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PAPERS

Association of fungus gnats with oomycetal plant pathogens

Sarah Arnold¹, Stephen Wraight², Eric Nelson³, John Sanderson¹

¹*Dept. of Entomology, Cornell University, Ithaca, NY, USA, 14853-0901, sea35@cornell.edu;* ²*USDA-ARS, US Plant, Soil and Nutrition Laboratory, Ithaca, NY, USA, 14853-2901;* ³*Dept. of Plant Pathology, Cornell University, Ithaca, NY, USA, 14853-0901*

Abstract: Dark-winged fungus gnats in the genus *Bradysia* (Diptera: Sciaridae) are especially abundant in greenhouse plant production. Although it is thought adult fungus gnats generally do not feed in the greenhouse setting, sciarid larvae feed mainly on microorganisms in the soil, including various Oomycetes, Ascomycetes, Basidiomycetes, and Myxomycetes. However, larvae of several species have also been observed consuming root, stem, and sometimes leaf tissue of apparently healthy vascular plants in greenhouses, and have been implicated in the transmission of certain root pathogens. In this laboratory study, *Bradysia impatiens* larvae chose to associate with oomycetal cultures of *Pythium aphanidermatum*, *Pythium ultimum*, or *Pythium irregulare* more frequently than the medium on which each of these pathogens was grown.

Developments in greenhouse horticultural production systems

J.C. (Sjaak) Bakker

Wageningen UR Glastuinbouw, Violierenweg 1, 2665 MV Bleiswijk, Post Box 20, 2665 ZG Bleiswijk, The Netherlands; sjaak.bakker@wur.nl

Abstract: A short overview of recent developments in Dutch horticultural industry is presented focussing on four topics: 1) optimal use of the greenhouse area, 2) maximal utilisation of light, 3) reduction of energy use, and 4) complete control of the greenhouse environment.

Study of the efficacy of different concentrations of insecticidal soap, in comparison oxydemeton-methyl (Metasystox) to control *Aphis gossypii* in greenhouse cucumber

Valiollah Baniameri

Iranian Research Institute of Plant Protection (IRIPP), P. O. Box: 19395/1454 Tehran, Iran, baniameri@yahoo.com

Abstract: Insecticidal soaps have been used to control insects and mites because of low toxicity and environmental pollution with no residual effect. At present time, because of limitation in the use of chemical insecticides in greenhouse vegetables, it is needed to use an alternative product without poisoning active ingredient such as soaps. In this study, the effect of an insecticide soap named Palizin (Kimiasabzavar product) with three different concentrations (1.5, 2.5 and 5 g/lit), oxydemeton-methyl (Metasystox) (1 ml/lit.) and control were evaluated through a CRBD in 3 replications against *Aphis gossypii* in greenhouse cucumber of Tehran and Varamin, Iran. Mortality percentage was calculated using

Henderson-Tilton formulae and the arcsine transformed mortality percentage of aphids were analysed by SAS software. The comparison of the mean effectiveness of all treatments showed that there was no significant difference among treatments, but there is a significant difference to the control. The maximum and minimum mean effect of insecticide soap were 90.63 and 75.89 percent in concentrations of 2.5 and 1.5 g/lit, respectively. According to the results, insecticidal soap (Palizin) is recommended in 2.5 g/lit. for spraying application.

The switch to IPM in cut-chrysanthemum in the Netherlands

Ellen Beerling

*Wageningen UR Glasshouse Horticulture, Violierenweg 1, 2665 MV Bleiswijk, The Netherlands,
Ellen.Beerling@wur.nl*

Abstract: Within a few years time Dutch cut-chrysanthemum growers switched to IPM. In this paper we describe the causes that account for this change, and we summarize our research on thrips and spider mite control that contributed to it.

Development of a grower rearing-release system for *Atheta coriaria*, for low cost biological control of ground-dwelling pest life stages

Jude Bennison¹, Kerry Maulden¹, Heather Maher¹, Monique Tomiczek²

¹ADAS Boxworth, Boxworth, Cambridge, CB23 4NN, UK, Jude.Bennison@adas.co.uk; ²Formerly of ADAS Boxworth

Abstract: Following Canadian research and experience on the potential of *Atheta coriaria*, for biological control of sciarid flies, shore flies and western flower thrips (WFT), further research was done in the UK to develop a practical grower rearing-release system for the predator for low cost biological control of various pests. The system gave promising reductions in numbers of WFT on *Impatiens* and of sciarid flies on potted parsley. *A. coriaria* release rates needed for control of sciarid flies of a specific density on potted parsley were determined. A method for manipulating *A. coriaria* release rates from the rearing-release containers was identified. Further development and testing of the rearing-release system is needed before grower uptake can be recommended.

Strategies for aphid control in organically grown sweet pepper in the Netherlands

Chantal Bloemhard, Pierre Ramakers

*Wageningen UR Greenhouse Horticulture. P.O Box 20, 2665 ZG Bleiswijk, The Netherlands,
Chantal.Bloemhard@wur.nl*

Abstract: Within the framework of a ministerial program to encourage organic farming, a knowledge dissemination project on biological pest control was started. Organic sweet pepper growers participating in this project have adopted a more preventive strategy, especially with respect to aphid control. Natural enemies were released at much higher rates and frequencies, and repairing sprays with natural pyrethrum could be omitted. Crops still suffer from honeydew pollution and yield losses. Results of scouting both aphids and natural enemies in a representative case are presented.

Potential of alternative prey in the conservation and establishment of *Orius insidiosus* (Say) (Hemiptera: Anthocoridae)

Vanda H.P. Bueno, Lívia M. Carvalho, Alessandra R. Carvalho

Laboratory of Entomology, Department of Entomology, Federal University of Lavras, P. O. Box 3037, 37200-000 Lavras, Minas Gerais, Brazil, vhpbueno@ufla.br

Abstract: *Orius* species can be found in both managed and natural ecosystems, mainly in association with thrips. The objective of this study was to evaluate *O. insidiosus*' biological parameters using the thrips *Frankliniella insularis* and *Spodoptera frugiperda* eggs as prey, as well as its predatory capacity on *S. frugiperda* eggs and adults of *Haplothrips gowdeyi* + *Frankliniella* sp. The experiment was conducted in a climatic chamber at 25 ±1°C, RH 60 ±10%, and a 15-h photophase. *O. insidiosus* development lasted longer when *S. frugiperda* eggs were used as food (13.0 days), as compared with *F. insularis* (10.4 days). During the nymphal stage, *O. insidiosus* consumed significantly more thrips (58.1 adults) when compared with *S. frugiperda* eggs (34.6 eggs). Females fed thrips laid a greater number of eggs (80.7 eggs/female) as compared to females fed *S. frugiperda* eggs (25.8 eggs/female). Thrips were more suitable for *O. insidiosus* development and reproduction, and may contribute toward the conservation and establishment of this predator in agroecosystems located neighbouring of greenhouses.

Intra-guild predation between *Amblyseius swirskii* (Athias-Henriot) and *Neoseiulus cucumeris* (Oudemans) (Acari: Phytoseiidae)

Rosemarije Buitenhuis^{1, 2}, Les Shipp², Cynthia Scott-Dupree¹

¹University of Guelph, Environmental Biology Department, Guelph, Ontario, N1G 2W1, Canada, buitenhuis@AGR.GC.CA; ²Greenhouse and Processing Crops Research Centre, Agriculture and Agri-Food Canada, 2585 County Road 20 RR2, Harrow, Ontario, N0R 1G0, Canada

Abstract: The relationships between the predatory mites, *Amblyseius swirskii* (Athias-Henriot) and *Neoseiulus cucumeris* (Oudemans), and their prey, western flower thrips (*Frankliniella occidentalis* Pergande), were investigated to determine the effects of predation on intra-guild or extra-guild prey. Life history characteristics of both predatory mites were measured when fed eggs and larvae of the other predator species, and compared to data obtained when the predators were fed thrips larvae. In addition, choice tests were conducted to determine if the predators had a preference for any of the different prey or if they were indiscriminate predators.

Release rates of *Orius insidiosus* to control *Frankliniella occidentalis* on protected potted gerbera

Alessandra R. Carvalho, Vanda H.P. Bueno, Alexa G. Santana, Nazaré Moura, Elaine A. Louzada

Laboratory of Biological Control, Department of Entomology, Federal University of Lavras, P.O. Box 3037, 37200-000 Lavras, MG, Brazil, acarvalho@ufla.br, vhpbueno@ufla.br

Abstract: Reductions of *Frankliniella occidentalis* populations using *Orius insidiosus* were obtained in several ornamentals, such as saintpaulia, impatiens, and gerbera. The purpose of this study was to determine the action of this predator on the biological control of the thrips *F. occidentalis* after different release rates under a commercial protected cultivation area of potted gerbera. The experiment was conducted during the entire cultivation cycle, for a total of 16 weeks. The population dynamics of *F. occidentalis* was evaluated in two areas located in different greenhouses, one with releases of the predator (20 m²) and the other with the use of chemical control (25 m²). Eight releases of *O. insidiosus* adults + nymphs were performed, ranging from 0.15 to 1.20 *O. insidiosus* per gerbera pot. It was observed that under a release rate of 1.20 *O. insidiosus*/pot, the *F. occidentalis* population reached numbers that were lower (varying from 20 to 80%) than those observed in the area where chemical control was applied. *O. insidiosus* predators were found on the gerbera plants up to two weeks after they were released. The use of *O. insidiosus* to control thrips in commercial gerbera crops is promising; however, additional adjustments are needed with regard to release rates and frequencies.

Storage of adults of two species of *Orius* (Hemiptera: Anthocoridae) at low temperature

Livia M. Carvalho, Vanda H. P. Bueno, Alexandre J. F. Diniz, Alexa G. Santana

Laboratory of Biological Control, Department of Entomology, Federal University of Lavras, P.O. Box 37, 37200-000 Lavras, MG, Brazil, vhpbueno@ufla.br

Abstract: Storage at low temperatures is an important step during the process of mass rearing and use of natural enemies, since it allows greater flexibility in the rearing, transport, and release of beneficial agents. In Brazil, biological studies have been conducted with different species of *Orius*. Their use in biological control programs against thrips is promising in many protected crops. This study aimed to evaluate the influence of storage periods at low temperatures on the reproductive capacity and longevity of the predators *Orius insidiosus* and *Orius thyestes*. It was observed that *O. insidiosus* is less sensitive to low temperatures; adults of this predator can be stored for up to 10 days at 8°C, while *O. thyestes* adults can be stored for up to 6 days at 12°C. These results may be helpful to plan the processes by which these predators are mass reared and transported to the sites where they should be released.

Control of *Frankliniella occidentalis* (Thysanoptera: Thripidae) on greenhouse roses with *Amblyseius (Typhlodromips) swirskii* (Athias-Henriot) (Acari: Phytoseiidae) and *Orius insidiosus* (Hemiptera: Anthocoridae)

Andrew Chow, Amanda Chau, Kevin M. Heinz

Biological Control Laboratory, Department of Entomology, Texas A&M University, College Station Texas 77843-2475, US, achow@tamu.edu

Abstract: Despite the widespread use of insecticides, western flower thrips, *Frankliniella occidentalis* (Pergande), are still difficult pests to control on floriculture crops. As an alternative to chemical control, we evaluated the use of the predatory mite, *Amblyseius swirskii* (Athias-Henriot), alone and together with the predatory bug, *Orius insidiosus* (Say), for suppressing *F. occidentalis* on cut roses. In greenhouse trials simulating thrips infestations of cut rose crops, we compared control of *F. occidentalis* on roses with releases of only *A. swirskii* or both *O. insidiosus* and *A. swirskii*. Roses with or without predators produced similar numbers of harvestable flowers, but roses without predators had, on average, two to three times more thrips than roses with predators. Concurrent releases of *O. insidiosus* with *A. swirskii* did not improve suppression of *F. occidentalis* on cut roses because counts of thrips on flowers with both *O. insidiosus* and *A. swirskii* were not statistically different from counts on flowers with only *A. swirskii*.

Insecticide resistance in Ontario strains of the American serpentine leafminer (*Liriomyza trifolii* (Burgess)) in Ontario

L. Conroy¹, C.D. Scott-Dupree¹, C.R. Harris¹, G. Murphy², A.B. Broadbent³

¹*Department of Environmental Biology, University of Guelph, Guelph, ON Canada N1G 2W1, lconroy@uoguelph.ca;*

²*Ontario Ministry of Agriculture, Food and Rural Affairs, Vineland, ON Canada L0R 2E0;* ³*Southern Crop Protection Food Research Centre, Agriculture and Agri-Food Canada, London, ON Canada N5V 4T3*

Abstract: The American serpentine leafminer, *Liriomyza trifolii* (Burgess) (ASL), is a major pest of floriculture in Ontario. Growers rely heavily on chemicals to provide acceptable pest control and, as a result, ASL has developed resistance to many insecticides. Only a few are registered for use in Canada and growers have been reporting difficulty in achieving effective ASL control. The objectives of this study were to determine if ASL in Ontario has developed resistance to currently registered insecticides and to evaluate the potential of 2 newer reduced risk insecticides for inclusion in future ASL management programs. Two ASL cultures were established – one collected from greenhouses near Vineland, Ontario, the other being an insecticide susceptible strain never exposed to any of the test insecticides. Insecticide effectiveness was assessed using a leaf dip bioassay technique. Insecticides tested were cyromazine and abamectin – both currently registered; and, 2 novel reduced risk products - spinosad and chlorantraniliprole. At the LC₅₀, the Ontario strain was resistant (>10x) to both abamectin (17.5x) and cyromazine (10.2x). It also was significantly

more tolerant to spinosad (2.8x) and chlorantraniliprole (3.0x). Comparing the LC₉₅ to application rates showed that the amount of insecticide required to kill 95% of the Ontario ASL strain would be much higher than the recommended rate for cyromazine, slightly higher for abamectin and close to the suggested application rate for spinosad. The LC₉₅ for chlorantraniliprole was much lower than the suggested application rate. Nevertheless, the low level tolerance shown by the Ontario strain suggests that this highly effective insecticide has the potential to develop a higher level of resistance and that, if registered for use, it should be in the context of a multifaceted IPM program.

Wilt-Pruf: a novel control agent for American serpentine leafminer

L. Conroy¹, A.B. Broadbent², C.D. Scott-Dupree¹, C.R. Harris¹, G. Murphy³

¹*Department of Environmental Biology, University of Guelph, Guelph, ON Canada N1G 2W1, lconroy@uoguelph.ca;*

²*Southern Crop Protection Food Research Centre, Agriculture and Agri-Food Canada, London, ON Canada N5V 4T3;*

³*Ontario Ministry of Agriculture, Food and Rural Affairs, Vineland, ON Canada L0R 2E0*

Abstract: The appearance of insecticide-resistant American serpentine leafminer (*Liriomyza trifolii* (Burgess)) (ASL) in Ontario floriculture greenhouses has accelerated the search for alternative pest control methods. The objective of this study was to test efficacy of the anti-desiccant Wilt-Pruf[®] (WP) to deter ASL. Chrysanthemum plants sprayed with varying concentrations of WP were placed in a cage with a non-treated plant and exposed to ASL for 24 h. Residual activity of WP was evaluated over 3 and 6 d by placing treated chrysanthemums in one ASL cage and non-treated plants in another. Assessments following 24 h exposure indicated that ASL consistently chose non-treated or water treated over WP treated plants in both 3 and 6 d no-choice tests. WP may be a useful barrier to ASL in a multi-faceted IPM program.

Artificial production of arthropod biological control agents

Patrick De Clercq

Laboratory of Agrozoology, Department of Crop Protection, Ghent University, Coupure Links 653, B-9000 Ghent, Belgium, patrick.declercq@ugent.be

Abstract: Augmentative biological control should be based on a cost effective and reliable production of high-quality natural enemies (Bolckmans, 2007). To reduce costs, alternatives have been proposed for a number of tritrophic rearing systems (i.e., those including the plant, natural prey or host, and predator or parasitoid levels) and some of these have found their way into practice. Currently, several species of mites and insects are being used as factitious prey or hosts for the complete or partial commercial production of arthropod predators and parasitoids, including bran mites and dried fruit mites for phytoseiid, lepidopteran eggs for heteropteran, coleopteran and chrysopid predators and for trichogrammatid parasitoids, and brine shrimp cysts for heteropteran predators (De Clercq, 2004). Artificial diets (or media) have been developed, with a varying degree of success, for various beneficial arthropods, but the practical use of these diets is still in its infancy (Grenier & De Clercq, 2003, 2005). Only very few of these artificial diets are nowadays routinely used in commercial insect cultures (e.g., the diet developed by Cohen [2003] for *Chrysoperla* spp.). It deserves emphasis that the development of artificial foods for beneficial arthropods is not about nutrition alone. The complexity of designing artificial media requires inputs from nutritionists, food technologists and process engineers, microbiologists, insect ecologists, physiologists and geneticists (see the potential of genomics and other -omics as tools in diet development). A major concern is the quality of artificially reared natural enemies (Grenier & De Clercq, 2003, 2005). Assessing development and particularly reproduction of natural enemies reared on an unnatural food is often a time consuming activity. In this respect, increasing attention is given to the development of rapid tools to assess reproductive potential, including dissection tests (e.g., Vandekerckhove et al., 2006) and ELISA-based detection of yolk proteins (e.g., Shapiro et al., 2000). Arguably, excellent field performance of the artificially produced natural enemy against the target pest remains the ultimate quality criterion. However, quality assessments of artificially reared natural enemies have mostly been performed at a laboratory scale or in semi-field conditions, and only rarely so in practical field conditions (Grenier & De Clercq, 2005). Besides animal foods, many natural enemies require plant materials for moisture, supplementary nutrients or growth factors, or as an oviposition substrate. Replacement of plant substrates for oviposition by artificial substrates constitutes a further challenge for the rationalisation of rearing processes for several predatory insects that deposit their eggs in plants tissues, like mirid and anthocorid bugs.

Combined use of predatory mites for biological control of *Tetranychus urticae* (Acari: Tetranychidae) in commercial greenhouse cucumber

Gillian Ferguson

Ontario Ministry of Agriculture, Food and Rural Affairs, 2585 County Rd 20, Greenhouse and Processing Crops Research Centre, Harrow, ON, N0P 2G0, Canada, gillian.ferguson@ontario.ca.

Abstract: Two types of predators were used for biological control of spider mites (*Tetranychus urticae*) in commercial greenhouse cucumber crops. Initial general releases of *Neoseiulus californicus* were followed by targeted releases of *Phytoseiulus persimilis* in areas with higher populations of *T. urticae*. This strategy combined the biological traits of the less specialized *N. californicus* with those of the highly specialised *P. persimilis* to successfully suppress *T. urticae* populations under commercial conditions.

Comparative efficacy of oil- versus aqueous-based formulations of the entomopathogenic fungus *Beauveria bassiana* applied against melon aphid, *Aphis gossypii*

Melanie Filotas¹, John Sanderson¹, Stephen Wraight²

¹Department of Entomology, Cornell University, Ithaca, NY, USA, 14853, jps3@cornell.edu; ²USDA-ARS, Robert W. Holley Center for Agriculture and Health, Ithaca, NY, USA, 14853

Abstract: Oils are known to act as highly effective spray stickers and have been claimed to improve efficacy of fungal pathogens under dry conditions. Oil formulation is thus considered one of the most promising technologies for improving efficacy of mycoinsecticide spray applications. The objective of this study was to investigate effects of oil vs. water formulation on the efficacy of *Beauveria bassiana* conidia applied against *Aphis gossypii* under relatively dry conditions. In laboratory tests, formulation in emulsifiable oil did not significantly increase virulence of the fungus nor increase its capacity to infect aphids under dry conditions compared to unformulated fungus. Nevertheless, the oil formulation was consistently more effective than a wettable powder. The results support a hypothesis that oils function primarily as spray stickers, improving the efficiency of spray applications.

The effect of reduced risk pesticides for use in greenhouse vegetable production on bumble bees (*Bombus impatiens* Cresson)

A. E. Gradish¹, C. D. Scott Dupree¹, L. Shipp², C. R. Harris¹, G. Ferguson³

¹Department of Environmental Biology, University of Guelph, Guelph, ON, Canada, N1G 2W1, agradish@uoguelph.ca; ²Agriculture and Agri-Food Canada, Greenhouse and Processing Crops Research Centre, Harrow, ON, Canada, N0R 1G0; ³Ontario Ministry of Agriculture, Food and Rural Affairs, Harrow, ON, Canada, N0R 1G0

Abstract: In recent years, bumble bees (*Bombus impatiens* Cresson) have increasingly been used commercially for pollination in greenhouses and now play an essential role in Canadian greenhouse vegetable production. Effective pest control also is crucial to producing high, marketable yields of greenhouse vegetables and pesticides remain an important tactic in greenhouse integrated pest management (IPM) programs. Many pesticides are toxic to other bee species, yet pesticide toxicity data on bumble bees are lacking. We examined the toxicity of reduced risk pesticides for use in greenhouse vegetable production to bumble bees. The active ingredients (technical grade > 95% purity) of fungicides (fludioxonil, cyprodinil, myclobutanil) and insecticides (imidacloprid, metaflumizone, abamectin, chlorantraniliprole) were applied to adult bumble bee workers using a Potter spray tower (PST) to determine their relative toxicities. All of the fungicides were harmless. Imidacloprid, abamectin, and metaflumizone were harmful, while chlorantraniliprole was harmless.

Complex interactions between *Rhizoglyphus robini* and *Fusarium oxysporum*: implications on onion pest management

Tal Hanuny¹, Moshe Inbar¹, Leah Tsrer², Eric Palevsky³

¹Department of Evolutionary and Environmental Biology, University of Haifa, Mount Carmel, Haifa 31905, Israel, thanuny@study.haifa.ac.il, minbar@research.haifa.ac.il; ²Department of Plant Diseases, Institute of Plant Protection, Agricultural Research Organization (ARO), Gilat Research Center, D.N. Negev, 85280, Israel, tsror@volcani.agri.gov.il; ³Department of Entomology, Institute of Plant Protection, ARO, Newe-Ya'ar Research Center, Ramat Yishay, 30095, Israel, palevsky@volcani.agri.gov.il

Abstract: The effects of the soilborne pathogen *Fusarium oxysporum* and the bulb mite *Rhizoglyphus robini* on onion sprout survival were experimentally tested in pots and an in-vitro bioassay (Petri dishes). Survival after 8 weeks in potted plants although significant, was subtle. However in the in-vitro bioassay, within 4 days we detected severe additive effects of the pathogen and mite on onion sprout rootlet growth. The importance of host-plant, fungi and mite interactions with respect to control are discussed.

Alternative food sources to enable establishment of *Amblyseius swirskii* (Athias-Henriot) on chrysanthemum without pest presence

Hans Hoogerbrugge, Yvonne van Houten, Elmer van Baal, Karel Bolckmans

Koppert Biological Systems, P.O. Box 155, 2650 AD Berkel en Rodenrijs, The Netherlands, HHoogerbrugge@koppert.nl

Abstract: Seven alternative food sources; cysts of the brine shrimp *Artemia* sp. (Branchiopoda: Artemiidae), honey bee pollen, *Carpoglyphus lactis* (Acarina: Acaridae), *C. lactis* + diet A, diet B, diet B + honey bee pollen and eggs of the Mediterranean flour moth, *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) + fresh corn pollen were tested in a cage experiment on young chrysanthemum plants to check if it had a positive effect on the population development of *Amblyseius swirskii*. The results showed that there is a positive effect in the treatments where *E. kuehniella* eggs + fresh corn pollen and *C. lactis* were added on to the plants. When *C. lactis* was released on the plants in combination with diet A it resulted in a significantly higher population of *C. lactis* and *A. swirskii* on the plants than the treatments with only *C. lactis*. The treatments with cysts of *Artemia* sp., honey bee pollen, diet B and diet B + honey bee pollen resulted in only a slightly higher population of *A. swirskii* compared to the untreated control.

Results of a survey on plant protection in organic nursery production in Germany

Martin Hommes, Julianna Bors, Katharina Raupach, Sabine Werres

BBA, Institute for Plant Protection in Horticulture, Messeweg 11-12, D-38104 Braunschweig, Germany, m.hommes@BBA.DE

Abstract: In Germany a survey relating to plant protection in 31 organic production nurseries was conducted in 2003. At that time 44 nurseries were run organically. The survey was carried out by interviewing the nurserymen on their premises. The organic production nurseries were very heterogeneous in size and structure. Nearly all growers inspected their crops regularly for plant diseases, pests, and weeds. If plant protection problems arose, nurserymen consulted primarily technical literature or asked other colleagues. The occurrence of economically significant causes of damage varied very much from nursery to nursery. A great range of different disease species were recorded by the growers without indicating a particular one. In contrast sucking insects like aphids and scale insects, vertebrates, spider mites and black vine weevils were mentioned as pests playing a major role. Common couch and creeping thistle were reported as weeds difficult to control. The most important criteria for controlling weeds, pests and diseases were economic thresholds, tolerance by the customer and operating procedures. A systematic change of plant selection was an important instrument in organic nursery production to avoid or minimise infestations with viruses and pests. In existing stock, nurserymen controlled harmful organisms and undesired weeds by various preventive and direct measures. Growers take a lot of different measures to encourage the occurrence of beneficials. They set up additional food sources and refuges with hedges, green fallow, tolerating weeds and wood or stone piles.

The potential of eggplant as a trap crop for the management of *Trialeurodes vaporariorum* (Homoptera: Aleyrodidae) on poinsettia

Doo Hyung Lee, Jan Nyrop, John Sanderson

Department of Entomology, Cornell University, Geneva, New York 14456, USA; Department of Entomology, Cornell University, Ithaca, New York 14853, USA, dl343@cornell.edu

Abstract: Eggplant, *Solanum melongena* L. was tested as a trap crop for the management of the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) on poinsettia, *Euphorbia pulcherrima* Wild. ex Koltz. In an experimental greenhouse, 70 poinsettias were placed in a 9×8 rectangular formation with 2 eggplants in the middle of the poinsettias. Two-thousand whitefly adults were released from the outside of the rectangular plot to test whether eggplant would attract whiteflies from poinsettias. The presence of eggplant remarkably changed the spatial distribution of the whiteflies resulting in a high level of aggregation on the eggplant. At 24h after release, 39 and 66% of the whiteflies were observed on the 2 eggplants in the 1st and 2nd trials, respectively. At 72h after release, the proportions increased to 66 and 83% in the 1st and 2nd trials, respectively.

Towards a robust IPM programme for organic tomato

Rob Jacobson

RJC Ltd, Milnthorpe Garth, Bramham, Yorkshire, LS23 6TH, UK, rob.jacobson@tiscali.co.uk

Abstract: The demand for organic food is steadily increasing in the UK and it has become necessary to grow organic tomato crops on a larger scale to satisfy the requirements of retail outlets in urban areas. This paper describes the additional challenges to cost effective pest control in such crops and outlines the control measures, which have been built upon the IPM programme for conventional tomato crops. These measures include i) a new method of culling populations of *Macrolophus caliginosus* which prevents economic plant damage and allows the insect to be exploited as a valuable biocontrol agent, ii) physical means of preventing mealybugs becoming established on tomato crops, and iii) methods of recycling biocontrols from areas of surplus in commercial crops. The involvement of growers in the project ensured immediate industry uptake of the new ideas.

Intraguild predation among biological control agents used in greenhouse floriculture crops: a preliminary review

Sarah Jandricic, John Sanderson, Steve Wraight

Cornell University, Department of Entomology, Ithaca, NY, 14850, USA, jps3@cornell.edu; USDA-ARS U.S. Plant, Soil, and Nutrition Laboratory, Tower Rd., Ithaca, NY 14853, USA

Abstract: Literature on intraguild predation (IGP) in greenhouse floriculture (GHFC) was reviewed. Despite production practices that could increase the incidence IGP, no studies concretely showed that IGP disrupts GHFC biocontrol. Further studies need to include large-scale trials over entire crop cycles. However, based on studies to date, it appears that IGP effects are not sufficiently problematic to be of serious concern in GHFC, or can be surmounted by modifications in biocontrol practices.

Influence of continuous lighting on the biology of *Trialeurodes vaporariorum* (Homoptera: Aleyrodidae)

Nina Svae Johansen

Bioforsk Plantehelsetse, the Norwegian Institute of Agricultural and Environmental Research, Hoegskoleveien 7, N-1432 Ås, Norway, nina.johansen@bioforsk.no

Abstract: In greenhouse rose production, there is a trend towards the use of extreme long days (up to 24 hours lighting) and high light intensity to reduce problems with powdery mildew. Continuous lighting has been found to have adverse effects on some insects as well. The effect of continuous lighting on the survival, development and fecundity of the greenhouse whitefly, *Trialeurodes vaporariorum* on cut roses was investigated in climatic chambers with artificial light at 21°C and 70% RH. Compared to whiteflies exposed to 20:4 hours L:D, whiteflies exposed to continuous lighting had lower egg and larval/pupal survival, and lower fecundity and female longevity. Egg and egg-adult developmental time was only slightly affected.

Synergistic interaction between parasitoids and sterile insects

R. Kaspi, M.P. Parrella

Department of Entomology, University of California, One Shields Avenue, Davis, CA 95616, USA, rkaspi@ucdavis.edu

Abstract: We examine the hypothesis that the use of *Diglyphus isaea* for biological control of leafminers in greenhouse crops may be more practical and efficient when supplemented with additional control strategies, such as the Sterile Insect Technique (SIT). Our results validate previous theoretical models, and demonstrate synergistic control with releases of parasitoids (*D. isaea*) and sterile insects (*Liriomyza trifolii*). In light of these results, possible mechanisms underlying this synergistic interaction effect are discussed.

Occurrence and population trends of spider mite specialist predators under field and greenhouse conditions

Neda Kheradpir¹, Valliollah Baniameri², Mohammadreza Rezapanah²

¹Islamic Azad University, Science and Research Branch, Faculty of Agriculture & Natural Resources, Dep. Entomology, Po. Box 14155-4933, Tehran, Iran, n.kheradpir@gmail.com; ²Plant Protection Research Institute (PPRI), Po. Box: 19395/1454 Tehran, Iran

Abstract: The objective of this study was to examine the population growth of spider mites in cucumber fields and greenhouses, followed by identification of the main specialist predators and monitoring their synchronization with prey population dynamics. The samples were taken for 150 days in spring and summer 2007 in two pilot plots in the Tehran Province. The results showed the predatory thrips, *Scolothrips longicornis* as a persistent predator in both conditions able to function at lower prey population densities than *Stethorus gilvifrons*. Good synchronization in both prey-predator populations showed the direct effect of prey availability on predator survivorship followed by direct and indirect effects of temperature.

New dipteran pests in Belarus greenhouses

Tatiana P. Kondratenko

RUC "Institute of plant protection", Laboratory of Microbiological Method, Minsk region, p. Priluki, Mira 2; Kondratenko-T@yandex.ru

Abstract: Data on the specific composition and monitoring of phytophagous Dipteran is presented in this article. In Belarusian greenhouses phytophagous insects of the *Diptera* order are widely spread. Some of the following species are present in all examined greenhouses: *Bradysia brunripes* Mg., *Bradysia fungicola* Winnertz (*Sciaridae*), *Scatella*

stagnalis Fll. (*Erhydridae*), *Psychoda cinerea* Banks, and *Psychoda gemina* Eaton (*Psychodidae*). An evaluation of monitoring methods for adult Diptera by the use of yellow sticky traps was done, revealing that a horizontal arrangement of traps results in higher catches. Notes on pest morphology and biology are given.

Application methods for commercial biofungicides in greenhouses

Marja-Leena Lahdenperä, Maiju Korteniemi

Verdera Oy, Luoteisrinne 2, FI-02270 Espoo, Finland, Marja-Leena.Lahdenpera@verdera.fi

Abstract: There are several alternative ways of using biological fungicides, as for chemical pesticides. In this paper, the application methods of the biofungicides Mycostop[®] and Prestop[®], developed by Verdera Oy in Finland, are presented. Mycostop[®] is based on the bacterium *Streptomyces*, while the Prestop[®] products contain the fungus *Gliocladium catenulatum* as the active ingredient. The performance of the products in practice has been studied using various crops and pathogens. In the case of Mycostop[®], seed treatment was the most effective method for the control of damping-off, whereas incorporation into the growing medium turned out to be successful for the Prestop[®] formulations. The most practical way of controlling root and wilt diseases is to deliver Mycostop[®] and Prestop[®] by drip irrigation at regular intervals. Foliar diseases like *Didymella bryoniae* on cucumber and *Botrytis cinerea* on tomato can be controlled by sprayings directed to the site of infection.

Prospects for biological control of pest problems in outdoor nursery production in Western Canada

Mario Lanthier

CropHealth Advising & Research, P.O. Box 28098, Kelowna British Columbia, Canada, office@crophealth.com

Abstract: Because of a variety of climates and surrounding vegetation, the nature of pest problems and requirements for seasonal monitoring change from nursery to nursery within Canada. Preservation of naturally-occurring biocontrol agents is currently difficult because of pesticide control for various insect pests. On-going registration of low impact and microbial pesticides will allow the development of new management programs and increased reliance on biological control.

Status of Integrated Pest Management (IPM) practices in outdoor nursery production in Canada

Mario Lanthier¹, Peter Isaacson²

¹CropHealth Advising & Research, P.O. Box 28098, Kelowna, British Columbia, Canada, office@crophealth.com;

²Canadian Nursery Landscape Association, 7856 Fifth Line South, Milton, Ontario, Canada

Abstract: Surveys were conducted in 2002 in British Columbia and in 2004 across Canada to assess use of IPM practices by commercial nursery growers. Results indicated widespread knowledge of IPM concepts and regular use of crop monitoring and biologically-based pesticides. A second survey conducted at the same time measured the use of pesticides in outdoor nurseries. Results indicated common use of broad-spectrum insecticides such as organo-phosphates and organo-chlorines. These products are detrimental to naturally-occurring insect predators and parasites. Increased use of IPM practices may result from nursery certification programs being implemented to ensure plants are shipped relatively free of pest problems.

IPM strategies in the Colombian cut flower industry

Rebecca A. Lee

Colombian Centre for Innovation in Floriculture (Ceniflores), Cra 9 A, No.90-53, Bogotá, Colombia,
rebeccal@asocolflores.org

Abstract: Colombia is second world exporter of flowers after Holland. Flowers are the second most important agricultural export industry of the country. The Colombian Flower Exporters' Association (Asocolflores), through the Colombian Centre for Innovation in Floriculture (Ceniflores), provides leadership in the industry by implementing programmes that help maintain its competitiveness. Among these programmes is Florverde®, a management tool to help flower growers work toward socially and environmentally sustainable development, an agreement with the national plant protection organism for the coordination of plant health campaigns, and research projects in IPM coordinated by Ceniflores.

Can natural flightless ladybird beetles improve biocontrol of aphids?

Suzanne T.E. Lommen¹, Cock W. Middendorp², Carola A. Luijten¹, Jeroen van Schelt³, Paul M. Brakefield¹, Peter W. de Jong²

¹Institute of Biology, Leiden University, P.O. Box 9516, 2300 RA Leiden, The Netherlands,

S.T.E.Lommen@biology.leidenuniv.nl; ²Laboratory of Entomology, Wageningen University, P.O. Box 8031, 6700 EH Wageningen, The Netherlands; ³Koppert B.V., P.O. Box 155, 2650 AD Berkel en Rodenrijs, The Netherlands

Abstract: We investigated the effect of releasing flightless morphs of the ladybird beetle *Adalia bipunctata* onto single, caged pepper plants that were infested by aphids of *Myzus persicae nicotianae* or *Aulacorthum solani*. Overall, plants with flightless ladybird beetles showed lower aphid numbers after 48 hours than those receiving either winged or no beetles. These results were best explained by a longer residence time of the flightless beetles on the host plant. The benefit of using flightless beetles over winged ones was greatest for *M. persicae*, most likely because this species of aphid, in contrast to *A. solani*, does not drop off the plant as an escape response to the presence of beetles.

Do whiteflies help controlling thrips?

Gerben Messelink¹, Arne Janssen²

¹Wageningen UR Greenhouse Horticulture, PO Box 20, 2265 ZG Bleiswijk, The Netherlands,

Gerben.Messelink@wur.nl; ²IBED, Section Population Biology, University of Amsterdam, PO Box 94084, 1090 GB Amsterdam, The Netherlands

Abstract: Studies on pest species diversity suggest that pests can enhance each other's control through a shared generalist predator. This hypothesis was tested for control of western flower thrips by releasing greenhouse whiteflies in the presence of the shared predator *A. swirskii* on greenhouse cucumber. Predator densities strongly increased in the presence of both pest species, up to a tenfold compared to a situation with thrips only. However, this better performance of *A. swirskii* did not result in better control of thrips. Rather, thrips control was significantly delayed when whiteflies were present. We attribute this phenomenon to predator satiation caused by strong synchronisation of the pest populations after releasing high numbers of adults at once. It is suggested that repeated releases of lower numbers of whiteflies may improve biological thrips control.

Improving thrips control by the soil-dwelling predatory mite *Macrocheles robustulus* (Berlese).

Gerben Messelink, Renata van Holstein-Saj

Wageningen UR Greenhouse Horticulture, PO Box 20, 2265 ZG Bleiswijk, The Netherlands, Gerben.Messelink@wur.nl

Abstract: The predatory mite *Macrocheles robustulus* (Berlese) is frequently observed in greenhouse soils. A cage experiment was set up to assess the effects of this predator on western flower thrips in comparison with *Hypoaspis aculeifer* (Canestrini). *M. robustulus* controlled thrips significantly better (up to 70% reduction) than *H. aculeifer* (up to 50% reduction). Population build-up of soil-dwelling predatory mites was assessed in a freesia glasshouse. *M. robustulus* and *Hypoaspis miles* (Berlese) were introduced after soil sterilisation. *M. robustulus* reached densities up to 2800/m², whereas the maximum observed density of *H. miles* was 340/m² only.

Biological control of whitefly in poinsettia in Ontario, Canada

Graeme Murphy¹, Mike Short², Ann Marie Cooper³, Margarethe Fast⁴, David Neal⁵

¹Ontario Ministry of Agriculture and Food, Vineland ON L0R 2E0, graeme.murphy@ontario.ca; ²EcoHabitat Agri Services, Puslinch ON, N0B 2J0; ³Plant Products Co. Ltd., Brampton, ON L6T 1G1; ⁴Global Horticultural, Beamsville, ON, L0R 1B; ⁵Koppert Canada, Scarborough, ON M1X 1E4

Abstract: Trials demonstrating the use of biological control of whiteflies in poinsettia were carried out in commercial greenhouses in 2006 and 2007. Control was successful in nine out of twelve crops in 2006 and eight out of eleven in 2007. The trials are described and reasons for success and failure discussed.

Bug Gardens for education and research in conservation biological control and sustainable horticulture

Michelle Nakano, James Alan Matteoni

School of Horticulture and the Institute for Sustainable Horticulture, Kwantlen University College, Surrey, British Columbia, Canada V3W 2M8, Michelle.Nakano@kwantlen.ca

Abstract: About five years ago a group of educators and researchers decided to design a garden for use in conservation biological control and sustainable horticulture. The goal was to develop a garden template that could be installed across Canada, using low maintenance, drought tolerant plants that would attract and support beneficial arthropods. The garden would include some standard hardy species that could be used across Canada, but also allow space for species that were either local favourites or regionally hardy. The gardens could be located at schools for teaching and research, or at greenhouses and nurseries as plant insectaries. One such garden, planted at Kwantlen School of Horticulture, has been extremely useful for demonstrating the principles of conservation biological control and sustainable horticulture in different classes, as well as encouraging student research projects. The garden provides an educational context that supports heterogeneous learning styles in situated and inquiry based learning.

Some pest problems and solutions in Swedish organic greenhouse production

Barbro Nedstam

Swedish Board of Agriculture, Plant Protection Centre, Box 12, SE-23053 Alnarp, Sweden, Barbro.Nedstam@sjv.se

Abstract: Plant protection in organic greenhouse production relies heavily on pest control with natural enemies. In Sweden organic growers can often but not always rely upon experience of pest control in IPM production. In this overview the pest situation in solanaceous crops and in blueberries and blackberries is discussed. The need for additional low-risk pest control products is obvious but hampered by present registration costs.

Potential of entomopathogenic fungus *Isaria fumosorosea* to protect potted ornamental plants against *Bemisia tabaci* during shipping

Lance S. Osborne¹, Zdenek Landa², Andrea Bohata², Cindy McKenzie³

¹Mid-Florida Research & Educational Center, IFAS, University of Florida, 2725 Binion Road, Apopka, FL 32703-8504, USA, lsosborn@ufl.edu; ²Department of Plant Sciences, Faculty of Agriculture, University of South Bohemia, Studentska 13, 370 05 Ceske Budejovice, Czech Republic, ³US Horticultural Research Laboratory, ARS-USDA, 2001 South Rock Road, Fort Pierce, FL 34945, USA

Abstract: The efficacy of entomopathogenic fungus *Isaria fumosorosea* has been evaluated under abiotic conditions similar to those typical for shipping of ornamental plants. When applied to a synchronized population of *B. tabaci* L4 nymphs on poinsettias, *I. fumosorosea* induced mortality even in regime of low temperature. The efficacy of this fungus was increased by dose, application of pre-germinated conidia and additional nutritional supplements. In some treatments, the population of *B. tabaci* was practically eradicated and there were no symptoms detected which would indicate a fungus related phytotoxicity.

Prey-Stage Preference in *Scolothrips longicornis* Priesner (Thysanoptera: Thripidae) on *Tetranychus urticae* Koch (Acari : Tetranychidae)

H. Pakyari¹, Y. Fathipour², M. Rezapana³, K. Kamali²

¹Department of Plant Protection, Islamic Azad University, Takestan Branch, Iran, Hajar.Pakyari@gmail.com; ²Department of Entomology, Faculty of Agriculture, Tarbiat Modares University, P.O. Box 14115—336; Tehran, Iran, fathi@modares.ac.ir; ³Department of Biological Control, Iranian Research Institute of Plant Protection, Tehran, Iran, Rezapana@yahoo.com

Abstract: The prey-stage preference of the predatory thrips, *Scolothrips longicornis* Priesner, for the two-spotted spider mite, *Tetranychus urticae* (Koch) was studied in 24-h laboratory experiments at 26 ±2°C, 60 ±5% RH and 16:8 L:D. The results showed that adult spider mites were the most preferred stage with approximately 8 individuals being eaten per day. *S. longicornis* has no preference between the juvenile stages of the spider mite, the consumption being approximately 5 individuals per day.

Predatory mites for biocontrol of Western Flower Thrips, *Frankliniella occidentalis* (Pergande), in cut roses.

Juliette Pijnakker & Pierre Ramakers

Wageningen UR Glastuinbouw, Violierenweg 1, 2665 MV Bleiswijk, The Netherlands, juliette.Pijnakker@wur.nl

Abstract: Integrated Pest Management is used on less than 15% of the cultivated rose area in The Netherlands. Control of the Western Flower thrips *Frankliniella occidentalis* is an obstacle for further expansion of IPM in this crop. Research was started on a number of generalist phytoseiids in order to enlarge the number of predator species available for rose growers. A series of phytoseiids were tested for their affinity to rose as a host plant and to greenhouse conditions as an environment. Among four species compared, *Amblyseius swirskii* and *Euseius ovalis* were found to be promising control agents for thrips.

Biological activity of two strains of *Lecanicillium lecanii* (Zimmerm.) Zare & Gams to *Myzus persicae*

Lyudmila Prischepa, Ekaterina Ugnachyova

RUC "Institute of Plant Protection", Laboratory of Microbiological Method, Minsk region, p. Priluki, Mira – 2, Belarus, Prischepa-2625@yandex.ru

Abstract: The pathogenicity of two strains of the entomopathogenic fungus *Lecanicillium lecanii* (Zimmerm.) Zare & Gams (IIV-1 and BL-2) to green peach aphid *Myzus persicae* Sulzer was investigated. There were no significant differences in strains effectiveness. The highest biological effect was on the 10th day after application (73% aphid mortality). The fungus productivity depended on the media and the temperature of cultivation. Malt-agar and a temperature of 26°C were optimal for cultivation of the strains. The strain BL-2 has higher spore titer than IIV-1.

Efficacy of Eradicoat and Eradicoat T against *Tetranychus urticae* (Koch), their toxicity to *Phytoseiulus persimilis* (Athias-Henriot) and their role in integrated pest management programs

Adam Root, Clare Sampson, Jennifer Lewis

Biological Crop Protection Ltd. Occupation Road, Wye, Ashford, Kent. TN25 5EN, AdamR@biological-crop-protection.co.uk

Abstract: Eradicoat and Eradicoat T are physically acting insecticides based on Maltodextrin. They control a wide range of insect pests. Trials on pepper plants resulted in control of *Tetranychus urticae* that was comparable to conventional pesticides. Although direct spray would be harmful to *Phytoseiulus persimilis* there is no residual toxic effect, allowing these predatory mites to re-colonize or be re-introduced into treated areas immediately following treatment. This makes Eradicoat and Eradicoat T very valuable tools in an IPM program.

Development and implementation of biological control of spider mites in Oregon nurseries

Robin Rosetta

Oregon State University, Department of Horticulture, North Willamette Research and Extension Center, 15210 NE Miley Rd., Aurora, OR 97002-954, USA, robin.rosetta@oregonstate.edu

Abstract: A research program was developed to promote the implementation of a biological control program for management of spider mites in outdoor nurseries in Oregon. Experiments were conducted to select appropriate phytoseiid species; study mite dispersal; develop application rates, timing, and strategies; and assess factors to improve success of implementation in commercial sites. The predator *Neoseiulus fallacis*, proved most adapted for the program. Establishment and spider mite suppression was most successful in broadleaved shrubs, particularly planted in blocks with a continuous canopy. Augmentative releases were considered unlikely to be successful in shade tree production.

Developments in the use of predatory mites for biological pest control

Maurice W. Sabelis, Arne Janssen, Izabela Lesna, Nyanie S. Aratchige, Maria Nomikou, Paul C.J. van Rijn

Section Population Biology, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Kruislaan 320, 1098 SM Amsterdam, The Netherlands, sabelis@science.uva.nl

Abstract: Predatory mites (Acari: Phytoseiidae, but now also Laelapidae) have gained momentum as agents for successful biocontrol of plant pests. The time has gone where they were mainly considered for the control of spider mites. Various new predatory mite species have been identified for the control of other groups of pests, either plant-feeding insects or mites other than spider mites, feeding on either above-ground or below-ground plant parts and feeding either concealed in plant structures or exposed on a leaf. However, do we really understand why these predatory

mites are so effective? In this article we review the underlying mechanisms and generate new questions, based on case studies of our own research on biocontrol of thrips, whiteflies, bulb mites and eriophyid mites with the use of predatory mites. Finally, we ‘wrap up’ by providing a brief ecological and phylogenetic perspective on predatory mites and their use in biocontrol.

Using bees to disseminate multiple fungal agents for insect pest control and plant disease suppression in greenhouse vegetables

Les, Shipp¹, Jean Pierre Kapongo¹, Peter Kevan², John Sutton², Bruce Broadbent³

¹Agriculture and Agri-Food Canada, Harrow, ON Canada N0R 1G0, shippl@AGR.GC.CA; ²Department of Environmental Biology, University of Guelph, ON, Canada N1G 2W1; ³Agriculture and Agri-Food Canada, London, ON Canada N5V 4T3

Abstract: The bumble bee (*Bombus impatiens*) was used to vector a combined inoculum consisting of *Beauveria bassiana* (BotaniGard 22 WP) and *Clonostachys rosea* (ADJ 710 OMRI) in greenhouse tomato and sweet pepper for simultaneous control of insect pests (*Lygus lineolaris* and *Trialeurodes vaporariorum*) and plant disease suppression of grey mould. Four densities, 1) $6.24 \times 10^{10} + 1.38 \times 10^8$; 2) $6.24 \times 10^{10} + 1.38 \times 10^7$; 3) $3.12 \times 10^{10} + 1.68 \times 10^8$; 4) $9.36 \times 10^{10} + 1.06 \times 10^8$ conidia of *B. bassiana* and *C. rosea* respectively per g of inoculum and 5) a control (bees, but no inoculum) were assessed. Ninety-six, 47 and 88% of the bee, pest insect and plant samples contained detectable amounts of *Beauveria* and *Clonostachys*. Infection levels for both pest species, as well as disease suppression were greatest at the highest concentrations of both agents. However, bee mortality was also significantly greater at the highest concentration of *Beauveria*. Therefore, the optimal combined concentration ratio of *Beauveria* and *Clonostachys* was 6.24×10^{10} *B. bassiana* + 1.38×10^7 *C. rosea*.

Commercial application of beneficial insects in Canadian nurseries

Brian Spencer

Applied Bio-nomics Ltd., 11074 West Saanich Road, North Saanich, British Columbia, Canada, V8L 5P5, brianabl@telus.net

Abstract: Commercial applications of beneficial insects and mites have largely been limited to glasshouse production of food crops, such as pepper, tomato and cucumber. In the past decade, many of the same traditional commercial beneficials for biological controls have been used in outdoor nurseries, with excellent results. Today, many commercial nurseries use biological control as the primary pest control method. Many of the traditional beneficials have also found new applications.

A preliminary predictive model for the consumption of powdery mildew by the obligate mycophage *Psyllobora vigintimaculata* (Coleoptera: Coccinellidae)

Andrew Sutherland, M.P. Parrella

Department of Entomology, University of California, Davis, CA, USA, asutherland@ucdavis.edu

Abstract: Powdery mildews are important plant pathogens worldwide, often warranting chemical control measures. Effects on non-target organisms and resistance concerns have recently prompted the consideration of biological control. A cosmopolitan coccinellid tribe (Psylloborini) is composed of obligate consumers of powdery mildew. A western North American species, *Psyllobora vigintimaculata*, is being evaluated for its ability to consume spores and hyphae of mildews in greenhouses, in an attempt at augmentative biological control. A predictive consumption model has been created utilizing known biological attributes of the insect, a modified Leslie matrix, and an individual larval consumption model. The model has then been employed to simulate the population growth and subsequent removal of visible mildew colonies by the insects in a closed and controlled horticultural system. When compared against real data from a greenhouse efficacy trial, the model slightly underestimates consumption. Model limitations and assumptions are

discussed. The possibility of using such a model as a calculator to determine optimum insect release rate in a system with known parameters is also discussed.

Experimental studies on *Typhlodromips (Amblyseius) swirskii* in greenhouse cucumbers

Y. Trottin-Caudal¹, J.-M. Leyre¹, V. Baffert¹, C. Fournier¹, C. Chabrière²

¹Centre Technique Interprofessionnel des Fruits and des Légumes, BP 32, 30 127 Bellegarde, France, Trottiny@ctifl.fr;

²Association Provençale de Recherche et Expérimentation, Route de Mollégès, 13210 St Rémy de Provence, France

Abstract: The major pests on cucumber are whiteflies and thrips. Trials were conducted to evaluate the efficacy of *Typhlodromips swirskii* released in sachets in greenhouse cucumber crops in the Southeast of France as well as studying the side effects of a few chemical products in field tests. *T swirskii* was an excellent predator of thrips and whiteflies at the dose of one sachet per three plants. Among tested products, only Vertimec (abamectin) showed a real toxicity on the predator.

Plant health in innovative growing systems

Carin van der Lans, Ellen Beerling, Pierre Ramakers

Wageningen UR Glasshouse Horticulture, Violierenweg 1, 2665 MV Bleiswijk, Post Box 20, 2665 ZG Bleiswijk, The Netherlands, Pierre.Ramakers@wur.nl

Abstract: ‘Closed greenhouses’ and ‘mobile cropping systems’ are important innovations in Dutch glasshouse horticulture. A survey was done on their consequences for (integrated) plant protection. Based on a literature study and interviews with experts, opportunities and threats were identified, as well as aspects requiring further study, with the principle of sustainable horticultural as a guideline.

***Silene dioica* (Caryophyllaceae: Silenoidea) as a reservoir and a hibernation site for predatory mites (Acari: Phytoseiidae)**

Anton van der Linden

Wageningen UR, Applied Plant Research, Flower bulbs, Nursery Stock & Fruits, Lisse, The Netherlands, current address: Wageningen UR Greenhouse Horticulture, P.O. Box 20, 2665 ZG Bleiswijk, The Netherlands, anton.vanderlinden@wur.nl

Abstract: On leaves of Red Campion *Silene dioica* (L) (*Melandrium rubrum*) collected in three successive seasons in The Netherlands, nine species of predatory mite species were identified. *Amblyseius andersoni* was the predominant species with 74% of the overall number of the specimens. Other species were, in order of abundance: *Neoseiulus cucumeris*, *Euseius finlandicus*, *Amblyseius graminis*, *Amblyseius rademacheri*, *Proprioseiopsis okanagensis*, *Amblyseius isuki*, *Typhlodromus pyri* and *Amblyseius reductus*. *Amblyseius andersoni* was found hibernating on the lower leaves of this plant.

Natural occurrence and establishment of predatory mites (Acari: Phytoseiidae) on nurseries for amenity trees

Anton van der Linden

Wageningen UR, Applied Plant Research, Bulb Growing, Nursery Stock and Fruit Growing, Lisse, The Netherlands, current address: Wageningen UR Greenhouse Horticulture, P.O. Box 20, 2665 ZG Bleiswijk, The Netherlands, anton.vanderlinden@wur.nl

Abstract: Natural occurrence of predatory mites on cultivars of *Fraxinus*, *Tilia*, *Acer* and *Carpinus* was investigated on 4 nurseries in 2004 and 2005. *Amblyseius andersoni* (Chant), *Euseius finlandicus* (Oudemans), *Neoseiulus californicus* (McGregor) and *Typhlodromus pyri* Scheuten were the most common species. Occasionally, *Phytoseiulus persmilis* Athias-Henriot, *Neoseiulus cucumeris* (Oudemans), *Kampimodromus aberrans* (Oudemans) and *Paraseiulus triporus* (Chant & Shaul) were encountered. Releases of *Amblyseius andersoni* resulted in higher numbers of this predator on *Acer platanoides*, *Tilia platyphyllos* and *Fraxinus* cultivars, but this effect did not persist into the next season. *Kampimodromus aberrans* was found in high numbers on an older tree of *Tilia platyphyllos*. After being transferred to nursery trees of the same species, this species was outnumbered by other predatory mites.

Market demands for food safety: perception of a public sale company

Arie van der Linden

The Greenery, Spoorwegemplacement 1, 2991 VT Barendrecht, POB 79, 2990 AB Barendrecht, The Netherlands

Abstract: The Greenery bv is a market-oriented sales company whose shares are owned by the producers who are members of the horticultural cooperative The Greenery U.A. The 1,350 producer-owned member companies market all their products via The Greenery. The Greenery B.V. is one of the leading concerns in Europe in the vegetable, fruit and mushroom sector. The main activity of The Greenery is to provide a complete range of vegetables, fruit and mushrooms to supermarket chains in Europe, North America and the Far East throughout the year. Other major target groups are wholesale businesses, catering companies and industrial processing companies. Food safety, sustainability, innovation and logistic efficiency have a high priority in all The Greenery's activities. The company has some 2,500 employees. Recent developments have put food safety at the top of the consumer agenda. As a response to pressure from consumer and non-governmental groups, retailers have increased their demands on their suppliers. Examples of these increasing demands are the MRL-demands that surpass national and international legislation. To meet these demands, Integrated Pest Management has become a pillar of food safety policy. Arie van der Linden, director Quality and Environment of The Greenery, will elaborate on the changed market demands and the role of IPM. A short overview of recent developments in Dutch horticultural industry is presented focussing on four topics: optimal use of the greenhouse area, maximal utilization of light, reduction of energy use and complete control of the greenhouse environment.

The generalist predator *Typhlodromalus limonicus* (Acari: Phytoseiidae): a potential biological control agent of thrips and whiteflies

Yvonne M. van Houten, Julietta Rothe, Karel J.F. Bolckmans

Koppert Biological Systems, P.O. Box 155, 2650 AD Berkel en Rodenrijs, The Netherlands, yvhouten@koppert.nl

Abstract: A strain of the phytoseiid predatory mite *Typhlodromalus limonicus* Garman & McGregor, collected from tomatoes, was tested in a laboratory study as a biological control agent of *Trialeurodes vaporariorum*, *Frankliniella occidentalis* and *Tetranychus urticae*. The following features were tested on cucumber leaf discs: (1) predation and oviposition rate with small *F. occidentalis* larvae as prey, (2) oviposition rates on different juvenile stages of *T. vaporariorum*, (3) oviposition rates on different stages of *T. urticae*. The oviposition rate on young, white eggs of *T. vaporariorum* was also tested on tomato leaf discs. The results showed that *T. limonicus* exhibits a high predation and oviposition rate on a diet of thrips larvae and a high oviposition rate on white eggs, on crawlers and on a mix of the 2nd and 3rd instars of *T. vaporariorum*. The oviposition rate on older, brown eggs of *T. vaporariorum* was much lower. *T. limonicus* produced less eggs on a diet of *T. urticae*. The predator was hampered by the webbing of the spider mites. The oviposition rate on white eggs of *T. vaporariorum* on tomato was significant lower than on cucumber but was still 3

eggs per day. The suitability of this candidate for biological control of whiteflies on tomato remains to be shown in greenhouse experiments.

Prey preference of the generalist predator *Amblyseius swirskii*

Roos van Maanen, Arne Janssen

University of Amsterdam, IBED, Institute for Biodiversity and Ecosystem Dynamics, Department of Population Biology, Kruislaan 320, 1098 SM Amsterdam, The Netherlands, rmaanen@science.uva.nl

Abstract: Recent research has shown that with a mixed diet of whitefly eggs and first instar thrips, juvenile survival and developmental rate of the predatory mite *Amblyseius swirskii* was significantly higher than on either prey species separately. We studied the prey choice of the mite in a pilot laboratorial experiment in order to detect a preference to uptake of a diet of two different prey species instead of one. Our preliminary results suggest that mites previously fed on whitefly eggs have a preference for first instar thrips larvae. To verify whether this is due to a preference for a varied diet or due to the fact that whitefly eggs are an inferior diet, replication of the experiments and further examination are needed.

The release of beneficials in greenhouses with an air blower, a new wind in biocontrol

Jeroen van Schelt, Alex Tetteroo, Hans Hoogerbrugge, Rene Veenman, Karel Bolckmans

Koppert B.V., Veilingweg 17, P.O. Box 155, 2650 AD Berkel en Rodenrijs, The Netherlands, JvSchelt@Koppert.nl

Abstract: A new type of air blower for releasing predatory mites in greenhouse crops has been developed. With this new type air blower predatory mites with a carrier material can be dispersed over the crop up to 5 meters to each side without mechanically damaging the mites. Even distribution of beneficials throughout the crop improves biocontrol in crops like roses, chrysanthemum, and pot plants. Labour costs for distribution biological control agents can be reduced up to 80%.

Knowledge transfer of IPM to Finnish ornamental growers in 2004-07

Irene Vänninen¹, Marika Linnamäki², Pauliina Laitinen¹

¹AgriFood Research Finland MTT, Plant Production Research, 31600 Jokioinen, Finland irene.vanninen@mtt.fi;

²Biotus Oy, Särkeläntie 6, 30100 Forssa

Abstract: In 2004, a three-year technology transfer project “Integrated Pest Management (IPM) in Ornamental Production” (INTO) was launched in Southern and Western Finland to support greenhouse growers in switching to IPM. In the 25 pilot companies totalling 22 ha, area under IPM doubled during the project. IPM elements included pest monitoring, preventive control, biocontrol and biorational pesticides as part of resistance management. The proportion of pilot companies using biocontrol increased from 31% to 92%. In the end, 54% of the pilot companies were either very satisfied or satisfied with the efficacy of IPM, and 31% were rather satisfied. All pilot companies intended to continue IPM post-project at least in some part of their crop area. The total expenditures – including work input by the staff of pilot companies - to achieve these results was 33966 euros/ha.

Food for thought: how to cater to the nutritional needs of biological control agents?

Felix L. Wäckers

Centre for Sustainable Agriculture, Lancaster Environment Centre, Lancaster University, Lancaster LA1 4YQ, United Kingdom, f.wackers@lancaster.ac.uk

Abstract: Predaceous and parasitic arthropods can play an important role in the regulation of herbivore populations. However, the majority of predators and parasitoids also use plant-derived foods as a source of nutrients. This vegetarian side of the menu may include various plant-provided substrates, such as nectar, pollen, or foods indirectly derived from plants (e.g. honeydew). Predators and parasitoids may either use plant-derived food as a supplement, or they may strictly depend on these foods during part of their life. Plant-provided foods can have a dramatic impact on longevity, fecundity, and distribution of predators and parasitoids. Each of these parameters affects herbivore-carnivore dynamics in the field. Modern agricultural systems are characterized by a scarcity of nectar and pollen sources, which can severely compromise the effectiveness of biological pest control. Despite the obvious importance of non-prey food, little is known about the extent to which particular categories of plant-derived foods contribute to the diet of predators and parasitoids under field conditions. Novel technologies allow us to better study the factors that limit survival, dispersal and efficiency of natural enemies under field conditions. These insights will allow us to target these bottlenecks through informed design of cropping systems that address food, prey and shelter requirements of key biocontrol agents.

Recent progress in IPM and biological control in Japan

Eizi Yano

Kinki University, Faculty of Agriculture, Entomological Laboratory, Nakamachi 3327-204, Nara 631-8505, Japan, yano@nara.kindai.ac.jp

Abstract: I summarise the recent progress in biological control and integrated pest management (IPM) in greenhouses in Japan. Two indigenous predators, the big-eyed bug *Piocoris varius* and a predaceous thrips *Haplothrips brevitubus*, have been tested as new biopesticides of macro-organisms in Japan. Both species are polyphagous predators. *P. varius* can be used for simultaneous control of thrips, aphids and spider mites. *H. brevitubus* can be released to control thrips before the release of *Orius strigicollis*. *H. brevitubus* suppresses the initial increase of thrips and can be consumed by *O. strigicollis* when it starves. A new method using native populations of natural enemies in the field has been developed. *Orius* spp. populations are conserved in the field by planting landscape plants. Special instruments have been developed to collect *Orius* populations in the field and to release them in greenhouses. A banker plant system to establish *Aphidius colemani* has been developed to control *Aphis gossypii* on eggplant in Japan using wheat, barley or oat seedlings infested with *Rhopalosiphum padi* as banker plants. This method can be used for preventive release of natural enemies. Biological control of whiteflies on greenhouse tomatoes is hampered by tomato yellow leaf curl virus (TYLCV) transmitted by *Bemisia tabaci*. Since the whitefly density necessary to transmit TYLCV is very low, farmers do not use natural enemies such as *Encarsia formosa*. Whiteflies are controlled by insect screens, proper use of pesticides and removal of infected tomato plants within and around greenhouses. Whiteflies on tomato plants after harvest are killed by high a temperature treatment involving sealing greenhouses under sunshine.

Creating crop solutions in chrysanthemums by using the combined strengths of beneficials and chemicals

Martin Zuijderwijk¹, Caroline van den Hoek¹, Jan Mostert²

¹Syngenta Bioline Ltd, Holland Road, Little Clacton, Essex, CO16 9QG, United Kingdom, martin.zuijderwijk@syngenta.com; ²Syngenta Crop Protection, Jacob Obrechtlaan 3a, 4611AP Bergen op Zoom, The Netherlands

Abstract: Chrysanthemums are known as a difficult crop for the use of beneficials due to the short crop cycle and low thresholds for pests. Because of the loss of important crop protection products, conventional chemical control of pests has become increasingly difficult. Growers needed to approach crop protection in a different way. Over the last seven

years, Syngenta has worked with growers and distributors to create a successful and practical Integrated Crop Management programmes which has resulted in an increase in successful use of beneficials from 5% in 2003 to 85% in 2007.

POSTERS

A review of thrips (Insecta: Thysanoptera) fauna of ornamental plants in Iran

Valiollah Baniameri, Ebrahim Gilasian

Iranian Research Institute of Plant Protection (IRIPP), P. O. Box: 19395/1454 Tehran, Iran, baniameri@yahoo.com

Abstract: A faunistic study was carried out to collect and identify thrips of ornamental plants in Tehran, Markazi and Mazandaran provinces which are located in the north and central parts of Iran during 2002 to 2005. The thrips species were collected from more than 100 species of ornamental plants in greenhouses or in open fields. In this study we report 18 species belonging to the families Thripidae, Aeolothripidae and Phlaeothripidae. We also include the 5 previously recorded species. A total of 23 species, genus *Thrips* with 7 species had the most diversity and *Thrips tabaci* was collected in all greenhouses. The collected (18 species) and reported (5 species) are listed as follows: A: suborder: Tubulifera, Family: Phlaeothripidae: *Hoplandrothrips bidens* (Bagnall), *Haplothrips reuteri* (Karney), *Haplothrips tritici* (Kurdjumov), *Haplothrips subtilissimus* (Haliday). B: suborder: Terebrantia, Family: Aeolothripidae: *Aeolothrips intermedius* Bagnall *Aeolothrips fasciatus* (Linnaeus), Family: Thripidae: *Scolothrips longicornis* Priesner, *S. latipennis* Priesner, *Microcephalothrips abdominalis* (Crawford), *Thrips physapus* Linnaeus, *T. atratus* Haliday, *T. meridionalis* Priesner, *T. major* Uzel, *T. tabaci* Lindeman, *T. simplex* (Morison), *T. vulgatissimus* Haliday, *Frankliniella occidentalis* Pergande, *F. schultzei* (Trybom), *F. intonsa* (Trybom), *F. tenuicornis* (Uzel), *F. pallida* (Uzel), *Tenothrips discolor* (Karny), *T. frici* (Uzel).

Novel products for control of American serpentine leafminer *Liriomyza trifolii* in greenhouse floriculture

L. Conroy¹, A.B. Broadbent², C.D. Scott-Dupree¹, C.R. Harris¹, G. Murphy³

¹*Department of Environmental Biology, University of Guelph, Guelph, ON Canada N1G 2W1, lconroy@uoguelph.ca;*

²*Southern Crop Protection Food Research Centre, Agriculture and Agri-Food Canada, London, ON Canada N5V 4T3;*

³*Ontario Ministry of Agriculture, Food and Rural Affairs, Vineland, ON Canada L0R 2E0*

Abstract: The American serpentine leafminer (ASL), *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae), is a serious pest of chrysanthemum and gerbera daisy in greenhouse floriculture. Growers in Ontario have recently reported decreased ASL control using registered insecticides. Research suggests that this strain of ASL, accidentally imported from the United States on contaminated propagation material, is resistant to both Avid® and Citation®. In light of this insecticide resistance, it is important to develop an effective multifaceted IPM program to control this greenhouse pest. Previous research has suggested that plant anti-desiccants can repel ASL, decreasing both feeding and oviposition. This study investigates the efficacy of two products, Wilt-Pruf® and VaporGard®, as repellents against ASL on chrysanthemum. When given a choice between treated and non treated chrysanthemums, ASL consistently chose non-treated chrysanthemums for feeding and oviposition. Significantly fewer ASL mines developed on treated plants compared to the non-treated plants when ASL were exposed to chrysanthemums for 6 days.

Integrated management of powdery mildew and grey mould of greenhouse pepper in Egypt

Wafaa M. Haggag

Department of Plant Pathology, Division of Agricultural Research and Biology, National Research Center, Egypt

Abstract: Powdery mildew, caused by *Leveillula taurica* and grey mould caused by *Botrytis cinerea* are the most important diseases of greenhouse pepper. Various environmentally friendly natural compounds as the biological control agents (BCAs) (*Verticillium lecanii*, *Rhodotorula glutinis* and *Tilletiopsis minor*); mineral salt (phosphate solutions, KH₂PO₄); antitranspirant (kaolin) and antioxidant (ascorbic acid) applied independently or in mixtures as alternatives to chemical fungicides were evaluated for their efficacy in controlling pepper powdery mildew and grey mould in an integrated management system. Application of BCAs, kaolin alone and/or in combination with KH₂PO₄ in vitro to mango leaf disks before inoculation with *L. taurica* or *B. cinerea* markedly decreased conidial germination and leaf

infection. The largest decrease was obtained with combined treatments. In commercial greenhouse trials during 2005 and 2006 in El-Noubaria naturally infected by powdery mildew and grey mould, each treatment, applied at 15 d intervals effectively controlled *L. taurica* on leaves and *B. cinerea* on leaves, fruit and stem. BCAs and kaolin treatments were superior in reducing grey mould infection. Powdery mildew was inhibited by using a mixture of BCAs with or KH_2PO_4 . Other tested compounds, such as ascorbic acid as a single treatment or in combination with other compounds showed some effectiveness in reducing powdery mildew and grey mould diseases severity. Mixtures of all four natural compounds were more effective in significantly reducing diseases severity and conidia counts on leaves and fruits and increasing fruit yields than mixtures of two or three or single applications. BCAs, mineral salts, antitranspirant and antioxidant in combinations could be used in an integrated management system to control powdery mildew and grey mould in greenhouse pepper.

Ceratitis capitata* larvae as an alternative food source for *Macrolophus caliginosus

Mauro Nannini¹, Luca Ruiu, Ignazio Floris²

¹AGRIS Sardegna, V.le Trieste 111, 09123 Cagliari, Italy, laiu@cras.sardegna.it; ²Dipartimento di Protezione delle Piante, University of Sassari, Via E. De Nicola, 07100 Sassari, Italy

Abstract: The suitability of mature larvae of the Mediterranean fruit fly, *Ceratitis capitata*, as an alternative food source for the predatory bug *Macrolophus caliginosus*, was evaluated in comparison with other standard preys. Our experiment results show that this fictitious prey is accepted by all stages of the mirid bug, although specimens reared on fruit fly larvae are not as performing as those reared either on *T. vaporariorum* immatures or *E. kuehniella* eggs. Nevertheless the use of this prey could be envisaged for mass rearing purposes in reason of its low cost.

A novel use of *Ceratitis capitata* for biological control programs

Mauro Nannini, Francesco Foddi, Giovanni Murgia, Riccardo Pesci, Francesco Sanna

AGRIS Sardegna, V.le Trieste 111, 09123 Cagliari, Italy, laiu@cras.sardegna.it

Abstract: Fruit flies are currently reared worldwide for IPM purposes (SIT programs, parasitoid rearing). In the present work a novel use of the Mediterranean fruit fly, *Ceratitis capitata*, as food source for *M. caliginosus* is proposed. Quality control tests have shown that the mirid bugs reared on a fruit fly larvae-based diet meet quality standards proposed by IOBC for this beneficial. Individuals fed the fictitious prey exhibit similar predation efficiency to insects reared on the natural prey *Trialeurodes vaporariorum*. On the other hand, the availability of *C. capitata* larvae on tomato plants failed to enhance the establishment of the predatory bug in commercial crops.