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USE OF A COMMERCIAL ORGANIC PRODUCT TO CONTROL THE BLACK WEEVIL (*ACLEES* SP. CF. *FOVEATUS*) OF THE FIG TREE

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Lodolini E.M., Nolasco A., Cutino I., Gargani E. - Use of a commercial organic product to control the black weevil (*Aclees* sp. cf. *foveatus*) of the fig tree.

A new alien parasite, *Aclees* sp. cf. *foveatus* (Coleoptera: Curculionidae), is causing considerable crop losses and deaths in many Italian fig (*Ficus carica* L.) tree nurseries and orchards and it is quickly spreading in central Italy. The adult and larval stages of this weevil are closely related to the fig tree. To date, no phytosanitary products are registered for fig against this insect, so if this pest is not systematically managed, fig trees could be decimated. A commercial organic product, LaserTM, widely used on other crops, was used to assess its effectiveness on the adult stage of this weevil. In the first trial, the concentration recommended on the label for other fruit trees was used and compared with the control (only water), while in the second trial a comparison between the label concentration and the half was tested. Mortality of the adults was recorded in the following 3-4 days after treatment. A very high adult mortality was recorded when LaserTM was applied, even at lowest concentrations, and damages (erosion) on the sycons were strongly reduced compared to the control. The tested commercial product is very effective in controlling this pest and can represent a possible solution by significantly reducing the adult population.

KEY WORDS: *Ficus carica*, Spinosad, *Saccharopolyspora spinosa*, fruit erosions, adult stage

INTRODUCTION

In 2005, the presence of a new exotic insect, causing severe damages to common fig trees *Ficus carica* L. (CIAMPOLINI *et al.*, 2005) was reported for the first time in Italy. *Aclees* sp. cf. *foveatus* Voss 1932 is a curculionid native of Asia (BENELLI *et al.*, 2014). Between 2005 and 2007 it was found in many areas of the Tuscan provinces of Pistoia and Lucca where several cultivated and wild fig trees are present (CIAMPOLINI *et al.*, 2008; BENELLI *et al.*, 2014). After noting the acclimatization at European level, this phytophagous has been recognized as a highly harmful insect on *Ficus carica*, on which the insect seems to be strictly associated (CIAMPOLINI *et al.*, 2005; 2008). To date, the species is quickly spreading in Northern and Central Italy. In the area of Carmignano (Prato Province, central Italy), well known for its typical production of dried figs, the economic losses due to the death of the trees are considerable (GARGANI *et al.*, 2018). Likewise, in the fig germplasm collection located at CREA - Research Center for Olive, Fruit and Citrus Crops in Rome, the number of the registered dead trees due to the attack of this pest has rapidly increased in the last two years.

The damages caused by the black weevil concern epigeal, hypogean and xylematic portions of the tree. The adult injures the epigeal parts by mainly eroding the sycons (infructescences, Fig. I, 1) but also the soft

wood of the vegetative sprouts, the leaf blades and sometimes the petioles (CIAMPOLINI *et al.*, 2005; 2007). The xylophagous larvae instead produces the greatest damage, by digging tunnels in the woody tissues at the base of the trunk and eroding the internal structure of the tree in a disordered manner (Fig. I, 2 - 3).

Before the complete decay of the internal wood caused by the larvae, the epigeal portion of the plant shows desiccations, vigor reductions and leaf drop (CIAMPOLINI *et al.*, 2005; 2008) (Fig. II). Although many years have passed since the first report of this alien pest in Italy, the knowledge on the methods for its control is still limited. As indicated by CIAMPOLINI *et al.* (2008), a non-selective action, in terms of use and application times, of chemical pesticides is not decisive and would not stop the infestations of adults from outside, as well as being a not sustainable pest control system. Thanks to their studies, interesting results were obtained with contact products, first of all the pyrethroids, obtaining a reduction of the mobile forms and of the pre-imaginal active stages reached by the product for the channeling in the ground and in the excavation of the infested wood (CIAMPOLINI *et al.*, 2008). Subsequently, GARGANI *et al.* (2017) discovered the first natural enemy in our environments: an entomopathogenic fungus, *Beauveria bassiana*, associated with *A. sp. cf. foveatus* and very effective on adult specimens.

Fig. I - Typical erosion of sycons caused by *Aclees* sp. cf. *foveatus* adults (1) and galleries excavated by xylophagous larvae that lead to the death of the fig tree (2-3).

Fig. II - Effects of the larvae damage in the epigeal portion of the fig trees.

New strategic approaches, testing innovative formulations (montmorillonite based clays, either in their native state or containing copper (II) species, and clinoptilolite zeolites) that could have an impact on the selection of the target plant by the insect by masking the chemical signals of the host plant, are also tested in laboratory and in fields trials (GARGANI *et al.*, 2018), obtaining remarkable results.

The objective of this study was to improve the knowledge about organic control methods and to evaluate the effectiveness of a commercial organic product to control the adult stage of the black weevil of the fig.

MATERIALS AND METHODS

Two lab-scale trials were conducted between August and September 2019 in the Ecophysiology Laboratory of CREA - Research Center for Olive, Fruit and Citrus Crops, Rome.

The adults of *A. sp. cf. foveatus* used for the experiments were captured from the fig germplasm collection located at CREA experimental farm in Rome. During field monitoring at the end of July, the captured insects were $n = 22$ adults while, during a second trial conducted in early September, $n = 30$ adults were captured. The periods when the surveys were conducted coincided with the maximum reproductive activity and with the intense feeding of the adults (CIAMPOLINI *et al.*,

2007). The distinction based on the sex ratio of the insects was carried out during the second experiment at the laboratories of the CREA - Research Center for the Protection and Certification of Plants in Florence.

FIRST TRIAL

Two preliminary experiments were performed with the same methodology with the aim to test the effect of Laser™ (Dow AgroSciences Italia srl, Milan, Italy) on the invasive black weevil. This biological product is based on *Spinosad*, an active ingredient produced by the bacterium *Saccharopolyspora spinosa* naturally present in the soil (KIRST *et al.*, 1992). This commercial product was tested on a total of $n=22$ adults of *Aclees* ($n=10$ for the first experiment and $n=12$ for the second round, respectively) and a 30 ml hl^{-1} dilution was compared with deionized water (Control). Laser™, never tested before on fig, was diluted to the recommended concentration reported on the label for other fruit trees species such as apple, pear, etc. The treatment and the water for control were applied with a manual sprayer on a cutting apical portion of fig branch of about 12 cm long with at least two fruits, leaves and shoots. Each portion of the treated branch was placed in a plastic box (16 cm $\times$ 15 cm $\times$ 11 cm) with $n=5$ and $n=6$ adults of unsexed *Aclees* sp. cf. *foveatus* for each of the two theses in the first and second experiment, respectively. Afterwards, the boxes were closed with perforated lids and kept at lab climatic conditions: average temperature of 27 ± 1 °C, relative humidity of $51 \pm 2\%$ and natural light:dark cycle (L:D about 16:8). Insect mortality was monitored every 12 hours for 3 days.

SECOND TRIAL

Two different dilutions of Laser™ were prepared: a) 15 ml hl^{-1} and b) 30 ml hl^{-1} and they were compared with deionized water (as Control). The treatments were applied with a manual sprayer on cutting apical portions of fig shoots with sprouts, fruits and leaves. The insects were randomly and individually placed in plastic cups (12 cm diameter, 16 cm depth) containing a previously treated fig branch, for a total of 10 adult black weevils per each dilution (total of 30 adults). The plastic cups were closed with perforated stoppers and kept at a temperature of 26 ± 1 °C, relative humidity of $46 \pm 3\%$ and under a natural light:dark cycle (L:D about 16:8) for 4 days. Insect mortality was checked every 12 hours for 4 days.

RESULTS

The results obtained in the two trials confirmed the high efficacy of the commercial product Laser™ in controlling the adult of *Aclees* sp. cf. *foveatus*. In all the conducted experiments, abnormal behaviors of the insects were registered (feeding stop and spasmodic movements) and in 3-4 days after the treatment of the shoots, the black weevils treated with Laser™ died (regardless of the applied concentration).

In both experiments conducted during the first trial, the mortality of 100% was achieved in weevil adults subjected to Laser™ at 30 ml hl^{-1} dilution in 72 hours after treatment, with $n=5$ and $n=6$ dead adults, respectively. The erosions on the shoot, leaves and fruits were clearly visible for the Control while were strongly reduced for the Laser™ (Fig. III) confirming the effect of the applied organic product as inhibitor of the feeding activity of the black weevil immediately after ingestion.

Control (deionized water).
72 hours after the treatment.

Laser™ 30 ml hl^{-1} .
72 hours after the treatment.

Fig. III - Difference of erosions on the sycons in the control and Laser™ treatment.

Results of the second trial, where two different Laser™ dilutions were tested, were useful to confirm the effectiveness of the organic product and to evaluate the reaction time and the mortality level of the weevil. The first collateral effects on the weevils were recorded 48 hours after the application of both concentrations of the organic product. At the beginning of the third day after the treatment, the first dead *Aclees* sp. cf. *foveatus* was recorded for the highest Laser™ concentration. After 60 hours, 50% mortality was recorded for the insects subjected to Laser™ 30 ml hl⁻¹ and after 72 hours 7 and 2 adults died, for the concentration 30 and 15 ml hl⁻¹, respectively.

The trial ended after 96 hours when the 90% of the insects died at the highest concentrations of Laser™ and the 70% at the lowest one. The trend of the weevils'

mortality per each applied treatment is reported in Fig. IV. The number of dead weevils divided by gender (male:female ratio was 30 to 70% for the Control, 20 to 80% for Laser™ at 15 ml hl⁻¹ dilution and 60 to 40% for Laser™ at 30 ml hl⁻¹) and subjected to the respective treatments, is reported in Fig. V. The still alive insects after 96 hours after treatment per each respective Laser™ concentration were mostly immobile and with imperceptible spasms. No dead weevils were registered for the Control during the trial period. The sycons did not appear very damaged, regardless of the concentration of the organic product sprayed on the apical portion of the fig shoot. As a consequence, it is clear that Laser™ was able to cause insect death in a few hours after ingestion at the tested concentrations.

Fig. IV - Adult mortality analysis of *Aclees* sp. cf. *foveatus* treated with two Laser™ concentrations (second trial): Laser™ 30 ml hl⁻¹ is represented by the dotted-gray line and Laser™ 15 ml hl⁻¹ by the dashed-black line.

DISCUSSION

In this study, an organic product never registered on fig for the control of *Aclees* sp. cf. *foveatus*, was tested for the first time. Very promising results were obtained applying the commercial organic product Laser™: a concentration of 30 ml hl⁻¹ induced a 100% mortality of the *Aclees* adults after 72 hours after the treatment (two preliminary experiments in the first trial) and a mortality of 90% after 96 hours (second trial). Moreover, thanks to the use of two different concentrations of the product in the second trial, it was demonstrated that even low

dilutions (15 ml hl⁻¹) are able to cause a high mortality on weevil adults (70%).

As Spinosad is a macrolide insecticide that activates nicotinic acetylcholine receptors, the insects, especially those subjected to a higher concentration of Laser™ (30 ml hl⁻¹), showed symptoms of stop feeding and spasmodic movements. This product, being rapidly absorbed by ingestion, is able to block and kill the weevil in less time than the entomopathogenic fungus *Beauveria bassiana* (GARGANI *et al.*, 2017). This latter, despite

Fig. V - Percentage of dead weevils divided by gender in each applied concentration in the second trial 96 hours after the treatment.

causing the mortality of 100% of the *Aclees* adults subjected to the test, takes about 7 days to reach the lethal time to 50% (LT₅₀) compared to the 60-84 hours for Laser™ to obtain the LT₅₀ (average value of the two dilutions tested in the second trial).

The study conducted by SALGADO (1998) describes the symptoms of a cockroach after the ingestion of Spinosad and they are very similar to those noted on the black weevil of the fig tree during our study. Initially, it causes involuntary contractions of the muscles and tremors and after a period of hyper-excitation induced by prolonged use of the product, the insect becomes paralyzed. Therefore, products based on Spinosad should be seriously considered for the organic control of the black weevil of the fig because they are very effective in controlling the adult and can represent a possible solution by significantly reducing the populations. The combined use of other agronomic and biochemical control methods such as contact products and the *Beauveria bassiana* fungus can certainly increase the effectiveness of Spinosad-based products.

Furthermore, to better understand the potential of the tested product (Laser™), further studies are required to evaluate the methods and the periods of application in the open field and in the nursery. In order to optimize the application periods, it is also important to understand the residual time of the product on the sycons based on the fruit ripening and the harvest stage. Further studies are equally important to increase the knowledge of the behavior and nutritional needs of the *Aclees* sp. cf. *foveatus* adults in order to find new effective methods to control the species.

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