Effects of an azadirachtin-based compound on the host-parasitoid interactions between the Mediterranean fruit fly, *Ceratitis capitata* (Diptera: Tephritidae) and the braconid wasp *Psyttalia concolor* (Hymenoptera: Braconidae)

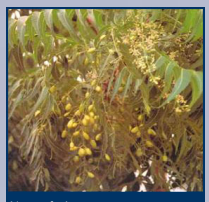
Giuseppe Carbone[1], Massimo Cristofaro[2], Carlo Tronci[1], Fortunata Minelli[2] and Antonino Fenio[1]

1. Biotechnology and Biological Control Agency
Via del bosco, 10, 00060, Sacrofano (Rome), Italy
e-mail: info@bbca.it;

2. ENEA Centro Ricerche Casaccia, UTS BIOTEC-SIC
Via Anguillarese, 301, 00060, S. M. di Galeria, Italy
email: massimo.cristofaro@casaccia.enea.it

1. Neem and azadirachtin

Azadirachtin is probably the most well known bioactive secondary metabolite produced by the neem tree, *Azadirachta indica* (Meliaceae).
This compound shows high toxicity for phytophagous insects, acting as a feeding deterrent and sterilant, interfering with insect growth regulation, gland neurosecretory activity and chitin synthesis.



Neem fruits

2. *Psyttalia concolor*

Psyttalia concolor is an oligophagous braconid wasp parasitizing several tephritid pests including the medfly, *Ceratitis capitata* and the olive fruit fly, *Bactrocera oleae*.
The wasp has been released as a biocontrol agent in the Mediterranean Basin, Hawaii and Central America,

Psyttalia concolor adult

3. The medfly

C. capitata is one of the most important fruit pests in tropical and subtropical regions of the world.
Its well known life cycle and ease of rearing make the medfly an excellent model for the present study.

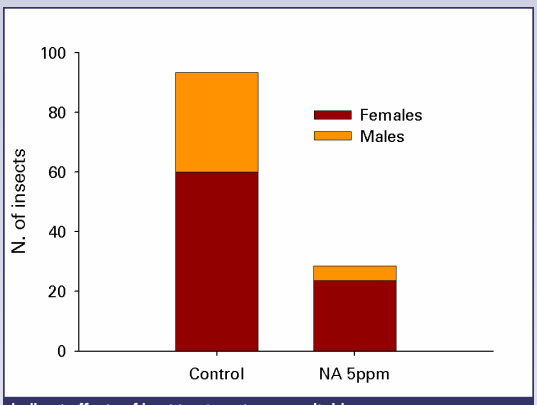
Female Mediterranean fruit fly

4. Objectives

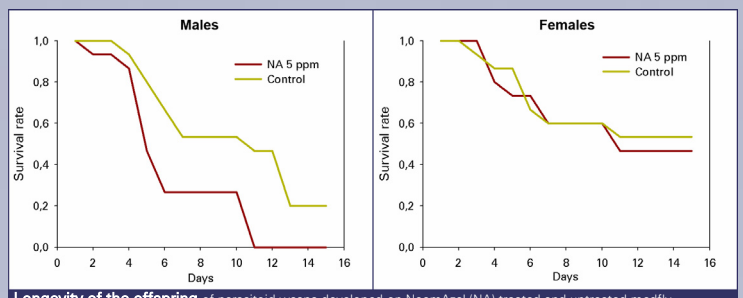
Although neem-based products are widely used in least-toxic, sustainable integrated pest control practices, the effects of azadirachtin on beneficial insects, such as parasitoids and predators, are still unclear, and subject of controversial opinions in the scientific community.
In the present work, the host-parasitoid system between the medfly and *Psyttalia concolor* has been studied to elicit the existence of indirect effects of an azadirachtin-based treatment of the host, on the life-cycle of the parasitoid. NeemAzal, a commercial azadirachtin formulate (Trifolio-M, Lahnau, Germany), was used (content in azadirachtin, 50.000 ppm).

5. Indirect effects

As a first step we evaluated the rate of development and the longevity of the F1 of a laboratory strain of *P. concolor*, parasitizing medfly larvae developed on azadirachtin treated larval medium.
The medfly larval medium was treated with a 5 ppm NeemAzal solution, previously selected as the optimal concentration to obtain the highest rate of larvae unable to complete the metamorphosis (unpublished data).
Results showed that the braconid wasp was able to normally complete its life-cycle on treated medfly larvae, and to produce fertile offspring, although a significant reduction in fecundity and males longevity was observed.



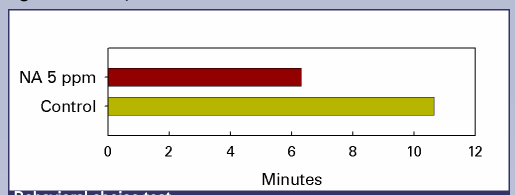
Indirect effects of host treatment on parasitoid
Total number of *P. concolor* adults emerged from medfly larvae treated and untreated with a 5 ppm NeemAzal (NA) solution



Longevity of the offspring of parasitoid wasps developed on NeemAzal (NA) treated and untreated medfly larvae (15 days)

6. Choice tests

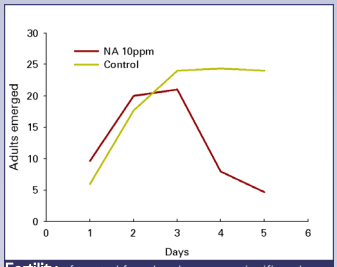
Behavioral choice tests were carried out in order to test host preference of *P. concolor* ovipositing females, between treated and untreated medfly larvae. Results showed that females spent significantly less time to find and oviposit into treated medfly larvae, indicating that host treatment with azadirachtin does not affect the chemicals involved in host individuation. Such unclear preference may be ascribed to a minor motility of treated larvae allowing faster oviposition.



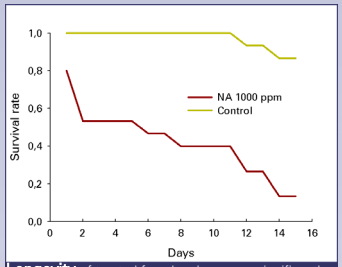
Behavioral choice test
Females used less time to find and oviposit into treated larvae

7. Direct effects

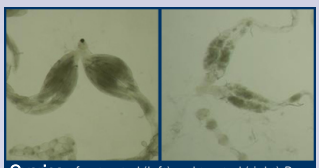
The fertility and longevity of *P. concolor* adults directly treated with azadirachtin through the feeding medium, showed a significant reduction, highlighting similar effects to those reported for phytophagous insects. These results were confirmed by hystological observations of the ovaries of treated females which showed high levels of degeneration.



Fertility of treated females decreases significantly after the 3rd day of treatment with NeemAzal 10 ppm



Longevity of treated females decreases significantly only at higher NeemAzal concentrations



Ovaries of untreated (left) and treated (right) *P. concolor* females (NeemAzal 1000 ppm)

8. Conclusions

This work showed that azadirachtin treatment of the host affects only partially the parasitoid allowing it to complete its life-cycle. Remarkable effects of azadirachtin on the braconid life-cycle were evidenced only upon direct treatment of the insects through the feeding medium.
In this framework, it is possible to assume that field applications of azadirachtin-based pest control strategies appear to be safe for beneficial insects and therefore, to sustain the synergistic use of this bioinsecticide with biological control agents.