Chapter

Valorization of Olive Mill Wastewater in the Control of *Aphis pomi* De Geer 1773 (Hemiptera, Aphididae) Infesting Apple Plants in Nurseries

Nahid Haouache, Soukaina El Asri, Adil Asfers, Abdelhadi Ait Houssa, Bouchra Tazi and Ahmed Boughdad

Abstract

Olive mill wastewater (OMW), are the liquid residues generated during the extraction of oil by traditional and modern three-phase type crushing units. These effluents are characterized by an acidic pH and composition rich in water, organic matter, minerals and polyphenols. In general, they are directly discharged into natural ecosystems. Their danger is linked to the enormous quantities produced in a short period between October and March. To mitigate the effects of vegetable waters on the environment, their valorization in different areas is discussed. As biopesticides, crude OMW have been shown to be very toxic to *Aphis pomi*; the LC50 and LC95 varied respectively from 27.17 to 45.59 and from 77.19 to 134.57 mg of OMW/L of water; they vary according to the stage of the aphid considered. The young stages of *A. pomi* were more sensitive than the elderly are. Therefore, the OMW can be used as a means of controlling aphids. However, before operating on a large scale, it is necessary to repeat the trials in field and assess their impact on non-target organisms and treated crops.

Keywords: Olive Mill wastewater, Biopesticides, *Aphis pomi*, Apple plants, Nursery

1. Introduction

In Morocco, with an area of 49731 ha and an annual production of 809762 t [1], apple cultivation is exposed to the pressure of various harmful biological agents; approximately 182 synthetic pesticides are registered against these organisms [2]. Aphids are small, soft-bodied insects with long, slender mouthparts used to pierce stems, leaves and other tender parts of plants and, suck up sap from the host plant. They are among the most dangerous pests of crops; they directly weaken plants by sucking their sap; these results in curling and deformation of the leaves of young shoots, which affects the photosynthetic function of the attacked plant. Among the indirect damage, aphids are vectors of many phytopathogenic viruses and the secretion of honeydew favoring the development of sooty mold on leaves and fruits [3, 4]. The green apple aphid, *Aphis pomi* De Geer (Hemiptera, Aphididae) is 1.3–2.3 mm long and light green or yellowish green in color, with short antennae and black or dark brown siphunculi; asexual development goes through 4 Nymphs and an adult (**Figure 1**). It is a monoecious holocyclic species, i.e., the aphid has one sexual generation and several asexual (parthenogenetic) wingless and /or winged generations; they grow on the same plant species or on plants of related species. The aphid is widely distributed in the northern hemisphere [5]. This species is very harmful to pome fruit (Rosaceae), especially apple trees; its infestations are rife regularly. The species is particularly harmful in nurseries and young orchards. To control aphids, apple growers only use synthetic insecticides; thus, 82 pesticides are registered against aphids [2]; these pesticides are broad spectrum and effective against many pests other than aphids; they mainly belong to the groups of organophosphates, carbamates, pyrethroids and neonicotinoids. However, the intensive use of these products raises health, environmental and ecotoxicological problems (e.g., [6–8]). The use of these pesticides also generates resistance phenomena in pests [9–11]. In addition, they can cause the resurgence of secondary pests [12]. This latter phenomenon is characterized by a reversal of the biological response such as the shortening of the duration of the development, the increase in fecundity with fertility and longevity due to the application of the sublethal doses of the pesticides used [13]. Besides the unwise use of pesticides increases the mortality of natural enemies that contribute to pest control [14, 15]; which increases the cost of production and affects the efficiency of the techniques applied and the environmental sustainability of the agroecosystem [16].

To mitigate the ecotoxicological, environmental and social consequences of synthetic pesticides; the research for effective, economical, safe and ecological alternative methods compatible with sustainable development is therefore imperative. In other words, adopt the concept of integrated pest management (IPM) [17, 18]. Among the products likely to replace synthetic pesticides and, at the same time reduce pollution of natural ecosystems; valorization of OMW in plant protection responds well to this dilemma.

Around the world, there are more than 800 million productive olive trees, occupying an area of 10 million hectares; olives are used either as table olives or for the production of olive oil. Global table olive production was 2900000 tons,

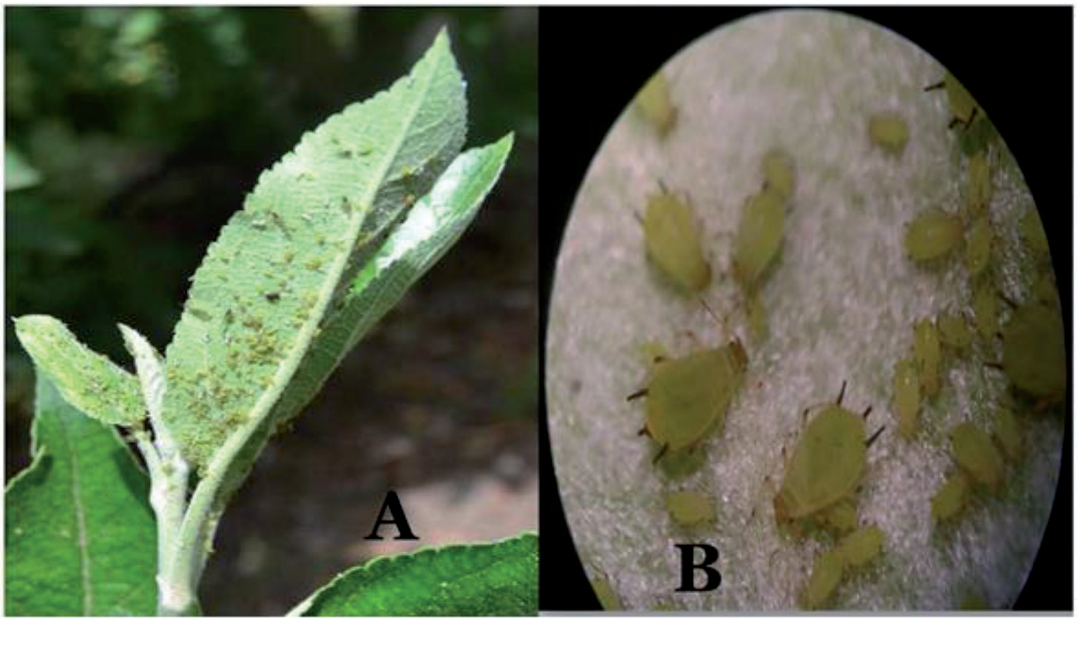

Figure 1.
Colony of Aphis pomi on an apple plant (A) and magnified 35 times under a stereomicroscope (B).

of survivors; their toxicity depends directly on their polyphenol content [46]. Tested on the Mediterranean fruit fly (*Ceratitis capitata* (Wiedemann) (Diptera, Tephriditae), the polyphenolic fractions of OMW inhibit egg hatching and female fecundity without affecting larval development [49]. Overall, from all the studies cited in this paragraph, it emerges that the toxicity caused by OMW depends mainly on their polyphenol content (*op. Cit.*). In addition, although, the biochemical modes of action of OMW have not yet been elucidated in insects, the high levels of phenols present in vegetable water could block the transmission of nerve impulses [66, 67]. However, in this case, it is not excluded that the vegetable waters contained insecticides, in this case organophosphates and/or carbamates, used against the olive fly and which inhibit acetylcholinesterase (eg, [68]).

5. Conclusions and perspectives

Rejected agricultural by-products offer multiple opportunities for recovery and have significant potential not only in the agricultural and agrifood sectors but also in plant protection. In fact, in this work, crude OMW tested against *A. pomi* were effective in reducing the level of their populations to economically tolerable levels. However, the effect of products tested in nursery pest management must be compatible with integrated pest management (IPM) concept. Since, some plant producers also carry out augmentative releases of natural enemies (Unpublished data). Therefore, like conventional pesticides, risk assessment of side effects of OMW is still necessary ([17, 18]; the evaluation of the effects of OMW on non-target organisms must include both lethal and sublethal effects (e.g., [14, 15]). In the event that the natural enemies bred massively and purchased by plant producers, their releases must be carried out outside the treatment periods. It is also possible to spray against pests with OMW outside the activity of natural enemies; preferably during vegetative rest against overwintering forms.

Moreover, knowing that OMW can also show phytotoxicity [69], an evaluation in this direction is planned. Our work can help to enhance the use of MOW to control the green apple aphid among other pests while integrating the ecological services provided by beneficial organisms in agroecosystems, and at the same time avoid the harmfulness of OMW. At the industrial level, the large-scale direct extraction of polyphenols for the production of biopesticides would result in high added-value. The identification and quantification of the constituents of polyphenols with their biochemical modes of action in treated pests should precede the economic estimation of pest control based on OMW and their polyphenols.

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