

SESSION IV
MICROBIALS FOR IPM PROGRAMS

Efficacy of *Beauveria bassiana* strain ATCC 74040 against whiteflies on protected tomato and compatibility with *Nesidiocoris tenuis* and *Orius laevigatus*

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The efficacy of *Beauveria bassiana* strain ATCC 74040 (Naturalis[®]) against whiteflies (*Trialeurodes vaporariorum* and *Bemisia tabaci*) on tomato was tested in two greenhouse trials. Furthermore, the compatibility of the formulated product with two beneficial insects, *Nesidiocoris tenuis* and *Orius laevigatus*, commonly used in Mediterranean greenhouses, was evaluated in semi-field trials. The microbial control agent confirmed its efficacy against whiteflies on greenhouse tomato, already evidenced in previous studies, and affected survival of none of the two species of beneficials. These studies suggest that *B. bassiana* strain ATCC 74040 can be used for the control of whiteflies in greenhouses in combination with *N. tenuis* and *O. laevigatus*.

Efficacy of commercial strains of *Bacillus thuringiensis* in controlling *Tuta absoluta*: laboratory tests

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Several commercially available strains of the entomopathogenic bacteria *Bacillus thuringiensis* (Bt) were tested to evaluate their efficacy in controlling *Tuta absoluta*, in terms of larval mortality, reduction in larval feeding activity and subsequent damage. Tests were conducted on *T. absoluta* young larvae under laboratory and extended laboratory conditions, both after ingestion and topical application. The mortality rate, the number of infested leaflets and the amount of infested surface per each leaflet were recorded. The formulation containing the strain *kurstaki* SA12 resulted the most effective in controlling *T. absoluta* in terms of induced mortality as well as damage reduction, both in the topical and ingestion toxicity trial. Similar trend, although without significant differences, was recorded in the extended laboratory trial.

Red clover as a model plant for studying the effects of fungicide and biological treatments to control *Calonectria* diseases

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The efficacy of 12 fungicides, applied alone and in mixtures at different rates, and 8 biological control agents (BCAs) were evaluated in 9 assays to test their ability to reduce infections caused by *Calonectria morganii* and *C. pauciramosa* on the host-model plant *Trifolium pratense*. Overall, good results were obtained with prochloraz + cyproconazole, thiophanate-methyl, Cu hydroxide and *Trichoderma* spp. against collar and root rot caused by both pathogens. In detail, propamocarb + fosetyl-Al, azoxystrobin, cyproconazole, K phosphite and fosetyl-Al were the most effective fungicides for reducing *C. morganii* infections. Of the BCAs, *Clonostachys roseae* and *Penicillium oxalicum* were effective for controlling *C. morganii* infections, while *Bacillus subtilis* QST713 and *Streptomyces griseoviridis* K61 were not effective.

Field evaluation of the nucleopolyhedrovirus preparation Littovir[®] against the cotton leafworm *Spodoptera littoralis*

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Littovir[®] is a new nucleopolyhedrovirus-based insecticide for the control of the cotton leafworm, *Spodoptera littoralis*, which can cause severe damage on many horticultural and ornamental crops. Over the last years, numerous studies have been conducted to evaluate the efficacy of the product against this target pest. The results obtained in the most recent trials, conducted on strawberry, lettuce and bell pepper, are reported. Littovir[®] always resulted in a significant reduction of *S. littoralis* damage in comparison to the untreated control, with efficacy values being comparable to those of the reference treatments. Due to its favourable toxicological and ecotoxicological profile and the absence of MRL requirements, the microbial control agent can be considered a valuable tool to be included into organic and integrated plant protection strategies and in resistance management programs for *S. littoralis*.

Larvicidal effect of plant extracts on *Tuta absoluta* (Lepidoptera: Gelechiidae)

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Seven plants (*Thymus vulgaris*, *Ricinus communis*, *Ononis natrix*, *Peganum harmala*, *Argania spinosa*, *Urtica dioica*, and *Lawsonia inermis*), collected in the Souss valley, were tested for their insecticidal effects on the larvae of *Tuta absoluta* under laboratory conditions. After maceration in ethanol, the extracts were obtained by using rotary evaporator. For each extract, the concentrations 100%, 20%, 10%, 2% and 1% were prepared for bioassays on the larvae of *T. absoluta* according to the "Leaf-dip bioassay" method. The results showed that the extracts have varying toxicity on the larvae. The extracts that showed the highest rate of mortality were those of *T. vulgaris* leaves (95%) and the seeds of *R. communis* (58%) in response to 46667 mg/l and 77500 mg/l concentrations, respectively. The other plant extracts had a moderate larvicidal effect. In fact, *O. natrix*, *P. harmala*, *U. dioica*, *L. inermis* and *A. spinosa* caused respectively 45%, 43%, 42%, 32% and 28% of mortalities. The LD₉₀ of these extracts revealed that the ethanol extract of *T. vulgaris* was the most toxic (LD₉₀ = 89383 mg/l).

Biocontrol of the tomato pinworm *Tuta absoluta* (Lepidoptera: Gelechiidae) in Egypt

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The three microbial control agents *Bacillus thuringiensis* var. *kurstaki* (Bt), *Beauveria bassiana* (Bb) and *Metarhizium anisopliae* (Ma) were tested against tomato pinworm *Tuta absoluta* (Lepidoptera: Gelechiidae) under laboratory and greenhouse conditions. The results showed that under laboratory conditions, the LC₅₀ values was 243.9 U_g/ml for Bt, 129.4×10^4 spores/ml for Bb, and 98.7×10^4 spores/ml for Ma. Under greenhouse conditions, the LC₅₀ values corresponding to microbial control agents were 211U_g/ml (Bt), and 102×10^4 (Bb) and 100×10^4 (Ma) spores/ml. Under laboratory conditions, the percentage of egg parasitoid *Trichogramma evanescens* decreased after treatments with *M. anisopliae* to 93.2% as compared to 98.2 in the control. Under greenhouse conditions, the mean infestation significantly decreased to 9.8 ± 9.9 and 10.8 ± 11.9 individuals after treatments with Ma and Bb respectively as compared to 21.7 ± 8.6 individuals in the control.

Evaluation of a *Helicoverpa armigera* nucleopolyhedrovirus product and its potential for use in protected and open field crops

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The cotton bollworm, *Helicoverpa armigera* remains one of the most damaging pests with economic importance in many vegetable and ornamental crops in southern and south-eastern European countries. This lepidopteran species is predominantly a pest in a large range of outdoor crops, but can also cause severe damage in protected crops, for example in pepper or tomato. Resistance against some chemical substances, such as pyrethroids or organophosphates, is reported in different European countries, and alternative and specific insecticides are needed to ensure an effective control of the cotton bollworm in the future.

Nucleopolyhedroviruses belong to the family of baculoviruses that are considered to be one of the most promising microbial control agents against lepidopteran pests. They are highly virulent for its host and absolutely harmless for the environment and non-target organisms. Helicovex[®], a *Helicoverpa armigera* nucleopolyhedrovirus-based bioinsecticide, has been developed by the company Andermatt Biocontrol AG for the specific control of the cotton bollworm larvae. The efficacy of Helicovex[®] has been assessed in numerous field trials from 2006 to 2011 and compared to reference products according to EPPO guidelines and GEP principles. Results of these field studies are discussed in the presented poster.

Helicovex[®] has been applied at rates of 100 and 200 ml per hectare. The efficacy on damage control ranged between 68 and 89% in protected tomato and pepper crops, and between 51 and 100% in various open field crops (lettuce, tomato, pepper, sweet maize and green beans). Helicovex[®] is highly effective, non-toxic, harmless to non-target organisms and leaving nil residues on the crops, which make it a valuable tool for cotton bollworm control and offer new and important solutions for organic or integrated plant protection strategies. Helicovex[®] is currently evaluated for registration in several European countries, and has been already granted provisional approval in Italy and Greece.