Calabria (Micieli De Biase, 1975) on various *Citrus* trees. The list of aphid species occasionally found on citrus trees was enriched by Patti (1983 and 1985) who reported *Aulacorthum solani* (Kaltenbach) and *Hyadaphis coriandri* (Das),which usually attack different Ombrelliferae species, and by Barbagallo (1986) who found in Sardinia *Myzus ornatus* Laing another highly polyphagous species. To date, the *Citrus* aphid species found in Italy are eleven.

The fauna composition of citrus aphids is quite the same across the Italian citrus-growing regions and does not differ from that reported in the other Mediterranean countries (Barbagallo and Inserra, 1974).

II – Morphology

Several Italian authors have contributed to probing into the morphology of citrus aphid species. As to *A. spiraecola* (1966a), Barbagallo describes in detail also the main morphological traits which help discriminating between the green aphid and the similar *Aphis pomi* DeGeer. Other data on *A. spiraecola* morphology were later published by Micieli De Biase (1970). Again, Barbagallo (1966a) provided an accurate morphological description, complemented with detailed drawings, of eight apterous and alate virginoparous citrus aphid species. Of paramount importance is the morphological, anatomical and histological description of *A. gossypii* (sub *Aphis* (*Doralis*) *frangulae* Koch) published by Roberti in 1946. Further contributions to the morphological description and brief information on the geographical distribution, the biological cycle and the ecology of the Italian aphid species, including all those that can be found on the citrus, were given by Roberti (1991) in his work on aphids in Italy.

Dichotomic keys to identifying the main aphid species in the Italian citrus groves, valid for the apterous virginoparous forms, were reported by Barbagallo (1966b), Micieli De Biase (1975) and Patti (1983), who reminded that the colonies on the same shoot may sometimes include several aphid species.

III – Symptomatology and damages

Aphids may become harmful both when their populations attain high density values, thereby causing veritable pullulation, and with a few individuals per plant as pathogen vectors.

In the first case, the damage results from sap sucking and injection of toxic saliva in the tissue, with alterations of the plant cell metabolism which impact the crop yield. The symptomatology displays a lower development of the shoots, leaf deformations of variable entity according to the species, drop of flowers and fruitlets, production of honeydew with the development of sooty mould, which contributes to worsening the damage by reducing photosynthesis and decreasing the gaseous exchange (Zappalà, 2001). The most harmful species reported in Italy is *A. spiraecola* which causes leaf rolling and deformations or stops the growth of shoots. Less harmful, in decreasing order, are *A. gossypii* and *T. aurantii* (Barbagallo, 1966a; Micieli de Biase, 1970; Patti, 1983).

In the second case, the harmfulness is higher due to the ability of some aphid species to transmit virus diseases which are sometimes lethal. Although the importance of aphids as virus vectors (mention should be made to *Citrus tristeza virus*) has been known in Italy for more than fifty years (Russo, 1956; Barbagallo, 1965, 1966a, 1966b) a few studies have been carried out in our country on the ability of the various aphid species to transmit viruses, on the mode of transmission, on the diffusion of virus diseases according to the bio-ethological characteristics of the aphid species, etc. In some trials conducted in Italy by Cartia *et al.* (1980), *A. gossypii, A. spiraecola, A. craccivora* and *T. aurantii were* not able to transmit CTV. However, it is notorious that in the

citrus-growing areas of other countries, *A. gossypii, A. spiraecola* and other aphid species have proved to transmit CTV although less efficiently than *T. citricidus* (Kirkaldy), the most efficient tristeza vector (Lim and Hagedorn, 1977). Few years later, Davino and Patti (1986) and Davino *et al.* (1990) showed that also the Italian populations of *A. gossypii* were able to transmit CTV under restricted environment. More recently, Davino *et al.* (2004) stated that *A. gossypii* is the main responsible for CTV dissemination in the Sicilian citrus groves, with a 5% increase of infected plants in two years.

IV – Bio-ethology

With the exception of *T. aurantii*, oligophagous on Citrus and on a few other genera of trees or herbaceous plants, citrus aphid species are highly polyphagous (Barbagallo, 1966b; Patti, 1983 and 1985) and can infest, in some instances, several hundred host species (*A. gossypii* can infest about 700 hosts worldwide). The surveys conducted in the Italian citrus-growing regions on the aphid species and their Citrus hosts could confirm that *T. aurantii* does not prefer any specific citrus species whereas *A. gossypii* and *A. spiraecola* clearly prefer clementine, mandarin and orange trees and to a lesser extent lemon and citron (Barbagallo, 1966b; Patti, 1985). Aphid infestations on lemon and citron are mostly ascribable to *T. aurantii* since these citrus trees are rarely infested by other Aphididae species (Patti, 1985). More detailed information on the bio-ethology of the citrus aphids were reported by Barbagallo (1966a) for *A. spiraecola* and by Barbagallo (1966b) and Patti (1983, 1985 and 1996) for the other species found in Italy. In the Italian citrus-growing regions, various aphid species behave as anholocyclic, sometimes obligate (*T. aurantii*) whereas others, such as *A. spiraecola* and *M. persicae,* can complete the holocycle. In Italy, holocyclic species use citrus trees as secondary hosts since the amphigonic generation never grows on them (Patti, 1983).

Aphid infestations usually turn into pullulation in spring and are less intense in autumn (Patti, 1983).

V – Control

The wide resources of natural antagonists of the aphid species living on citrus were reported by several authors, mainly by Patti (1983) and Longo and Benfatto (1987) for predators and by Stary (1967), Tremblay *et al.* (1978 and 1980) and Marullo (1985) for parasitoids. In a study on the complex of parasitoids of *T. aurantii*, Tremblay (1984) reported seven species of Imenoptera Braconidae highlighting the competition relationship between the prevailing species *Lysiphlebus fabarum* (Marshall) and *Lysiphlebus testaceipes* (Cresson). Surveys conducted in the main Italian citrus-growing regions over twenty years have highlighted that *A. spiraecola* colonies are less visited by the parasitoids with respect to those of other citrus aphid species (Tremblay *et al.* 1978 and 1980). Liotta (1988), apart from evaluating the parasitization activity of *Aphelinus chaonia* Walker at the detriment of *T. aurantii*, gave evidence of the importance of the host-feeding activity of the entomophagan.

For the protection of the natural enemies Barbagallo and Inserra (1974) suggest integrated control strategies along with a reduced application of selective aphicides.

As for integrated control measures, Stary (1964 and 1967) suggested that *Pittosporum tobira* (Thunb.) W.T. Aiton hedges should be replaced with oleander, willows or other species which can favour the development of numerous parasitoids without hosting aphid species (mainly *T. aurantii*) likely to infest the Italian citrus groves. By adopting integrated control measures and maximising the action of entomophagans, Ortu and Prota (1983) could limit the populations of aphids and of other citrus pests with a few insecticidal treatments.

For the control of *A. spiraecola*, 5% and 10% thresholds of infested shoots have been proposed on clementine and sweet orange respectively whereas the threshold can equal 25% for the control of *A. gossypii* and *T. aurantii* infestations (Cavalloro and Prota, 1983; Patti, 1983; Zappalà, 2001). In Sardinia, Delrio *et al.* (1981) adopted thresholds equalling 10-15% of shoots infested by *A. spiraecola*.

Pertaining to aphicides, over the years nicotine sulphate and quassia-wood have been adopted (Silvestri, 1939), along with white oils, whose low impact on the entomophagans in Calabria was highlited by Micieli De Biase (1975), phosphorus esters and carbammates (Barbagallo, 1966a; Patti, 1983), imidachloprid (Micieli De Biase and Russo, 1996; Nucifora, 1998), acetamiprid (Domenichini and Roffeni Tiraferri, 1998).

For the control of aphid species on citrus plants grown in the nursery, the following active ingredients are now used: : imidachloprid, methomyl, pymetrozine+thiamethoxan, thiamethoxan, tau-fluvalinate (Di Franco and Benfatto, 2007).

As to the biological control of citrus aphids, Tumminelli *et al.* (2004) cast light on the efficacy and selectivity towards natural enemies of a mixture of paraffin oils, pyrethrins and rotenone.

Finally, mention shall be made of the side effects of insecticides on the useful arthropodofauna. Bernardo and Viggiani (2000) could show that pymetrozine, an insecticide active against various phytomyzae, having a new mode of action and thought to be selective towards the entomophagans, is highly toxic on the parasitoids and on the adults of *Rodolia cardinalis* (Mulsant) and spares just the pre-imago stages of the Coccinellid.

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