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IPM Systems

- Consequences of the wide scale implementation of biological control in greenhouse horticulture in Almeria, Spain.
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- The economic benefits of adopting integrated pest management in protected pepper, chrysanthemum and strawberry crops.
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- Biological control of important pests on vegetable crops in Polish greenhouses
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- Prerequisites for tomato and potato ecological farming in Ukrainian steppe
M. M. Kharytonov, I. M. Loza, S.M. Garmash, D.G. Pfeiffer.....25-30

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Progress with biological control and IPM strategies in protected cultivation in Brazil

V. H. P. Bueno, M. Poletti.....31-36

Abstract: A pilot program of biological control in commercial greenhouses for strawberry and azalea crops with releases of the predatory mites *Neoseiulus californicus* and *Stratiolaelaps scimitus* against the spider mite *Tetranychus urticae* and the fungus gnat *Bradysia matogrossensis*, respectively, proved successful. These actions stimulated growers to use biological control more intensively. In addition, the use of *Phytoseiulus macropilis* and *Orius insidiosus* were also the focus for several crops under protected cultivation. The implementation of biological control programs in greenhouse crops is beginning to be developed as a commercial activity in Brazil.

Relationship between cultural practices and infestation of potato crops by the potato tuber moth

S. A. Salem, M. Y. El-Koly, A. M. E. Abd-El-Salam.....37-40

Abstract: The potato tuber moth *Phthorimaea operculella* is one of the most important pests of potatoes in the field and in stores world-wide. The target pest is active throughout the year but it is most active from May to August. Many cultural practices that are used by farmers to improve the yield can also protect the tubers from or limit the development of the potato tuber moth. However, to control the pest, farmers depend mainly on the use of chemical insecticides. Ideally, there is a need to integrate pest management practices in potato fields and stores. Control of the potato tuber moth in stores was found to be more effective if infestation in fields was kept to a minimum. Low infestation at harvest and rapid handling of the yield that goes into store established good initial storage conditions and low post-harvest losses. Time and depth of seed plantation played an important role in tuber infestations. Larval densities in foliage and tubers were significantly higher at the margins of the field than in the centre.

Integrated fungicidal control programs to maximize economic return on tomato production in Albanian greenhouses

J. Tedeschini, H. Pace, I. Papingji, D. Pfeiffer.....41-44

Abstract: This research project evaluated the performance of tomato disease control under four different disease control programs ranging from a minimally acceptable to a highly intensive program. These four disease control spray programs were compared on the basis of cost and disease management as well as the environmental impact. These experiments were carried out in Lushnja region (Albania) during 2007 for the first crop of tomato cultivation. The standard fungicide program remains the most efficacious recommendation. It gave better results against the main tomato diseases than the other programs and had no significant differences with intensive program. However, it was more expensive than the control and low cost programs but less expensive in cost and with lower environment impact than intensive program.

Plant and Soil-borne diseases

Evaluation of a simple and inexpensive method for disinfestation of water used in recirculated water systems in California

M. P. Parrella, T. C. Costamagna, M. Nagata, J. MacDonald, L. Bolkan.....47-50

Abstract: The availability of high quality water is now at a crisis level in California. The most inexpensive way to create water is to conserve and reuse it. Many of the glasshouse operations in California are exploring ways of doing this, but there is a concern over the quality of the reused water, particularly with respect to plant pathogens. For the past year, we have been evaluating the

use of chlorine dioxide as a safe and inexpensive method for water disinfection. Chlorine dioxide was evaluated for control of *Phytophthora sp.*, *Pythium sp.*, *Colletotrichum sp.*, *Fusarium sp.*, *Alternaria sp.* and *Cylindrocladium sp.* – important plant pathogens in most recirculating water systems. When bioassays were conducted in clean water, 0.1ppm was completely effective against zoospores of *Phytophthora sp.* and *Pythium sp.*, and 0.1-0.2ppm was needed to control *Colletotrichum sp.* and *Fusarium sp.* Concentrations of 0.2ppm did not completely inactivate *Cylindrocladium sp.* and there was 40-50% viability of *Alternaria sp.* fungal spores at 0.6ppm. Bioassays were also conducted in ‘cloudy’ pond water from a commercial nursery, and as expected, a much higher concentration of chlorine dioxide was required to overcome the ‘demand’ presented by the particulate/organic matter in the water. Nonetheless, once this demand was satisfied, we obtained similar pathogen control as in clean water. We believe that chlorine dioxide may provide an inexpensive and safe alternative for water disinfection, provided that some sort of filtering is in place to reduce the load presented by ‘cloudy’ irrigation water.

Baseline sensitivity of *Botrytis cinerea* to pyrrolnitrin, an antibiotic produced by several biological control agents

S. Ajouz, M. Bardin, C. Troulet, G. Riqueau, V. Decognet, C. Leyronas, A.S. Walker, P. Leroux, P.C. Nicot.....51-56

Abstract: To establish a distribution of baseline sensitivity of *Botrytis cinerea* to pyrrolnitrin, an antibiotic produced by several biological control agents, 166 isolates collected from different crops were tested for sensitivity to pyrrolnitrin using a spore germination assay. Baseline EC₅₀ (effective concentration to reduce spore germination by 50% comparing to the control) was determined. The results showed that the isolates exhibited a wide range of sensitivity to pyrrolnitrin, with a 8.4-fold difference in EC₅₀ values between the least and the most sensitive isolates (from 0.0038 µg.ml⁻¹ to 0.032 µg.ml⁻¹). For all the isolates tested, the conidial germination was completely inhibited by pyrrolnitrin at doses above 0.1µg/ml. The efficacy of the pyrrolnitrin-producing *Pseudomonas chlororaphis* PhZ24 strain was tested *in vitro* on Petri plates and on tomato plants with isolates of *B. cinerea* having different EC₅₀ values. Whatever the EC₅₀ value of the isolates tested, no significant differences in sensitivity were observed towards this bacterium suggesting an absence of resistance to this biological control agent within *B. cinerea* isolates.

Biological control of bacterial pathogens which attack plants for durable agriculture

M. Pamfil, M. Moscovici, M. Oprea, A. Stefaniu, G. Savoiu, T. Caraiani.....57-59

Abstract: In order to obtain microbial antagonists, ten bacterial strains were isolated from nature: cereals, wood leaves, medicinal plants, weeds, etc. Three strains of *Bacillus subtilis* were selected that had strong antagonistic activities towards pathogenic bacteria (85-95%) after tests carried out on vegetables and vines. The strains had a high rate of sporulation, and the spores had the capacity of releasing antibacterial lipoprotein substances with an antibiotic function. The effect of the microbial antagonists was studied in the laboratory and in the greenhouse against strains of *Erwinia carotovora*, *Xanthomonas vesicatoria*, *Agrobacterium tumefaciens*, and *Pseudomonas syringae*. Antagonists obtained from microbial cultures of *Bacillus subtilis* had the important advantage of also acting as biostimulators for the plants, compared to the controls. Bacterial products were obtained by biosynthesis using different substances as substrates: corn steep extract as a source with a low amount of carbon and a high level of growth factors, mineral substances and microelements. Fermentation studies were carried out with the isolated strains that showed the highest antimicrobial activities, in order to follow the growth and protection of bioactive compounds. For combating plant diseases, integral bacterial cultures, dried biomass or supernatant from one or more strains of *B. subtilis* could be used with very good results on pathogenic bacteria. Compared with chemical products, biological products have the following advantages: they do not pollute the soil and rivers, and, therefore, flora and fauna; they are harmless for man and animals; they have a great capacity for controlling certain phytopathogenic bacteria; the residual waters which result from fermentation and manufacture of bacterial cultures to the final product do not pollute the surrounding environment.

Potential use of botanical fungicides against grey mould and powdery mildew in greenhouse grown vegetables

E. Markellou, A.E. Kalamarakis, A.M. Kasselaki, N. Dafermos,, E. Toufexi,, C. Leifert, F. Karamaouna, S. Konstantinidou-Doltsinis.....61-66

Abstract: In eighteen trials performed in different regions of Greece in greenhouse-grown tomato, cucumber and zucchini plants, weekly applications of a) Milsana[®], b) a microencapsulated mixture of eugenol, thymol and geraniol and c) a mixture of canola oil derivative and thymus oil, significantly reduced powdery mildew severity on leaves by 40-42% and grey mould severity on leaves by 30% in all trials. A significant increase of cucurbit yields was observed following Milsana[®] applications. Similar effects were not observed in the tomato/*Leveillula* pathosystem. The applications of the aforementioned botanicals had no impact on tomato vegetative growth and on quality parameters of fruits (concentration of antioxidants). Aspects related to the mode of action of the aforementioned botanicals are discussed.

Reduction of the corky rot infection by soil solarization in greenhouse tomato production in Albania

H.Paçe, J. Tedeschini, D. Pfeiffer.....67-70

Abstract: Increasing concern for the environment in Albania has stimulated the research for environmentally sound disease control including soil-borne fungal management under farm conditions. Hence, the effectiveness of soil solarization for corky root (*Pyrenochaeta lycopersici*) management in two naturally infested plots of tomatoes in Lushnja region were evaluated using transparent polyethylene (PE) mulches during July-August of 2008. After land preparation, the moist soil was covered with transparent mulches and two other plastic houses were left uncovered as a control. The soil temperature was measured up to 20cm depth. The transparent mulches significantly increased the soil temperature which results in proper control of corky root disease and increase in tomato yield. Results obtained so far indicated that the maximum temperatures of 51.0-52.4°C were observed at a depth of 20cm in the heavy clay soil type in Kemishtaj and Goricaj (Lushnje). The native fungal populations in covered moist soil were significantly reduced in comparison with uncovered treatment. At the end of harvest season the incidence of *P. lycopersici* was 1.7-1.9% and 100% respectively. In the soil solarization treatment the severity of root damage was 1.1 compared with 4.0-5.0 registered in the control. The difference in root fresh and dry weights between plants grown in solarized soil were 40.2-43.5gr, 7.5-9.1gr and in the untreated control were 15.8-20.0gr, 3.1-3.4gr that was used as a measure of overall root damage by the soil borne pathogen. The method was also responsible for a significant increase in yields (about 4 fold), as well as for improving the growth of tomato plants. Based on these encouraging preliminary results, it is recommended the solarization method for soil-borne management in plastic houses as an environmentally sound profitable and easy agricultural practice which should be implemented in Albania.

Ecofriendly management of root-knot nematode *Meloidogyne incognita* in Albania

V. Jovani, J. Tedeschini, A.Ramadhi, D. Pfeiffer.....71-76

Abstract: Tomato and lettuce cultivation in Albania are susceptible to infection by soil-borne diseases and severe yield losses can result. The effectiveness of solarization, a soil disinfection technique that use passive solar heating, to control the incidence of root knot nematode under greenhouse condition was studied during the second crop of the years 2007-2008 in Lushnja and Durres regions. Solarization was accomplished by the application of 0.05-0.06 mm clear polyethylene sheets to moist soil for 4-weeks during the hot season. The treatment increased maximum soil temperature of more than 50°C at 20 cm below the soil surface, whereas this temperature was not reached at all in un-mulched soil. In solarized soil, no galls were found on tomato roots. The treatment reduced nematode populations more than 90% on tomato and lettuce. In non-solarized plots, the infestation was present at a high density, with decrease plant growth and crop production. Tomato fruit yield was three fold higher in the solarized soil as compared with the non solarized treatment. The yield of lettuce was about two fold higher in solarized soil as compared with untreated control. Based on these results, we suggest that solarization, which prevents chemical contamination and is suitable for organic farming, is an appropriate technology where the risk of nematode infestation is high in the second crop.

Whiteflies

Integrated pest control using indoor screenhouses within plastic greenhouses

D. Janssen, M^a.C. García, A. Belmonte, F. Pascual, T. García, G. Bretones, F. M. Gil, I. M^a. Cuadrado79-84

Abstract: Common polyethylene-covered greenhouses from the Mediterranean area are deficient for insect exclusion. Therefore, an insect-proof nethouse was designed and installed within traditional greenhouses from Almeria, Spain. Performance for cucumber crop protection against whitefly *Bemisia tabaci*, *Cucurbit yellow stunting disorder virus* (CYSDV) and *Cucumber vein yellowing virus* (CVYV) was evaluated during three consecutive autumn seasons from 2006 to 2008. The amounts of the pest, as well as percentages of plants showing symptoms of virus disease, were reduced in the insect-proof greenhouses. Also, the apparent area under disease progress rate was lower in the case of CYSDV. It is concluded that screenhouses can be introduced into traditional greenhouses, offering pest exclusion and insect-vectored plant diseases, compatible with IPM.

Field evaluation of physical and chemical means for the management of TYLCD and its vector *Bemisia tabaci* on greenhouse tomatoes

M. Nannini, A. Sirigu85-90

Abstract: The effectiveness of TYLCD management strategies based on chemical control of vectors or the integration of chemical (insecticide and plant activator applications) and physical (use of non-woven floating covers) measures was evaluated in a field experiment carried out on greenhouse tomatoes in the south of Sardinia (Italy). The use of floating covers and intense insecticide applications significantly reduced the incidence of the viral disease in comparison with the other experimental treatments. Also the effects of acibenzolar-S-methyl (ASM) were significant, but to a lesser extent. A combined use of non-woven fabric and the systemic acquired resistance elicitor ASM demonstrated a viable and reliable option for the management of TYLCD and its vector *B. tabaci*.

Bionomics of *Encarsia inaron* parasitizing *Bemisia tabaci* in Israel.

D. Gerling, N. Rejuan91-96

Abstract: The polyphagous species *Encarsia inaron* is known as a parasitoid of the Ash whitefly *Siphoninus phillyreae*. It attacks also many other whitefly species including *Bemisia tabaci*. Following the spontaneous invasion of our greenhouses by this species, we examined the biology of *E. inaron* as a parasitoid of *Bemisia tabaci* in the greenhouse. Parasitoids lived up to 21 days, laid an average of 56.77 eggs/female and developmental duration on *B. tabaci* was 12-17 days at 25°C. The developmental duration of the parasitoids on the two whitefly hosts is similar but *E. inaron* lays fewer eggs and lives shorter as a parasitoid of *B. tabaci* than as a parasitoid of *S. phillyreae*. The low oviposition rate in comparison with *B. tabaci* may preclude its effective use in controlling that pest.

Efficacy of nematodes for biological control of the whitefly *Bemisia tabaci* (Hem.: Aleyrodidae) in a pepper crop

A.L. Ruiz-Platt, T. Cabello97-101

Abstract: The virulence and efficacy of three species of nematodes: *Steinernema feltiae*, *Heterorhabditis bacteriophora* and *S. carpocapsae* were evaluated in immature stages of the whitefly *Bemisia tabaci*, under controlled conditions in peppers. All nematode species mentioned were able to penetrate the whitefly nymphs. However, virulence evaluated by the penetration of infective juveniles, had very low values of below 26%, whereas the more developed stages of the nymph were more susceptible than the less developed. Equally, mortalities found in early nymph stages (I-II instars) were very low: 37.96% or 17.44%, for *H. bacteriophora*, 35.26% for *S. carpocapsae* and 18.48% for *S. feltiae*.

Resistance to neonicotinoid insecticides in the greenhouse whitefly, *Trialeurodes vaporariorum*

N. Karatolos, K. Gorman, M. Williamson, R. Nauen, R. Ffrench-Constant, I. Denholm103-106

Abstract: *Trialeurodes vaporariorum*, also known as the greenhouse whitefly, is a serious pest of protected vegetable and ornamental crops in Europe. Neonicotinoid insecticides are important tools for controlling this pest, although resistance has been documented and may be becoming widespread. Mortality rates of UK and Mediterranean populations of *T. vaporariorum* to a range of neonicotinoids were calculated and significant resistance was found in some of those strains. The development of insecticide resistance management tactics is important in order to suppress the potentially increasing problem of neonicotinoid resistance.

Insecticide tolerance of *Eretmocerus mundus* populations collected in commercial vegetable greenhouses

S. Malo, J. Riudavets, R. Gabarra.....107-112

Abstract: *Eretmocerus mundus* is a natural enemy able to control efficiently the whitefly *Bemisia tabaci* in greenhouses as well as in open fields in the Mediterranean basin. The susceptibility to imidacloprid and deltamethrin was tested on populations of this parasitoid collected in five commercial greenhouses periodically sprayed with wide spectrum insecticides. Insecticides were selected based on their common use to control the whitefly *B. tabaci* in vegetable crops. *E. mundus* adults and pupae were tested using the glass bottle bioassay method and the topical application test, respectively. *E. mundus* adults showed no tolerance to imidacloprid and only pupae of one population were slightly tolerant. Significant tolerance to deltamethrin was shown by adults and pupae of all parasitoid populations, with mortalities below 50% in comparison to 100% mortality observed in the susceptible population. No significant differences in mortality within adults and pupae of each population were observed, indicating that tolerance to deltamethrin was similar in adults and pupae. The results indicated that *E. mundus* had the capacity to develop high levels of tolerance to deltamethrin that probably depended on the past selection pressure exerted by insecticide treatments applied in the area in which they were collected.

Mites

Genetic diversity of the invasive tomato spider mite *Tetranychus evansi* (Acari: Tetranychidae) in the Mediterranean basin, assessed by sequences of the ribosomal internal transcribed spacers (ITS).

A. Boubou, A. Migeon, K. Lebdi-Grissa, M. Navajas.....115-119

Abstract: The tomato red spider mite *Tetranychus evansi* was first discovered in 1952 in north-east Brazil (Silva, 1954), where the species probably originated. The mite is now present in many parts of the world and it is considered as an invasive species in Africa and in the Mediterranean basin. It is an important pest of solanaceous crops. In this study, we present the current distribution map of *T. evansi* in the Mediterranean basin based on both bibliographical records and samples obtained in this work. The genetic variation of the nuclear ribosomal Internal Transcribed Spacer (ITS) region (1137 nucleotides) was estimated based in sequences obtained from mites collected in different localities from several countries around the Mediterranean perimeter including, Algeria, Greece, France, Israel, Italy, Spain and Tunisia. Two types of ITS sequences were obtained which clearly separate the samples in two main groups. One gathers all individuals from the French and Spanish Catalonia. All the rest of the Mediterranean *T. evansi* samples gather in a second group. Our results show that this mite is well established in the Mediterranean basin being a serious threat to both outdoor and protected cultivation of solanaceous crops in this region. The obtained molecular data suggest that there were two ways of introduction and dissemination of this mite around the Mediterranean basin.

Forecasting population dynamics of mites from scouting and climatic data on greenhouse cut roses

R. Boll, A. Bout, C. Poncet.....121-126

Abstract. Applied integrated pest management (IPM) often leads to many simultaneous tritrophic interactions. For crops in a greenhouse, this complexity renders mechanistic and practical models impossible. In order to take more advantage of the scouting information, we suggest a parsimonious predicting model. This model uses easily gathered variables from endogenous and exogenous crop factors. The study at hand refers to the two-spotted spider mite

Tetranychus urticae, which was the main arthropod pest encountered during the test period. Numerous candidate predictors are tested in a non-parametric regression model to forecast qualitative abundance classes, which are defined to observe mites on stems. Weekly scouting gathers four biotic predictors, which provide a viable one-step-ahead prediction, and one basic climatic predictor. All predictors are coded into factors. The global state of crop infestation is calculated based on predictions that are taken from each sampling zone of a regular grid. Space and area estimates provide us with free additional information that can be helpful in the overall decision making process. Incorrect and especially delayed predictions have to be studied further to make this a reliable method.

Evaluation of an anthocorid predator, *Blaptostethus pallescens* against two-spotted spider mite, *Tetranychus urticae*
 C. R. Ballal, T. Gupta, S. Joshi, K. Chandrashekhar.....127-132

Abstract: The two-spotted spider mite *Tetranychus urticae* (Acari: Tetranychidae) is a very serious pest of many crops in temperate and tropical climates. Several of the attempts to control this mite by using chemical insecticides have failed mainly because of development of pesticide resistance. Though several natural enemies have been recorded as potential predators of *T. urticae*, the predator used most often has been the phytoseiid mite *Phytoseiulus persimilis*. Earlier studies have also indicated that anthocorid predators are effective biological control agents of spider mites. An anthocorid predator *Blaptostethus pallescens* (Heteroptera: Anthocoridae) was collected from the field and successfully multiplied on the eggs of the rice moth *Corcyra cephalonica*. Laboratory studies indicated that *B. pallescens* could feed on 190 and 116 *T. urticae* nymphs during its nymphal and adult stages, respectively. In the net house studies, there was a 78% reduction in the mite population in the treated bhendi plants (*Abelmoschus esculentus*) where the anthocorid releases were made, in comparison to control indicating that *B. pallescens* is a promising candidate to control two spotted spider mites.

Effect of hunger period and prey density on foraging behavior of *Scolothrips longicornis*
 N. Kheradpir, M. Maleki.....133-137

Abstract- There is increasing evidence that host plant's features can be used as reliable indicators for location behavior of natural enemies. The predaceous thrips *Scolothrips longicornis* was used into two release and recapture tests by different host plants, infested by different densities (50, 100 and 300 individuals per plant) of spider mites and experienced different hunger periods (4, 8 and 12 hours). The response of predaceous thrips toward different densities of prey was significant and high number of preys (300) attracted the most predators. On the other hand, hunger period affected *S. longicornis* efficiency. It was generally concluded that the predator locates spider mites colonies by the host plants signals enhanced by prey density and last experience of feeding.

No-choice prey stage preference and functional response of *Scolothrips longicornis* (Thysanoptera: Thripidae) on *Tetranychus urticae* (Acari : Tetranychidae)
 H. Pakyari, Y. Fathipour139-144

Abstract: Prey-stage preference and functional response of the predatory thrips *Scolothrips longicornis* for the two-spotted spider mite *Tetranychus urticae* were studied in 24 h laboratory experiments at 26±2°C, 60±5% RH and 16:8 L:D. Results showed that spider mite eggs were the most preferred stage with approximately 12 being eaten per day. *S. longicornis* had no preference between nymphs and adults of the spider mites, the consumption being approximately 7 individuals per day. Using a logistic regression, a type II functional response was determined for *S. longicornis*. The Holling and Rogers models were used for estimating searching efficiency (*a*) and handling time (*T_h*) and, based on the *R*² values data, were better fitted by the Rogers equation. The estimated values of searching efficiency and handling time were 0.0694 ± 0.007 h and 1.616 ± 0.043 h, respectively.

Control of Broad Mite, *Polyphagotarsonemus latus* and the Whitefly *Bemisia tabaci* in Open Field Pepper and Eggplant with Predaceous Mites
 P. A. Stansly, J. Castillo145-152

Abstract Broadmite *Polyphagotarsonemus latus*, and the sweetpotato whitefly, *Bemisia tabaci*, are serious pests of pepper and eggplant in Florida and elsewhere. Both pests have been controlled in greenhouses by *Amblyseius swirskii*, and broad mite has been controlled by *A. cucumeris*. However, little has been reported regarding the effectiveness of these Phytoseiid mites in eggplant or in open field crops of any kind. We evaluated both species of predaceous mite in eggplant and ‘Serrano’ pepper in experimental plots in southwest Florida, and also assessed control of broad mite in ‘bell’ pepper on a commercial farm in the same region. Both mites provided significant levels of control of broad mite on both crops, although fewer releases of *A. swirskii* were necessary and it achieved better control when both mites were compared directly. In addition, *A. swirskii* controlled *B. tabaci* which is an especially important pest of eggplant in this region. Both pepper and eggplant receiving *A. swirskii* yielded significantly more fruit than untreated plants or even eggplants receiving two acaricide sprays in 2007. However, the cost of releasing *A. swirskii* in eggplant exceeded average insecticide costs by a factor of 2 or more. Furthermore, *A. swirskii* did not provide adequate control of the spidermite *Tetranychus urticae*, another important pest of this crop in south Florida. Therefore, further research is warranted to define lower effective rates of *A. swirskii* and combinations with spidermite specific predators.

Thrips

Quick pest and disease scouting to implement IPM in greenhouse rose crops

A. Bout, R. Boll, C. Poncet 155-160

Abstract: Integrated pest management (IPM) strategies treat and manage crop as an ecosystem, including plants, pests, and beneficial insects. Researchers and growers need to go beyond replacing toxic chemicals with biological agents. They need to understand precisely how, when, and why these alternatives should be used. The first step towards this goal is a constant monitoring of the overall crop health. To this end, the study at hand recommends a quick visual sampling method for all main bioaggressors that can be found on greenhouse rose crops. The scouting is founded on a global abundance classes system and takes into account the ecological traits of the pests’ communities. All potential pests were treated with the same scouting action. Furthermore, we tested a method for reducing initial sampling grids without losing crucial information on pest distributions on the crop.

A comparison of precision and economic efficiency for three methods of thrips population density assessment

A. Sutherland, T. Costamagna, A. Melicharek, M. Nagata, M. P. Parrella 161-166

Abstract: Western flower thrips, *Frankliniella occidentalis*, is a major pest and vector in many parts of the world. Methods for assessing thrips population density for pest management decision support are often inaccurate and/or imprecise due to thrips’ positive thigmotaxis, small size, and naturally aggregated populations. Two established methods, flower tapping and an alcohol wash, were compared to a novel method, plant desiccation coupled with passive trapping, using precision and economic efficiency as comparative variables. Flower tapping was the least expensive method, in terms of man-hours, while the alcohol wash method was the most expensive. Precision, expressed by relative variation, depended on location within the greenhouse, location on greenhouse benches, and the sampling week, but was generally highest for the flower tapping and desiccation methods. Economic efficiency, expressed by relative net precision, was highest for the flower tapping method and lowest for the alcohol wash method. Advantages and disadvantages for all three methods are discussed. Additionally, the difference between accuracy and precision is discussed in terms of insect population density assessments, pest management and pesticide efficacy.

Frankliniella occidentalis capture on blue and yellow sticky traps treated with floral compound mixture thrips attractant (Thrips-Lure) in greenhouses

C. Kazak, K. Karut, Ch. Chu, A. Arslan 167-170

Abstract: *Frankliniella occidentalis* is considered to be among the main pests in horticultural crops in Turkey, including vegetables and fruits. In this study, the effect of floral compound

mixture Thrips-Lure when in conjunction with blue and yellow sticky traps for the attraction of *F. occidentalis* was studied under greenhouse conditions on cucumber and pepper in Southern Turkey. In 2007, significantly higher numbers of adult *F. occidentalis* were captured on blue sticky traps with or without the lure treatments from 2+ to 9+ days compared to yellow sticky traps on cucumber. In 2009, similar to the cucumber experiment, the highest adult *F. occidentalis* capture was in the lure-treated blue sticky traps on sweet pepper. This was followed by non-treated blue, treated and non-treated yellow sticky traps. Mean cumulative adult catches on treated blue sticky traps was statistically different from the other 3 traps, 10 days after trap placement. Further greenhouse and field experiments are warranted for catching *F. occidentalis* and other thrips species.

Suivi de la dynamique des populations de thrips à l'intérieur et à l'extérieur d'une serre de rosier à l'aide de pièges jaunes englués

J. Pizzol, P. Hervouet, D. Nammour, S. Voisin, M. Ziegler.....171-176

Abstract: Thrips species *Frankliniella occidentalis* and *Thrips tabaci* [Thysanoptera: Thripidae] are two important pests of greenhouse rose crops in the south of France. Thrips catches on yellow traps placed outside reach their peak 2 to 3 weeks before the thrips infestation peaks inside the greenhouse. The rapid increase in the number of thrips captured on the traps outside the greenhouse can be explained partly by warmer temperatures. In the same way, the observation of peak catches in these traps 3 weeks earlier in 2006 than in 2005 can be also explained by higher temperatures.

Management of thrips (Thysanoptera: Thripidae) on strawberries in north-western Italy: biological control and damage evaluation

L. Bosco, M. Baudino, L. Tavella.....177-182

Abstract: Thrips of the genera *Frankliniella* and *Thrips* are considered worldwide to be the major pests of strawberries, even if the extent of their damage is unclear to date. To assess the involvement of thrips in fruit deformation of late-season strawberries in a Piedmontese area of north-western Italy, thrips populations were monitored in six commercial plastic polytunnels, where a high percentage of deformed fruits have been recorded in the past decade. Thrips were also monitored in an experimental field divided into plots, to compare two different management strategies: biological control with the release of *Orius majusculus* and chemical treatments. In the commercial polytunnels, thrips infestations were very low. However, intensive insecticide applications reduced natural enemies, in particular phytoseiid mites, thereby causing severe outbreaks of spider mites. In the experimental field, thrips and *Orius* densities were very similar in the biological and chemical trials. In both plots, thrips infestations were kept under economic thresholds, and the native anthocorids, mostly *Orius niger*, could thrive on strawberries even in the chemical plot, because it was not disturbed by the few well-targeted insecticide interventions. Moreover, no relation was found between the thrips densities and yield losses and harvest waste, or deformed fruit percentages, showing that thrips were not responsible for damage to strawberries in the surveyed area, which meant that there was no need for any routine control measures.

Control of thrips with *Orius insidiosus* in greenhouse cut roses: use of a banker plant improves the performance of the predator.

V. H. P. Bueno, A. R. Silva, L. M. Carvalho, N. Moura.....183-187

Abstract: Rose production is the strongest component of the cut flower industry in Brazil. On roses, *Frankliniella occidentalis* typically feeds within buds and open flowers. *Orius* species can reach confined habitats preferred by thrips species where they prey on both larvae and adult thrips. This study aimed to evaluate the use of the predatory bug *Orius insidiosus* alone and together with a banker plant, *Tagetes erecta*, to control thrips on fresh cut rose in the greenhouse. Two greenhouse areas measuring 316 m² with a density of 1,200 plants each were isolated in order to develop a pilot program to compare biological and chemical control of thrips. The two thrips species in both areas under biological or chemical control were *F. occidentalis* and *Caliothrips phaseoli*, with *F. occidentalis* being the most important pest. *O. insidiosus* was effective for controlling thrips populations and the carnation plant *T. erecta* showed potential to be used as a banker plant in ornamental crops, such as roses, in conjunction with *O. insidiosus*. *T.*

erecta plants are easily grown and produce seeds and flowers all year round. *O. insidiosus* was found mainly during the flowering period of the banker plant both on rose and on the banker plant. However, it is clear that more information should be carefully considered on the use of the banker plant *T. erecta* in conjunction with *O. insidiosus* releases in biological programs against thrips in protected cultivation in Brazil.

Control of western flower thrips: effects of two predators and treatment for powdery mildew

P. Weintraub, S. Kleitman, S. Pivonia, S. Steinberg 189-194

Abstract: Western flower thrips (WFT) are a primary pest of greenhouse crops worldwide. In organic and IPM control practices, frequently *Orius* spp. are used. However, *Orius* spp. are relatively expensive to produce. In these trials we released *Orius laevigatus* at different rates with or without the predatory mite, *Amblyseius swirskii*. Treatment for powdery mildew was with liquid sulfur. There was no statistical difference in the number of *O. laevigatus* recovered from tunnels in which 2 or 6 individuals were released per m², and there was no difference in thrips control between any of the releases with *O. laevigatus*, strongly suggesting that fewer *O. laevigatus* individuals could be released and still maintain effective WFT control. Thrips populations in tunnels with only *A. swirskii* were intermediate between non-treated control tunnels and the tunnels in which *O. laevigatus* were released. Furthermore liquid sulfur, used to control powdery mildew, did not adversely affect the predators.

Optimization of *Neoseiulus cucumeris* releases against thrips, *Frankliniella occidentalis*, in rose greenhouses

J. Pizzol, A. Gauthier, D. Nammour, L. Mailleret 195-200

Abstract: The predatory mite *Neoseiulus cucumeris* is an efficient beneficial against thrips. This study aims to develop a preventive control method against the thrips *Frankliniella occidentalis* in integrated production of roses in greenhouse. At the same time, the assumption of obtaining a better efficiency by increasing the frequency of releases and by decreasing the amount in every release was to check. Three treatments were carried out in this trial in compartments: a control treatment, without releases (1), introductions of *N. cucumeris* every 4 weeks with the amount of 1 sachet per m² (2) and introductions every week with the amount of ¼ sachet per m² (3). The study showed that for the same number of *N. cucumeris* released, a better efficiency is obtained with more frequent releases and reduced amounts in every release.

Lepidoptera

Tuta absoluta, a new pest in IPM tomatoes in the northeast of Spain

J. Arnó, R. Sorribas, M. Prat, M. Matas, C. Pozo, D. Rodríguez, A. Garreta, A.

Gómez, R. Gabarra 203-208

Abstract: The tomato borer, *Tuta absoluta*, is an important pest native to South America that was first detected in Spain in 2006 and is currently present in several Mediterranean countries. The mirid bugs *Macrolophus pygmaeus* and *Nesidiocoris tenuis* are among the most abundant natural enemies present in tomato greenhouses and open fields (GH/OF) in the Mediterranean, and are commonly used as whitefly control agents, both in inoculative and conservation pest management programs. Experiments were conducted in the laboratory to assess the predation capacity of both mirid species on *T. absoluta* eggs and larvae. In addition, 136 fields were monitored to evaluate pest incidence and the effect of the pest management strategy (pesticides vs. IPM based on mirid use). Data obtained in laboratory experiments showed that *M. pygmaeus* and *N. tenuis* may be important predators of *T. absoluta* eggs but not of larvae. Results from GH/OF sampling indicated that the pest was well established in the area and pest management strategy had a great effect on its incidence. Abundance of galleries and damage in young tomato fruits were significantly higher in GH/OF managed with pesticides than in those where inoculation/conservation of mirid bugs was used as a pest control strategy. The results suggested that mirid bugs may be very useful biological control agents for controlling this invasive pest.

Predation by the mirids *Nesidiocoris tenuis* and *Macrolophus pygmaeus* on the tomato borer *Tuta absoluta*

Ó. Mollá, H. Montón, P. Vanaclocha, F. Beitia, A. Urbaneja209-214

Abstract: The tomato borer, *Tuta absoluta* (Lepidoptera: Gelechiidae) is an important tomato pest native to South America which appeared in eastern Spain at the end of 2006. As a first step to discovering the extent to which two indigenous predators, *Macrolophus pygmaeus* and *Nesidiocoris tenuis* (Hemiptera: Miridae) can adapt to this invasive pest, the prey suitability of eggs and larval instars of *T. absoluta* was evaluated under laboratory conditions. Both predators preyed actively on *T. absoluta* eggs and all larval stages, although they preferred first-instar larvae. Secondly, in a greenhouse trial both mirids were separately inoculated on tomato plants to evaluate their predation on *T. absoluta*. After its installation in the crop, *N. tenuis* was highly effective in controlling *T. absoluta* under these experimental conditions, with reductions of up 97% infestation of leaflets and of 100% of fruits. *Macrolophus pygmaeus* was also effective on this new pest, although its efficacy was lower in comparison to *N. tenuis* (76% and 56% reductions of leaflet and fruit infestation). Our results demonstrate that both mirids can adapt to this invasive pest, contributing to their value as biological control agents in tomato crops. A challenge for future studies will be to investigate how both predators, especially *N. tenuis*, can be used in biological control programs targeting *T. absoluta*.

Preliminary evaluation of *Macrolophus pygmaeus* potential for the control of *Tuta absoluta*

M. Nannini215-218

Abstract: The control effect of the predatory bug *Macrolophus pygmaeus* on the tomato borer *Tuta absoluta*, recently introduced in Italy, was preliminarily evaluated in the laboratory. The mirid bug proved able to reduce pest infestation under most of the experimental conditions tested. However, the reduction in its efficacy observed at decreasing pest densities raises questions about the suitability of the beneficial for biological control programs. Therefore the role of *M. pygmaeus* in the management of the tomato borer on greenhouse tomatoes should be accurately estimated in the field.

The damsel bug *Nabis pseudoferus* (Hem.: Nabidae) as a new biological control agent of the South American Tomato Pinworm, *Tuta absoluta* (Lep.: Gelechiidae), in tomato crops of Spain

T. Cabello, J.R. Gallego, F.J. Fernandez-Maldonado, A. Soler, D. Beltran, A. Parra, E. Vila219-223

Abstract: The use of a new agent for biological pest control, the damsel bug *Nabis pseudoferus*, is being studied for application in Spanish greenhouses. This strict zoophagous insect has been described as an effective predator against aphids and lepidopteran eggs and larvae, although it can feed also on other preys. Preliminary results identify it as a candidate for biological control of the South American Tomato Pinworm, *Tuta absoluta*. Two semifield bioassays on tomato plants under controlled conditions have shown an important reduction (between 92 and 96%) in the number of *T. absoluta* eggs, when releasing 8 or 12 first stage *N. pseudoferus* nymphs per plant. An already known predator of *T. absoluta*, the mirid *Nesidiocoris tenuis*, was also tested, but the young nymphs did not cause any mortality of the pest.

Biological control of the South American Tomato Pinworm, *Tuta absoluta* (Lep.: Gelechiidae), with releases of *Trichogramma achaeae* (Hym.: Trichogrammatidae) in tomato greenhouses of Spain

T. Cabello, J.R. Gallego, E. Vila, A. Soler, M. del Pino, A. Carnero, E. Hernández-Suárez, A. Polaszek225-230

Abstract: The egg parasitoid *Trichogramma achaeae* has been identified as a candidate for biological control of the South American Tomato Pinworm, *Tuta absoluta*. On laboratory conditions a marginal attack rate of 100 % was found and 83.3 % of the parasitized eggs developed until the blackhead stage (apparent parasitism). On greenhouse conditions a high efficacy (91.74 % of damage reduction) was obtained when releasing 30 adults/ plant (= 75 adults/ m²) every 3-4 days on August and September of 2008. This shows that this parasitoid can be a good weapon to control *T. absoluta* on greenhouses of the southeast of Spain.

Physalis peruviana L. (Solanaceae), a host plant of *Tuta absoluta* in Italy

G. Tropea Garzia.....231-232

Abstract: *Tuta absoluta* appeared in Italy in 2008, first in Sardinia, Calabria and Campania, and suddenly later in Liguria and Sicily. It then became widespread very quickly, infesting protected tomato and eggplant crops. In Sicily, it was also recovered in a greenhouse cultivated with Cape gooseberry (*Physalis peruviana*), an ornamental solanaceous crop that has also been grown for edible and medicinal uses.

Parasitism dynamics of *Campoletis sonorensis* (Hymenoptera: Ichneumonidae) as a larval endoparasitoid of the Cabbage looper, *Trichoplusia ni* (Lepidoptera: Noctuidae).

H. Murillo, D. W. A. Hunt, S. L. Van Laerhoven233-238

Abstract: *Campoletis sonorensis* is a native parasitoid of the Cabbage Looper, *Trichoplusia ni* that was found parasitising *T. ni* in multiple field and greenhouse crops in South-western Ontario. *Campoletis sonorensis* is an important factor regulating *T. ni* populations that was the dominant larval parasitoid of *T. ni* in our survey locations with higher rates of parasitism than all other parasitoids combined. *Campoletis sonorensis* demonstrates potential as a commercial biocontrol agent of *T. ni* because *C. sonorensis* populations were chronologically and physiologically synchronized with those of *T. ni*. Thus, adult parasitoids were always available when suitable *T. ni* host stages were present. Additionally, *C. sonorensis* was a positively density-dependent factor in the regulation of the *T. ni* population.

Leafminers and Aphids

Spatial distribution of *Liriomyza sativae* (Diptera: Agromyzidae) in a cucumber greenhouse

M. Haghani, Y. Fathipour.....241-245

Abstract: The vegetable leafminer *Liriomyza sativae*, is known as one of the most serious pests of many vegetable crops and ornamental flowers. The major form of damage is mining of leaves by larvae, which results in destruction of leaf mesophyll. The aim of this study was to determine the spatial distribution patterns of *L. sativae* larvae in a cucumber greenhouse. A sampling plan to estimate the population level of *L. sativae* larvae was developed. Sampling of *L. sativae* larvae started in September 2004, and continued until the end of the growing season. At each sampling occasion, 40 leaves were randomly collected and the number of mines containing *L. sativae* larvae was recorded. The spatial distribution pattern of *L. sativae* was determined using regression models (Taylor's power law and Iwao's patchiness regression). Using the mentioned models, the regression slope was significantly >1, indicating an aggregated distribution of the pest, and implying that large samples were required to obtain density estimates at an acceptable level of precision. These results can be used to optimize monitoring methods for establishing integrated pest management (IPM) strategies against *L. sativae* in cucumber greenhouses.

Population fluctuation of leafminers and their parasitoids in a commercial American lettuce crop in Brazil

A. R. Carvalho, V. H. P. Bueno, D. B. Silva, L. L. Petrazzini, J. Yuri.....247-252

Abstract: American lettuce is a vegetable that is assuming an important role in some municipalities of the southern region of the State of Minas Gerais, Brazil. However, diseases and pests, including leafminers (Agromyzidae), require the constant use of pesticides in order to control them, thereby increasing production costs. This study aimed to gather data on the occurrence of leafminers and their parasitoids in commercial American lettuce crops grown in plastic tunnels. Collections of lettuce cultivar Raider Plus were performed weekly in commercial crops where pesticides were frequently used, in the municipality of Santana da Vargem, MG, Brazil, in two seasons of the year (spring and summer). Leaves showing the presence of mines were placed in Petri dishes (25 cm diameter) lined with moistened filter paper, sealed with plastic film and maintained in an air-conditioned room at 25±2°C and a 12h photophase until the emergence of the leafminer and/or parasitoid adults. Leafminers occurred in larger numbers in the summer than in the spring, with population peaks under mean temperature and RH conditions

of 21.1°C and 89.2%, and 24.4°C and 69.0%, respectively. Parasitism rates were higher in the spring (0-48.8%) than in the summer (1.0-13.3%). Species of the genus *Opius* were also observed to occur in the area. Future studies are needed involving strategies for the conservation of leafminer natural enemies, as well as to provide data on *Liriomyza* species and their associated parasitoids in protected crops in Brazil.

Spatio-temporal dynamics of aphid-transmitted viruses in lettuce crops under UV-absorbing nets

S. Legarrea, A. Fraile, F. Garcia-Arenal, E. Viñuela, A. Fereres253-258

Abstract. Aphid-transmitted viruses frequently cause severe epidemics in lettuce grown under Mediterranean climates. Spatio-temporal dynamics of aphid-transmitted viruses and its main vector were studied on lettuce grown under tunnels covered by two type of nets: a commercial UV-absorbing net (BioNet[®]) and a 50-mesh standard net. Four sealed compartments were included under each type of cover, where a series of ten plants artificially infected by either *Cucumber mosaic virus* or *Lettuce mosaic virus* were transplanted. The same infected-plants were infested by the vector *Macrosiphum euphorbiae*, whose population was monitored at weekly intervals. Infection rate of both viruses were lower under the BioNet[®] cover, probably due to the lower population density or lower dispersal rate achieved by their insect vector. However, spatial distribution of the viruses, which was “at random” once the viruses spread, was not associated to the distribution pattern of the vector. A wide range of interactions among UV-radiation, host plant, viruses and their insect vector should be dissociated and studied deeply to understand the mechanisms underlying the beneficial results obtained when growing lettuce under UV-absorbing nets. Our results show that UV-absorbing barriers are a good option to manage lettuce viruses in protected crops.

Development of the banker plant system to control aphids in protected culture in Japan

E. Yano, S. Nishikawa, M. Yamane, J. Abe259-262

Abstract: To establish the banker plant system with an indigenous strain of *Aphidoletes aphidimyza* to control *Aphis gossypii* on eggplant in Japan using barley seedlings infested with *Rhopalosiphum padi*, we carried out ecological studies on life history and diapause of the predator. We studied the effect of temperature on development and lifetime fecundity and estimated the intrinsic rates of natural increase of a Japanese strain of *A. aphidimyza* reared on *A. gossypii* and *R. padi*. In addition, we studied the effect of photoperiod and temperature on induction of diapause of *A. aphidimyza* in the laboratory, investigated the rate of the induction of diapause under different daylength conditions and estimated the critical photoperiod of diapause. Induction of diapause was completely stopped at high temperatures.

Biotical and abiotical requirements of immature stages of the aphid predator *Sphaerophoria rueppellii* (Diptera: Syrphidae).

R. Amorós-Jiménez, A. Pineda, I. Rocío Steba, A. Fereres M.A. Marcos-García..... 263
Abstract only

Non-chemical control of aphids in protected crops in Albania

E. Çota, A. Isufi.....265-266

Abstract: A number of cultural methods are used for control of aphids in protected crops, as weed removal, insect net around the greenhouse and in ventilation openings. Also, satisfactory results have been obtained by the use of insecticidal soap treatments against aphids during late spring time. The efficiency of natural enemies for biological control of main greenhouse pest was tested in commercial greenhouses. Two commercially available biological agents (*Aphidius colemani* and *Aphidoletes aphidimyza*) were introduced in two commercial greenhouses of tomatoes, aiming to control populations of aphids (*Myzus persicae*, *Aphis gossypii*, *Macrosiphum euphorbiae* and *Aulacorthum solani*). It was observed a considerable decrease of the aphid population. It was proved that there are real possibilities for the effective implementation of biological control in commercial greenhouses.

Quality of the aphid *Aulacorthum solani* for the parasitoid *Praon volucre*

D. B. Silva, Vanda H. P. Bueno, J. C. Lins Jr., L. A. Sidney, A. R. Carvalho267-271

Abstract: In Brazil, *Praon volucre* can be found parasitizing several species of aphids, mostly belonging in the tribe Macrosiphini. This study aimed to evaluate the quality of *Aulacorthum solani* as a host for *P. volucre*. The experiment was conducted in a climatic chamber adjusted to 22±1°C, RH 70±10%, and a 12-h photophase. One *P. volucre* female with a maximum age of 24 hours, mated and without previous oviposition experience was released into a Petri dish containing a lettuce leaf disk (6 cm diameter) in an agar/water solution (1%) and 20 second- and third-instar *A. solani* nymphs. The parasitoid developmental time from oviposition to mummy formation was 7.7 days, and 15.8 days from oviposition to emergence. Immature mortality, parasitism, and emergence percentages were 20.7%; 58.5%, and 79.3%, respectively. The sex ratio was 0.49, with male and female longevities of 14.1 and 11.8 days, respectively. *A. solani* had a tibial length of 0.52 mm at oviposition time (initial stage at the host), and 1.09 mm after mummification (final stage at the host). Tibial length in *P. volucre* was 0.67 and 0.61 mm for females and males, respectively. These results demonstrated that *A. solani* was a suitable host for the parasitoid *P. volucre* under the conditions evaluated.

Evaluation of two entomopathogenic fungi against some insect pests infesting tomato crops in Egypt

M. Sabbour.....273-278

Abstract. Two microbial control agents, *Beauveria bassiana* (*B.b.*) and *Metarhizium anisopliae* (*M.a.*), were evaluated against *Bemisia tabaci* and *Aphis gossypii* in tomato under laboratory, greenhouse and field conditions. Results showed that percentage infestations decreased after treatment with the fungi. Under laboratory conditions, LC50 values for *B. tabaci* were 111.6 x 10⁸ spores/ml for *B.b.* and 122.4 x 10⁸ spores/ml for *M.a.*, whereas the values for *A. gossypii* were 110.1 x 10⁸ spores/ml for *B.b.* and 117.4 x 10⁸ spores/ml for *M.a.* In the greenhouse, LC50 values for *B. tabaci* were 56.4 x 10⁸ spores/ml for *B.b.* and 76.6 x 10⁸ spores/ml for *M.a.*, and for *A. gossypii* they were 68 x 10⁸ spores/ml for *B.b.* and 88 x 10⁸ spores/ml for *M.a.* Under field conditions, the percentage of infested plants with *B. tabaci* and *A. gossypii* significantly decreased after treatments with both *B.b.* and *M.a.*, as compared with the control treatment, on the El-Esraa (Nobaria region) and El-Kassaseen (Ismailia) farms. The tomato yield weight for El-Esraa was 3,487 and 3,448 kg/feddan when *B.b.* and *M.a.* was applied, compared to 1,000 kg/feddan for the control, whereas it was 3,531 kg/feddan for El-Kassaseen when *B.b.* was applied and 3,400 kg/feddan when *M.a.* was applied, as compared to 977 kg/feddan in the control.

Generalist Predators

Selection of refuges for *Nesidiocoris tenuis* (Het.: Miridae) and *Orius laevigatus* (Het.: Anthocoridae): Virus reservoir risk assessment

M. Cano, E. Vila, D. Janssen, G. Bretones, E. Salvador, L. Lara, M. M. Tellez....281-286

Abstract: Preliminary results have identified *Mentha suaveolens* and *Dittrichia viscosa* as promising candidates for use as refuges for enhancing the activity of predators on protected crops. The first one as a refuge for the flower bug *Orius laevigatus* and the second as a refuge for the mirid bug *Nesidiocoris tenuis*, in the southeast of Spain. Augmentative releases of *O. laevigatus* and *N. tenuis* are commonly used on protected peppers and tomatoes, respectively, under IPM programs. However, establishment of these natural enemies is sometimes too slow to avoid pest problems in this area. Samplings of the native vegetal species surrounding greenhouses were conducted to identify the natural host species of these predators. A risk assessment of the identified refuges as possible hosts of pests and viruses that could damage the crops was also completed. Results showed that *M. suaveolens* and *D. viscosa* host high populations of *O. laevigatus* and *N. tenuis*, respectively. No viruses were detected on either refuge and none were able to be infected, either by mechanical inoculation or by whitefly transmission.

Tomato colonization by predatory bugs (Heteroptera: Miridae) in agroecosystems of NW Italy

B. L. Ingegnò, M. G. Pansa, L. Tavella.....287-291

Abstract: In 2007-2008, distribution and population dynamics of Dicyphini (Heteroptera: Miridae) on tomato in Piedmont (NW Italy) were surveyed to assess the presence of these generalist pest predators on tomato, to identify their natural host plants and to observe their movement between wild plants and tomato and viceversa. Samplings pointed out that in horticultural areas, independently of organic or conventional pest management, two species were present: *Dicyphus errans* and *Macrolophus pygmaeus*. In intensively vegetable cropped areas no mirids were found on tomato. By contrast, these predatory bugs were present and often abundant in agroecosystems characterized by ecological corridors rich of wild host plants.

The effects of prey size and mobility on prey selection by the predatory bug *Macrolophus pygmaeus*

D. Maselou, D. Perdikis, A. Fantinou.....293-296

Abstract: The prey selection and predatory efficiency of *M. pygmaeus* were evaluated by using four different prey species: the aphids *Myzus persicae* and *Aphis gossypii*, the greenhouse whitefly *Trialeurodes vaporariorum* and eggs of *Ephestia kuhniella*. The predator was exposed to various combinations of prey species under equal numbers of each single prey type. In addition, biomass obtained by the predator from each prey group was evaluated when it was offered patches of equal biomass of each prey type. According to the results, the predator preferred to feed on *E. kuhniella* and *T. vaporariorum*, a fact that was also supported by Manly's index evaluation. Predatory preference was determined by the small size and immobility of the prey type. It seems that the predator may prefer to feed on those species that may contribute to the lower energetic cost through foraging. When *A. gossypii* was included in the prey patch, the predator obtained a higher amount of biomass from the alternative prey. It appeared that in the treatments where a less profitable prey was found in the patch, the predator targeted more suitable prey.

Functional response analysis of predation by an omnivore predator: effect of hunger level and sex

S. Panagakis, D. Perdikis, A. Fantinou.....297-300

Abstract: The present work was carried out in order to evaluate the consumption rate and the functional response of *Macrolophus pygmaeus*. The predatory efficiency of fifth instar nymphs of the predator was studied on third and fourth instars of the aphid *Myzus persicae*. The effect of different levels of predator hunger level (24 and 48 h on eggplant without prey, as well as 24 h on wet cotton without prey) was investigated. The predator nymphs were maintained after the experiments until adulthood in order to record their sex. Although no significant differences were found for predation between sexes, females were found to consume a higher number of prey after 48 h of hunger. The increase of prey density was associated with an increase in the number of prey consumed. The functional response of *M. pygmaeus* followed a Holling's Type II asymptotic curve in all experimental settings. Saturation of the predator was observed at lower densities in the case that prey size increased. The increase of the predator's hunger and the size of prey resulted in an increased handling time.

Intraguild predation between *Macrolophus pygmaeus* and *Nesidiocoris tenuis*

D. Perdikis, E. Lucas, N. Garantonakis, A. Giatropoulos, P. Kitsis, D. Maselou, S. Panagakis, A. Paraskevopoulos, D. Lykouressis, A. Fantinou301-305

Abstract: The omnivorous predators *Macrolophus pygmaeus* and *Nesidiocoris tenuis* (Hemiptera: Miridae) are important biological control agents of pests on tomato crops. In this study the Intraguild Predation Interactions (IGP) between these two species were investigated. The experiments concerned the effect of hetero-specific treatments on: a) their within plant distribution in the field, b) the distribution on tomato caged plants, c) their behavioral interactions, d) the development of *M. pygmaeus* nymphs when together with adults of *N. tenuis* and e) the effectiveness in biological control. *N. tenuis* was most frequently recorded on the apex but also the upper 4 leaves of the plant whereas *M. pygmaeus* was recorded on the 2nd to 6th leaf from the top. The presence of *M. pygmaeus* caused a tendency of *N. tenuis* population to aggregate on the uppermost part of the plant. In hetero-specific treatments the mobility of the predators and particularly that of *N. tenuis* was increased. Without extraguild prey, all *M. pygmaeus* nymphs of 2nd and 3rd instars failed to develop to adulthood, whereas a high

percentage of nymphs found dead had their body fluids totally sucked, indicating IGP by *N. tenuis*. When occurred together, a significant negative impact on the suppression rate of whitefly population was recorded, despite this negative effect was lessened in more complex environments. Thus, although there might not be severe IGP interactions, sublethal effects associated to IGP may occur.

Tracking predation of *Macrolophus pygmaeus* and *Nesidiocoris tenuis* (Heteroptera: Miridae) in tomato protected crops by molecular methods

R. Moreno-Ripoll, R. Gabarra, N. Agustí 307-312

Abstract: Development of appropriate tools for identifying trophic interactions that occur between pests and natural enemies are necessary to improve joint utilization of natural enemies. In IPM tomato greenhouse crops two whitefly species (*Bemisia tabaci* and *Trialeurodes vaporariorum*) are the main pests and their biological control is based on the use of the predators *Macrolophus pygmaeus* and *Nesidiocoris tenuis* and the whitefly parasitoids *Eretmocerus mundus* and *Encarsia pergandiella*. Knowledge of their predator-prey relationships when predators and parasitoids coexist under field conditions is necessary to better understand their role in the ecosystem and optimize pest control. This study aims to determine trophic relationships when the whiteflies *B. tabaci* and *T. vaporariorum*, their parasitoids *E. mundus* and *E. pergandiella* and the two polyphagous predators coexist in field conditions. Eight greenhouses were sampled and predators gut contents were analyzed by using species-specific primers to detect prey DNA. The four target prey were detected in nymphs and adults of both predator species. Percentage of predation was lower in *M. pygmaeus* males. No significant differences were found between nymphs, males and females in *N. tenuis*. The majority of the predators analyzed contained DNA of only one target prey, but up to three different target prey DNA were detected in some predators.

Molecular markers for dispersal studies: plant DNA detection within omnivorous predators

N. Agustí, L. Pumariño, M. Fernandez, R. Gabarra, O. Alomar 313-318

Abstract Biological control programmes have recently benefited from the development of DNA-based techniques to evaluate predation on arthropods. However, many predators are omnivores, and the detection of plant-specific DNA should also allow the identification of the plant species they have fed on. In this study, we have tested three pairs of primers previously developed by other authors as a way to detect tomato DNA within the gut of the omnivorous predator *Macrolophus pygmaeus*. Results indicate that tomato DNA can be detected, but with different rates depending on the molecular markers used. The design of specific tomato primers from the ITS 1-2 region allowed the amplification of short fragments of tomato DNA in all individuals. Those results provide a useful technique to confirm plant food sources of arthropods and to evaluate crop colonization sources in Conservation Biological Control programmes.

Detection of egg protein in *Macrolophus pygmaeus* by serological techniques

K. Franco, J. Aramburu, N. Agustí, C. Castañé 319-322

Abstract: *Macrolophus pygmaeus* is a polyphagous mirid bug native to the Mediterranean region where it is currently used in the biological control of whiteflies and other pests in vegetable crops. To determine the success of predator establishment in a crop it is important to assess the reproductive status of females from inoculated or colonizing populations. However, it is difficult to evaluate fecundity in *M. pygmaeus* females because eggs are laid inside plant stems and veins, and are not easily observed. An alternative is to evaluate their egg load. A polyclonal antibody against the protein content in *M. pygmaeus* eggs was produced and the enzyme-linked immunosorbent assay (ELISA) protocol for *M. pygmaeus* female egg detection was validated. This method could reliably detect the presence/absence of eggs in each *M. pygmaeus* female.

Suitability of *Ceratitis capitata* (Diptera, Thephritidae) eggs as food source for *Macrolophus pygmaeus* (Heteroptera, Miridae)

M. Nannini, R. Souriau 323-328

Abstract: The suitability of *Ceratitis capitata* eggs as food source for the predatory bug *Macrolophus pygmaeus* was evaluated in comparison with *Ephesia kuehniella* eggs, the standard prey for mass rearing, and *Artemia* sp. cysts, a prey recently proposed as a cheaper

alternative. A diet based on fruit fly eggs increased nymphal mortality and reduced female fertility compared to the standard prey. However, maintained on relatively crowded hosts, the mirid bug produced nearly the same amount of progeny when fed *Ceratitis* or *Ephestia* eggs. Therefore further and more exhaustive investigations are needed to clarify the actual potential of fruit fly eggs as alternative food for the commercial production of *M. pygmaeus*.

Artificial rearing of the anthocorid predator *Orius laevigatus*
M. Bonte, P. De Clercq.....329-332
 No abstract.

Tests of prey consumption and response to plant odours as possible tools for evaluating the quality of mass reared *Orius laevigatus*
C. Castañé, C. Gigot, R. Gabarra.....333-338

Abstract: Simple testing methods that could provide information on the behaviour of arthropod natural enemies (NE) may be an important tool for checking the quality and maintaining the efficacy of commercial biological control agents. In this study, two simple laboratory tests are proposed that could provide an estimate of the capacity of predators for finding the host plants attacked by the target pests and also their acceptance as prey. One is an olfactometer test based on the perception by arthropod NE of semiochemicals emitted by plants when attacked by phytophagous arthropods, whereas the other is a prey consumption test in a no-choice situation. Studies were made with *Orius laevigatus*, a commercially produced polyphagous predator that is widely used for biological control in greenhouse crops. The performance of two commercial populations and one laboratory colony was tested against a wild population recently collected from the spontaneous flora. Predators from Company 2 fed significantly less on the target prey and had a lower response to odours of plants attacked by the target prey than predators from the wild population. Predators from Company 1 had a better performance although the laboratory colony had an even better performance, almost similar to that of the wild population.

Natural Pesticides and Side Effects on Beneficials

Effect of vaporizing sulphur on pest predators in greenhouses
J. Pijnaker, P. Ramakers341-345

Abstract: The effect of vaporizing sulphur was tested on *Amblyseius swirskii* (Acari: Phytoseiidae) and *Aphidoletes aphidimyza* (Diptera: Cecidomyiidae). Repeated exposure in a closed glasshouse during successive nights was found very harmful for both predators. The effect of the sheer sulphur deposit on *A. swirskii* was small and not significant.

Insecto-acaricidal effect of a microemulsion based on rape seed oil derivatives
V. Todirash, D. G. Pfeiffer, T. Tretiacov, V. Focsa347-351

Abstract: The effect of a microemulsion based on rape seed oil derivatives on greenhouse pests has been studied. The insecticidal activities of the rape seed oil derivatives were investigated on control of greenhouse whitefly (*Trialeurodes vaporariorum*), two-spotted spider mites (*Tetranychus urticae*) and aphids (*Aphis gossypii*). The insecticidal and miticidal microemulsion does not have phytotoxicity but has satisfactory effects even if it is used in a lower concentration. The results indicated that the most effective microemulsion based on rape seed oil derivatives include potassium salt of fatty acids, ethyl esters and glycerol. Possible implications for substances having an action of enhancing surface activity or a moisture-retaining that improves the insecticidal and miticidal activity of microemulsion are discussed.

Residual toxicity of pymetrozine, spiromesifen, spinosad and acetamiprid to the predacious ladybird *Serangium parcesetosum* (Coleoptera: Coccinellidae), a predator of the whitefly, *Bemisia tabaci* (Homoptera: Aleyrodidae) on greenhouse crops in the east Mediterranean region of Turkey
H. Kutuk, A. Yigit353-358

Abstract A variety of insecticides are used in greenhouses to protect plants. As predacious ladybirds are also used to control whitefly, it is important to understand the effects of such pesticides on these beneficial insects. The susceptibility of larval and adult stages of the ladybird beetle, *Serangium parcesetosum*, to four pesticides was examined. To evaluate residual contact

activity, ten *S. parcesetosum* larvae (3–5 days old, L₂- L₃) were placed in treated Petri dishes and their mortality was checked daily, but it was considered after 5 days for data analysis. The fecundity of surviving females was tested for 15 days. Female fecundity and egg hatching were recorded. Spiromesifen and pymetrozine had no significant effect on the survival and fecundity of *S. parcesetosum* when predators were exposed to pesticide residues. Spinosad and acetamiprid were detrimental by contact to both stages at the recommended dosages for thrips and whitefly control, respectively. These findings should be considered when releases of *S. parcesetosum* are used in greenhouses or on outdoor crops.