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Preliminary results of comparative efficacy evalutation trials against *Philaenus spumarius* L., vector of *Xylella fastidiosa*

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The meadow spittlebug *Philaenus spumarius* L. is currently considered as one of the most common insects in the world; the species is ubiquitous and widely polyphagous. *P. spumarius* has never been associated to significant direct damage on agricultural and ornamental crops, thus no specific control measures targeting this insect species have been so far developed. However, within the xylem-feeders, this species has been considered as one of the potential vectors of *Xylella fastidiosa* in the European and Mediterranean countries; a hypothesis unfortunately confirmed upon the finding of *X. fastidiosa* outbreaks in southern Italy, associated to a novel severe disease of olive, the quick decline syndrome (OQDS). So far *P. spumarius* is the only ascertained EU vector of *X. fastidiosa*.

The fact that both *P. spumarius* and *X. fastidiosa* are associated with a large number of woody and herbaceous plants and that *P. spumarius* turned to be an efficient vector of *X. fastidiosa* and the most abundant species of *Auchenorrhyncha* are detected in the olive orchards in the infected area (Cornara *et al*., 2016; Ben Moussa *et al*., 2016) poses major risks related to the rapid spread of the *Xylella*-induced disease. An integrated pest management strategy aimed at reducing the juvenile and adult spittlebug populations is extremely urgent for suppressing the vector population. A good control of the nymphs of *P. spumarius* can be achieved when they still feed on weeds by mechanical interventions, which have limited environmental impact. At this stage the interventions are highly effective as the insects do not harbour the bacterium yet. Conversely, the control of the adult population requires the use of insecticides. No active compounds are currently registered in Italy for the control of *P. spumarius* and no data are available on the efficacy of any insecticide for the control of this species. In 2015 and 2016, a 120-day temporary registration was granted to a formulation based on a citrus oil extract. Therefore in 2015, four field trials were set up in the infected area of Salento to evaluate the effectiveness against *P. spumarius* of different organic and chemical insecticides. All trials were carried out in semi-field conditions, with a randomized block and 6 replicates per trial. Each replication was made of an olive branch caged with insect net, in which a pre-fixed number of insects was introduced. Ten adults of *P. spumarius* were introduced in cages before application 3 and 7 days for all trials, with the exception of one trial in which a single introduction was performed, before application, with 20 adults of a spittlebugs.

Insecticides were selected on the basis of previous experiences reported in the literature for the control of other *Auchenorrhyncha* (*Aphrophoridae* and *Cicadellidae*) (Akey *et al*., 2001, 2002; Bezerra-Silva *et al*., 2012; Grafton-Cardwell *et* al, 2003; Janse and Obradovic, 2010; Purterka, 2002, Redak and Bethke, 2003), while taking into account the guidelines drawn up by the Puglia Region in 2014 upon the emergence of *X. fastidiosa* epidemics. A total of twelve different formulations based on active compounds belonging to different chemical/ organic families and with different mechanisms of action and translocation were tested. The doses tested were defined based on maximum doses at which these formulations are currently used for the control of other sucking insects. The treatments were performed by spraying the entire canopy with motor pumps

that supplied the equivalent of 1,500 L/ha, with the exception of a formulation based on sweet citrus oil in trial D, for which a volume of 2,000 L/ha was used, to ensure a good distribution of the product on the olive canopy. In all trials, four inspections of the cages were carried out, 3 (DAT_3 (days after treatment)), 7 (DAT_7), 10 (DAT_{10}) and 15 (DAT_{15}) days after the application of the insecticide. During each inspection, living and dead insects were counted; living adults were left in the cages whereas dead adults were removed. The data recovered were used to calculate the percentage of mortality based on total individuals introduced for each trial in the cages and the effectiveness index calculated on the cumulative value of living insects.

Under our experimental conditions neonicotinoids (acetamiprid and imidacloprid) and pyrethroids (deltamethrin and *lambda*-cyhalothrin) showed a high mortality rate, followed by etofenprox which gave similar results but with slightly more gradual action. The formulations containing these active substances showed a persistence of about a week that rapidly decreased ten days after the application. The action of both formulations based on dimethoate was poor and slow in time. No toxicity effects against the spittlebugs were recorded using buprofezin and pymetrozine; unexpectedly for its mobility in the plants, also using spirotetramat. Among the organic compounds tested, extract of citrus oil showed very low mortality when applied at the volume of 1,500 L/ha, while a good insect mortality was observed when applied at the volume of 2,000 L/ha. In both trials natural pyrethrin showed very low mortality, while no toxicity effect was recorded using azadirachtin; indeed, no persistence was recorded for any of these compounds.

Altogether, these results provide preliminary evidence on the efficacy of different formulations for their potential use for the biological and integrated control of *P. spumarius* toward the implementation of the containment strategies for *X. fastidiosa* induced diseases.

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