Field results of a sachet release system using the predator
Amblyseius swirskii (Athias-Henriot) (Acari: Phytoseiidae)
and the factitious prey, Suidasia medanensis Oudemans (Acari: Astigmata)
Ian Baxter, Audun Midthassel, Ward Stepman, Robert Fryer,
Fernando Puerto Garcia, Jennifer Lewis, Phil Walker, Jan Hulshof ................. 1-4
Abstract: Using sachets as a delivery system for the predatory mite Amblyseius swirskii into a
crop is popular with growers as the inoculation of predators is slower and provides an element of
flexibility over the timing of the introduction. The sachet itself is a complicated micro-
environment, providing refuge and food for A. swirskii, generally in the form of a factitious host
mite, Carpoglyphus lactis, which itself is sustained by materials within the sachet. The sachet
should be able to maintain a breeding population of A. swirskii, whilst releasing predators at the
appropriate rate and duration. This paper describes four field trials undertaken in different
climates to compare the C. lactis prey mite sachet system with that of an alternative prey mite,
Suidasia medanensis. It was found that C. lactis released predators more rapidly than the
S. medanensis system in the first seven-days. However, the release profile of the S. medanensis
sachets demonstrated a more sustained presentation of A. swirskii into the crop during subsequent
weeks. The implications of these different release profiles for the end-users are discussed.

Reducing pesticide emission from greenhouses: a joint agenda setting
Ellen Beerling ............................................................ 5-9
Abstract: Despite a high degree of IPM in the Netherlands, pesticides used in greenhouse
horticulture are exceeding environmental quality standards for surface water. In this paper the
joint fact-finding en agenda setting by stakeholders are described. An overview is given of the
emission routes in hydroponic growing systems and emission reducing measures and remaining
questions are discussed.

Biotype, origin and insecticide resistance of Bemisia tabaci interceptions in the UK:
Implications for IPM
Howard Bell, David Fleming, Andrew Cuthbertson, Michelle Powell,
Phil Northing ............................................................ 11-14
Abstract: Limited information is available with respect to Bemisia tabaci biotypes entering the
UK and whether insecticide resistance within outbreak populations occurs. Using a PCR-based
TaqMan assay, historic B. tabaci interceptions were analysed, of which 57% were determined to
be Q-type and 26% B-type. A number of very recent interceptions were exclusively Q-type.
Phylogenetic analysis indicated that plant origin is a good indicator of the source populations of
B. tabaci for some countries/regions but not for others. A recently established field strain (Q-
type) was shown to be highly resistant to imidacloprid, acetamiprid and pymetrozine but no
tolerance to flonicamid was seen. The findings indicate that B. tabaci entering the UK are mostly
Q-types that may exhibit high levels of resistance to insecticides commonly used for their control
and, because of this, IPM/biological strategies must be developed that remove overreliance on the
chemical eradication of this insect.
The potential use of flowering alyssum as a ‘banker’ plant to support the establishment of *Orius laevigatus* in everbearer strawberry for improved biological control of western flower thrips

**Jude Bennison, Tom Pope, Kerry Maulden**  ............................................................ 15-18

**Abstract:** Western flower thrips (WFT), *Frankliniella occidentalis* has recently become a serious pest of everbearer strawberry in the UK due to increasing problems with resistance to spinosad. Biological control of WFT with *Neoseiulus* (*Amblyseius*) *cucumeris* on everbearers is currently unreliable on farms with high WFT population densities. *Orius laevigatus* has good potential for use in combination with *N. cucumeris*, but is expensive to release and slow to establish on the crop, particularly when strawberry flowers are scarce. In a pilot experiment, flowering alyssum, *Lobularia maritima* proved to be a good host plant for *O. laevigatus*. Once established on the alyssum, *O. laevigatus* quickly dispersed to and established on flowering everbearer plants and rapidly reduced numbers of WFT. Alyssum has a long flowering period and has the potential for use as a combined ‘trap’ plant for WFT and ‘banker’ plant to support *O. laevigatus* populations in everbearer strawberry for improved biological control within an IPM programme.

The use and exchange of biological control agents worldwide

**Jacques Brodeur**  ..................................................................................... 19

Abstract only

Developing a biologically-based IPM program for western flower thrips, *Frankliniella occidentalis*, in greenhouse floriculture

**Michael Brownbridge, Taro Saito, Rose Buitenbuis, Angela Brommit, Graeme Murphy**  .................................................................................................... 21-24

**Abstract:** Few conventional insecticides registered in Canada today effectively control western flower thrips. Consequently, biological control agents are increasingly used. Recommendations and procedures developed for these natural enemies in vegetable crops though, do not translate directly to ornamentals. Furthermore, as tolerance for cosmetic damage is extremely low, a single biocontrol agent (the pesticide paradigm) rarely provides satisfactory levels of control. Strategic selection and use of several natural enemies together, within a bio-based IPM program, can provide an effective solution. Here, we report on trials on interactions between different natural enemies; by taking an integrated approach to their deployment, we are aiming to achieve maximum efficacy in the most cost-effective manner.

Does foliar trichome density affect walking activity and speed of *Aphidius colemani*, and its rate of parasitism of *Aphis gossypii* on chrysanthemum?

**Vanda H. P. Bueno, Marcus V. Sampaio, Joop C. van Lenteren, Maria C. M. Soglia**  .................................................................................................. 25-28

**Abstract:** The parasitoid *Aphidius colemani* is one of the major biological control agents of *Aphis gossypii* and plays an important role in the regulation of aphid populations on chrysanthemum under protected cultivation. The high density of foliar trichomes of the aphid resistant chrysanthemum cultivar White Reagan (WR) reduces the survivorship and fecundity of *A. gossypii*. The objective of this study was to evaluate the influence of chrysanthemum foliar trichome densities on the walking speed, walking activity and rate of parasitism of *A. colemani* on *A. gossypii*. Leaf discs of the aphid susceptible cultivar Yellow Snowdon (YS) or the resistant cultivar WR were put in Petri dishes to evaluate the walking activity and walking speed of *A. colemani* in the absence of hosts. The parasitism of the 2nd and 3rd instar nymphs of *A. gossypii*, reared on the two cultivars, was evaluated by counting the number of hosts containing parasitoid larvae. Parasitoid walking activity (= % time active of total time on leaf) was higher on WR (64%) than on YS (47%). No significant differences were observed in the walking speed of and the rate of parasitism by *A. colemani* on *A. gossypii* on the two cultivars, so in this case the characteristic of aphid resistance of WR may positively influence the reduction of the aphid population by *A. colemani*.
Can trichome density explain the differences in behaviour and performance of *Amblyseius swirskii* on greenhouse ornamentals?

*Rose Buitenhuis, Les Shipp, Cynthia Scott-Dupree, Angela Brommit, Wonhyo Lee*

**Abstract:** Biological control in ornamental crops is challenging due to the wide diversity of crops and cultivars. In this study, we tested the hypothesis that trichome density on different host plants influences the behaviour (walking speed and prey finding) and performance (predation and oviposition capacity) of the predatory mite *Amblyseius swirskii* Athias-Henriot (Acari: Phytoseiidae). Tests were done on leaf disks of ornamental plant species differing in trichome density (rose, chrysanthemum and gerbera) and compared to a smooth surface (plastic). Thrips (*Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae)) were used as prey. Behaviour and performance of *A. swirskii* were influenced by plant species. Up to a certain density of trichomes, trichome number had a negative effect. Walking speed was highest on plastic, followed by rose. No differences were found between chrysanthemum and gerbera. Proportion of time spent walking was the same on leaf disks of all plant species. Predation of thrips was highest on gerbera and least on rose. Predation rates on chrysanthemum and plastic were intermediate. In contrast, no differences in oviposition rate were found among plant species. According to these results, release rates of *A. swirskii* may need to be adjusted depending on the crop in which it is used.

Evaluation of *Trichogramma brassicae* for the control of carnation tortrix moth and light brown apple moth in protected nursery stock

*John Buxton, David Talbot*

**Abstract:** Initial experiments using insect cages to contain host and parasitoid showed that *Trichogramma brassicae* (as Tricholine from Syngenta Bioline Ltd.) were able to successfully parasitise egg masses of carnation tortrix moth (*Cacoecimorpha pronubana*), providing that the eggs were young and pale green when parasitoids were active. Egg masses turned black about 10 days after being parasitised. Mature egg masses, which were yellower in colour, were not parasitised. Tests in the laboratory showed that *Trichogramma* adults emerged from parasitised eggs on cards between 9 and 13 days (mean 11 days) after delivery. This time interval needs to be taken into account when planning introductions of this beneficial. A further trial on *Chaenomeles* plants in a polythene tunnel on a commercial nursery, which were naturally infested with light brown apple moth (*Epiphyas postvittana*), showed that weekly introductions of the parasitoid at 20 per m$^2$ between mid June and mid September gave good control over this period, although two applications of Dipel DF (*Bacillus thuringiensis*) were also needed to ensure complete control.

Dispersal of *Trichogramma ostriniae* (Hymenoptera: Trichogrammatidae) in greenhouse pepper for biological control of European corn borer

*Ostrinia nubilalis* (Lepidoptera: Crambidae)

*Gillian Ferguson, Tom MacDonald*

**Abstract:** The European corn borer (*Ostrinia nubilalis* Hübner), is an economic pest of greenhouse sweet pepper in Ontario and no adequate biological controls currently exist for this pest. The objective of this study was to investigate the potential of an egg parasitoid, *Trichogramma ostriniae* Pang *et al.*, as a biocontrol agent for ECB. Results of this study indicate that *T. ostriniae* can disperse to the upper canopy of greenhouse peppers. Although the number of infested fruits obtained from treated plots was not significantly less than that in the control plots, further work with release rates and strategies to prolong the period of emergence and longevity of the parasitoids are needed to determine if such factors can significantly reduce damage by ECB in greenhouse peppers.
Progress towards biological control of *Bactericera cockerelli* in covered crops in New Zealand
Robin Gardner-Gee ................................................................. 41-45

Abstract: *Bactericera cockerelli* is a North American pest species known in New Zealand as the tomato/potato psyllid (TPP). First reported in New Zealand in 2006, it has now become a major pest on both greenhouse and outdoor solanaceous crops in New Zealand. Effective biological control agents are urgently needed to increase and improve control options for growers. Searches conducted within New Zealand have identified a number of psyllid predators that are potential biocontrol agents for TPP. In addition, in 2009 a North American parasitoid, *Tamarixia triozae*, was imported into quarantine facilities at Plant & Food Research, Auckland, for assessment as a biological control agent for TPP.

Integrated Pest Management solutions for the control of *Polyphagotarsonemus latus* in ornamentals: from trial to practice
Bruno Gobin, Marc Vissers, Els Pauwels ................................................. 47-50

Abstract: The broad mite *Polyphagotarsonemus latus* is a major pest of ornamental crops, with outbreaks causing serious economic damage. Due to the disappearance of broad spectrum pesticides, control of broad mites proves to be a serious challenge for growers. Recent research focus on biological control of this pest showed promising results that could be implemented in an Integrated Pest Management (IPM) approach. In this paper we describe results of trials testing the biological efficacy of 2 complementary control strategies: biological and physical. In field trials on the sensitive ornamental plant Azalea, we show the strength of both independent strategies and suggest how these could be alternated to control broad mites throughout the production cycle.

Combined use of a mulch layer and the soil-dwelling predatory mite *Macrocheles robustulus* (Berlese) enhance the biological control of sciarids in potted plants
Amir Grosman, Gerben Messelink, Eric de Groot .............................................. 51-54

Abstract: Soil-dwelling predatory mites are important predators of sciarid flies (*Bradysia* spp.). The predatory mite *Macrocheles robustulus*, has been commercially available since 2010. The effectiveness of this predator in the control of sciarid flies has, however, not yet been tested. In this study we compare the effectiveness of *M. robustulus* and the frequently used *Hypoaspis aculeifer* in controlling sciarids in potted chrysanthemum under greenhouse conditions. We also evaluate the potential of using a mulch layer to improve establishment, population increase and performance of the predators. Both predators had a significant impact on sciarid densities, with a reduction of 97.1% by *M. robustulus* and 87.1% by *H. aculeifer*. When the predators were introduced in combination with a mulch layer of Biotop®, predator densities increased by a factor 3.1 for *M. robustulus* and 11 for *H. aculeifer*. The increase of predatory mite density was associated with an increase in the density of astigmatid mites, on which the predators were reared and that were introduced simultaneously with the predators. Sclerid density was reduced by 99.5%, when *M. robustulus* was introduced together with the Biotop® mulch layer, significantly lower compared to treatments with *H. aculeifer* with or without Biotop®. These results demonstrate that *M. robustulus* is an effective predator of *Bradysia* spp. and that in combination with Biotop® it provides better control than the frequently used *H. aculeifer*.

Control of whitefly (*Trialeurodes vaporariorum* (Westwood)) and thrips (*Thrips tabaci* Lindeman) with the predatory Phytoseiid mite *Typhlodromips montdorensis* (Schicha) on cucumber plants
Neil D. Holmes, Richard M. GreatRex ................................................................. 55-58

Abstract: In a commercial semi-field trial in England, the predatory mite *Typhlodromips montdorensis* (Schicha) gave 97% control of *Trialeurodes vaporariorum* (Westwood) and 100% control of *Thrips tabaci* Lindeman larvae. Mites were applied to the plants in a preliminary commercial formulation in proprietary paper sachets. From a single release point mites spread
from the top to the bottom of plants in large numbers, and the presence of all life stages demonstrates that they successfully established and bred on the plants. The peak mite population recorded on a single plant was 584 mites, of which 22% were eggs, 42% adults and 36% juveniles. Mites were present and easily visible amongst adult whiteflies in the heads of the plants.

**Biological control of greenhouse whitefly on roses with phytoseiid mites**

*Hans Hoogerbrugge, Yvonne van Houten, Markus Knapp, Karel Bolckmans ........... 59-63*

**Abstract:** The predatory mites *Amblyseius swirskii*, *Amblydromalus limonicus*, *Transennis montdorensis* and *Euseius ovalis* were evaluated as biological control agent of *Trialeurodes vaporariorum* on roses. When *A. swirskii*, *A. limonicus* and *E. ovalis* were released on separate plants in the same cage, *E. ovalis* increased to higher population levels than *A. swirskii* and *A. limonicus* but was not able to control the whiteflies. When *A. swirskii*, *A. limonicus* and *T. montdorensis* were released in separate cages, *A. limonicus* achieved a better control of whitefly populations than the other two predatory mites. In both cage trials only *A. limonicus* successfully controlled *T. vaporariorum*.

**Biological control of thrips and whitefly on strawberries with *Amblydromalus limonicus* and *Amblyseius swirskii***

*Hans Hoogerbrugge, Yvonne van Houten, Markus Knapp, Karel Bolckmans ........... 65-69*

**Abstract:** The performance of the predatory mite *Amblydromalus limonicus* was compared to *Amblyseius swirskii* in the control of thrips (*Frankliniella occidentalis*) and whiteflies (*Trialeurodes vaporariorum*) on greenhouse-grown strawberries. In addition, it was investigated if the provision of pollen as supplementary food improves the performance of *A. limonicus*. Both predatory mite species significantly reduced whitefly and thrips densities compared to the untreated control. Whitefly control was significantly better with *A. limonicus* than with *A. swirskii* whereas the differences in thrips control where less pronounced. The addition of pollen had a positive effect on the *A. limonicus* population but did not improve pest control.

**Tuta absoluta** Meyrick (Lepidoptera, Gelechiidae), a new pest in Montenegro

*Snežana Hrnčič, Sanja Radonjić ............................................................. 71-74*

**Abstract:** In the past few years *Tuta absoluta* has spread rapidly through Mediterranean countries. *Tuta absoluta* is considered to be one of the most important lepidopterous pests on tomato. The main area of tomato production in Montenegro is in the south of the country, where crops are typically grown in greenhouses. In order to detect the arrival of this pest, pheromone traps were set up in greenhouses, at four locations, at the beginning of July 2010. The first captured moths were found in the middle of July in one locality at the coast. In the period from the last week of July to the first week of August, large galleries in tomato leaves, green and ripe fruits were detected at all four monitored locations, as well as at some other sites. The same symptoms as those on tomato were detected on leaves of *Solanum nigrum*, which as a weed, is usually present around and inside greenhouses. At one location, during the end of August, symptoms were detected on aubergine leaves which were grown outdoors. From symptoms on infested plants, morphological features of larval instars, pupae and adult moths, the presence of *Tuta absoluta*, as a new pest in Montenegro, was confirmed.

**Hyperparasitoids: A threat to IPM of aphids on sweet pepper?**

*Rob Jacobson ............................................................. 75-78*

**Abstract:** This paper provides a brief introduction to hyperparasitism and explores the concept at various trophic levels. Studies in commercial pepper crops in the UK during 2010 are described in which seven different species of hyperparasitoid were detected. In addition, observations of intraguild predation are reported, which could also impact on the control of aphids by primary parasitoids. Finally, the paper considers how a thorough understanding of hyperparasitoid foraging behavior could enable us to interrupt the process and thereby reduce the commercial impact of hyperparasitism.
A potential role for entomopathogenic nematodes within IPM of 
*Tuta absoluta* (Meyrick) on organic tomato crops
Rob Jacobson, Gareth Martin  ................................................................. 79-83

**Abstract:** A series of four trials evaluated the potential of *Steinernema feltiae* and *S. carpocapsae* to control *Tuta absoluta* larvae in tomato leaves. In an initial ‘proof of concept’, high rates of 10 million nematodes/litre were found to be as effective as spinosad. The second trial demonstrated that 80% mortality could be achieved with 1 million *S. feltiae*/litre at a cost comparable to the standard chemical insecticide. The third and fourth trials evaluated the lower application rate on a large scale in a 1.17ha tomato crop using the nursery’s own robotic spray equipment. This provided 40-50% mortality. *Steinernema feltiae* could make an important contribution to the overall IPM programme by slowing down the population growth of *T. absoluta* while the primary biological control agents (*Nesidiocoris tenuis* or *Macrolophus* spp.) become established. This could be particularly important in organic tomato crops where there are very few effective alternatives.

*Aphidoletes aphidimyza* oviposition behaviour when multiple aphid pests are present in the greenhouse
Sarah Jandricic, John P. Sanderson, Stephen P. Wraight ........................................... 85-88

**Abstract:** The generalist aphid predator *Aphidoletes aphidimyza* was investigated for oviposition behaviour on the pest aphids *Myzus persicae* and *Aulacorthum solani* in greenhouse trials. Oviposition was significantly lower on plants with *A. solani* than with *M. persicae*. *Myzus persicae* were concentrated at the growing points of plants while *A. solani* predominately colonized lower leaves, indicating that lower leaves may be unattractive or undetected oviposition sites for *A. aphidimyza*. Thus, this natural enemy may not provide effective control of *A. solani* in the greenhouse, especially in the presence of other, more accessible aphid species. Future tests will determine the extent of this effect on aphid biological control programs.

Light quality influences trap catches of *Frankliniella occidentalis* (Pergande) and *Trialeurodes vaporariorum* (Westwood)
Nina Svae Johansen, Annichen Smith Eriksen, Leiv Mortensen .......................... 89-92

**Abstract:** The effect of different light environments on trap catches of *Frankliniella occidentalis* and *Trialeurodes vaporariorum* was investigated in a commercial greenhouse rose production unit during late autumn. Two top light treatments were used: 1) High pressure sodium lamps (HPSLs) and 2) HPSLs and light emitting diodes (LEDs) with 20% blue and 80% red light. More thrips and fewer whiteflies were caught on yellow sticky traps, and more thrips were found in the flowers, in areas were LEDs were used in addition to HPSLs compared to areas where only HPSLs were used. No effect of the light treatments was found on the population level of *Amblyseius swirskii*, but a lower ratio of predatory mites to thrips was found on the plants where LEDs were used. The results suggest that using blue and red LEDs as interlighting, or otherwise supplementary to HPSLs, will change thrips and whitefly spatial distribution in the rose crop, and that natural enemy release rates probably need to be adjusted accordingly.

Responses of the greenhouse whitefly to elevated CO$_2$ on tomato
Karin Koivisto, Anne I. Nissinen, Irene Vänninen ................................................... 93-96

**Abstract:** The effect of continuous exposure to 400, 800 and 1200ppm CO$_2$ on growth parameters of tomato seedlings and on fecundity and longevity of *Trialeurodes vaporariorum* (Westwood) was studied in growth chambers. Root/shoot ratio of tomato decreased with increasing CO$_2$ concentration, but was not affected by insect feeding. Stem length was significantly affected by both elevated CO$_2$ and insect feeding, but not by their interaction which means whiteflies did not substantially modify the response of their host plants to elevated CO$_2$. C/N-ratio of leaves increased with increasing CO$_2$ level. CO$_2$ treatment significantly reduced total number of eggs laid per female but not the female longevity. Whitefly fecundity thus decreased together with the significantly increasing C/N ratio, which may indicate diminishing plant quality for greenhouse whiteflies by the elevated CO$_2$. 
Effectiveness of pesticides and potential for biological control of the tomato leaf miner *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in Europe

Anton van der Linden, Marieke van der Staaij  ...................................................... 97-100

Abstract: Since 2006 the South American leaf miner *Tuta absoluta* occurs in tomato crops in Europe. In the winter season tomatoes from Mediterranean countries are being packed in packing stations in The Netherlands. *Tuta absoluta* is frequently monitored by means of pheromone traps in the packing stations. In order to safeguard the current practise of biological control of pests and pollination by bumble bees in tomato we investigated the effectiveness of pesticides and the possible occurrence of indigenous natural enemies. A rearing of *T. absoluta* was set up in 2009 in cages in a well confined greenhouse. Pesticides, which are currently applied against caterpillars or leaf miners were tested on the leaf miner *T. absoluta*. Particularly diflubendiamide (Fame), abamectin (Vertimec), spinosad (Tracer) and emamectin benzoate (Proclaim) were effective against caterpillars of *T. absoluta*. In 2010 a field survey was carried out in order to find natural enemies of *T. absoluta* in The Netherlands. Young leaf miners were parasitized at least by two ectoparasitoids, *Elachertus inunctus* and *Pnigalio soemius* (Hymenoptera: Eulophidae). *Dicyphus errans* and *Heterotoma* sp. (Heteroptera: Miridae) and an unidentified mason wasp (Hymenoptera: Euminidae) were observed to attacking *T. aboluta* larvae, with *D. errans* being the most common species.

*Tuta absoluta* egg predation by *Orius insidiosus*

Juracy C. Lins Jr., Vanda H. P. Bueno, Diego B. Silva, Joop C. van Lenteren, Ana Maria Calixto, Livia A. Sidney .................................................. ................... 101-104

Abstract: The objective of this work was to determine the predation capacity of *Orius insidiosus* (Hemiptera: Anthocoridae) on eggs of *Tuta absoluta* under laboratory conditions. Males and females of *O. insidiosus* were exposed individually to different egg densities of *T. absoluta* (10, 20, 40 and 60 eggs). Leaflets of tomato plants containing eggs of *T. absoluta* were kept inside a Petri dish (9cm diameter) together with the predator for 24h. The maximum number of eggs eaten by males and females of *O. insidiosus* was 19.1±0.24 and 32±0.33, respectively. At densities of 10 and 20 *T. absoluta* eggs, consumption was similar for males and females. At densities of 40 and 60 eggs, consumption of eggs by females was significantly higher than that of males. These data indicate that *O. insidiosus* might be a potential biological control agent of *T. absoluta*.

Towards enhancing biocontrol of thrips: effects of supplemental pollen and fibers on foliar abundance of *Amblyseius swirskii*

Loughner, R., J. Nyrop, K. Wentworth, J. Sanderson ............................................. 105-109

Abstract: *Amblyseius swirskii* (Athias-Henriot) will quickly leave the foliage of plants that lack both leaf hairs (leaf trichomes) and a supplemental food source (pollen). Many floral crops lack leaf trichomes. Applying artificial leaf hairs (low densities of tiny fibers) and/or pollen to the canopy of plants lacking these resources enhances phytoseiid persistence and egg production.

*Aphidius gifuensis*: a promising parasitoid for biological control of two important aphid species in sweet pepper

Gerben Messelink, Chantal Bloemhard, Hans Hoogerbrugge, Jeroen van Schelt  ................................................................................... ........... 111-114

Abstract: The parasitoid *Aphidius gifuensis* is able to parasitize both the green peach aphid *Myzus persicae* and the foxglove aphid *Aulacorthum solani* in sweet pepper. In a greenhouse experiment we showed that rates of parasitism on green peach aphids alone were equal to the commonly used *Aphidius colemani*, but lower than with *Aphidius matricariae*. Foxglove aphids were suppressed very effectively by *A. gifuensis*. In contrast, *A. matricariae* was not able to parasitize this aphid. When the two aphid species were offered simultaneously, *A. gifuensis* suppressed both aphid species, whereas the presence of foxglove aphids had a negative effect on the control of green peach aphids by *A. matricariae*. We conclude that *A. gifuensis* is a promising candidate for biological control of both foxglove aphids and green peach aphids in sweet pepper, especially when these aphids occur together.
Generalist predatory bugs control aphids in sweet pepper

Gerben J. Messelink, Chantal M. J. Bloemhard, Laxmi Kok, Arne Janssen ........ 115-118

Abstract: Biological control of aphids is often focused on releases of specialized natural enemies. Here, we evaluate the effects of inoculative releases of the generalist predatory bugs Orius laevigatus, Orius majusculus and Macrolophus pygmaeus on green peach aphids and western flower thrips in a greenhouse grown sweet pepper crop. We found that compared to the two Orius species, M. pygmaeus was by far the best predator for controlling aphids. Several releases of aphids did not result in an establishment of this pest in the compartments with M. pygmaeus, whereas aphids attained high densities in the O. laevigatus or O. majusculus treatments, causing serious crop damage. Thrips were controlled by all predators, but compartments with M. pygmaeus initially showed some thrips damage on the fruits. Currently, Orius laevigatus is the predator used most in inoculative releases in sweet pepper in Europe, but our data suggests that it might be better to use M. pygmaeus instead or in addition to O. laevigatus, when control of both thrips and aphids is required.

Participatory development of integrated management strategies for pest insects in cucumber

Lorna Migiro, Johanna Jansson, Mira Rur, Barbro Nedstam, Birgitta Rämer ........ 119

Abstract only

Development of genetic control in the tomato leafminer, Tuta absoluta


Abstract: Since the arrival in 2006 of a new tomato pest moth, the tomato leafminer (Tuta absoluta), European tomato growers have suffered significant losses. Furthermore, restrictions to their choice of pesticides have made control of this moth extremely difficult. Pesticide-free control methods, including natural predators and pheromone, are increasingly sought-after. A new chemical-free pest control method is being developed in T. absoluta, with the aim of providing another control option available to growers. This technique, called RIDL, is a variant of the sterile insect technique, in which a pest insect is mass-reared, sterilised by irradiation, and mass-released over an area infested by their wild counterparts. RIDL improves on this concept by avoiding the requirement for irradiation, so insects are likely to be more competitive in the field. Improved insect performance translates to improved efficiency of pest control. Avoidance of irradiation also means that the scale and location of a control programme is not restricted to those that would justify investment in a costly irradiation facility. This extends to protected crops, which would benefit from this more flexible technology. SIT and RIDL work best in settings where immigration and emigration of a pest is low. Protected cultivation, especially in greenhouses, inherently provides this by restricting movement of the pest. Here, we describe RIDL and how we plan to apply it to T. absoluta and other pests, with particular reference to protected crops.

An update on the use of biological control in greenhouse ornamental crops in Canada

Graeme D. Murphy, C. Gates, G. R. Watson ...................................................... 125-128

Abstract: The results of a recent survey of greenhouse ornamental growers in Canada show that 90% of commercial growers are currently using biological control. This is a significant increase from the 26% of growers who reported using biocontrol when previously surveyed in 2001. Reasons for the increased adoption of biocontrol are discussed.

The biology, life table and predation of Scolothrips longicornis fed on Tetranychus urticae eggs

Hajar Pakyari ................................................................. 129-133

Abstract: Biology, life table parameters and predation rate of the predatory thrips, Scolothrips longicornis Priesner fed on eggs of Tetranychus urticae Koch on bean leaves were studied at 26±1°C, 60±10% RH and a photoperiod of 16L: 8D h. The following average parameters were
obtained. Female longevity is 20.71 days, fecundity is 3.66 eggs/female/day, egg mortality is 12%, pre-oviposition period is 1.65 days, oviposition period is 15.61 days, post-oviposition period is 3.90 days, total immature development time is 13.55 days and sex ratio is 67%. Life table parameters were estimated as net reproductive rate ($R_0$) 31.09, intrinsic rate of natural increase ($r_m$) 0.201 day⁻¹, finite rate of increase ($\lambda$) 1.22, mean generation time ($T$) 17.04 days and doubling time ($DT$) 3.44 days. Thus it is concluded that S. longicornis can be considered as a valuable addition to the existing IPM methods for spider mites control.

**Biological control of tarsonemid mites in greenhouse grown gerberas**

*Juliette Pijnakker, Ada Leman* .......................................................... 135-138

**Abstract:** Several species of Phytoseiidae were evaluated as predators of *Tarsonemus violae* (Schaarschmidt) and the broad mite *Polyphagotarsonemus latus* (Banks) on gerbera plants in experimental and commercial greenhouses. *Amblyseius cucumeris*, *A. swirskii*, *Typhlodromips montdorensis* and *A. andersoni* appeared to possess the best abilities to control tarsonemids in this crop. These species displayed good survival and reduced mite densities at low levels directly after their releases. However, curative strategies did not effectively eliminate tarsonemids and the predators could not keep pests density below economic damage threshold year round without further releases.

**Survey of tarsonemid mites in greenhouse grown gerberas in The Netherlands**

*Juliette Pijnakker, Ada Leman* .......................................................... 139-144

**Abstract:** *Tarsonemus violae* (Schaarschmidt) and the broad mite *Polyphagotarsonemus latus* (Banks) were found to be the main tarsonemid species in gerbera crops grown in greenhouses in The Netherlands after examination of material collected by growers. *Tarsonemus violae* has never been described before as a pest in the Netherlands. Injuries were supposed to be assigned to the cyclamen mite *Phytodromus pallidus* (Banks).

**Side-effect testing of novel powdery mildew fungicides against biological control agents**

*Tom Pope, Kerry Maulden, Jude Bennison, Kim Green* ........................................ 145-148

**Abstract:** There is increasing interest in using alternative fungicides, such as inorganic salts and plant extracts, including those from giant knotweed (*Reynoutria sachalinensis*), to control powdery mildew on protected herbs. However, it is important that these alternative fungicides are compatible with biological pest control, which is used in Integrated Pest Management (IPM) programmes by growers of protected herb crops.

This study tested mortality effects of a range of inorganic salts and an extract of giant knotweed on two biological control agents, *Aphidius colemani* and *Neoseiulus cucumeris*, which are used to control aphids and thrips on protected herb crops. The bioassays completed used worst case (Tier 1) scenarios where the biological control agent was either dipped or exposed to leaves sprayed with the fungicide.

Based on the IOBC classification of plant protection products for their side-effects on beneficial arthropods the inorganic salts and extract from giant knotweed were ‘non-toxic’ against *N. cucumeris* and *A. colemani* adults. Although the side-effects of these potential alternative controls for powdery mildew should be tested against the full range of biological control agents used in IPM programmes on protected herbs, these results indicate that they should be IPM compatible.

**Spatial and temporal dynamics of Frankliniella occidentalis on protected ornamentals**

*Alberto Pozzebon, Andrea Boaria, Carlo Duso* ........................................... 149-152

**Abstract:** Western flower thrips (WFT) *Frankliniella occidentalis* is a worldwide problem of various ornamentals and vegetables, especially under greenhouse. Here we present preliminary results of a study on spatial structure of a WFT population and its evolution over time on ornamentals under greenhouse. We used Spatial Analysis with Distances Indices (SADIE)
methods to evaluate nonrandomness of the distribution and association of the distributions observed at different time. Spatial analysis of WFT population provided interesting information on the role of surrounding environment on the insect population inside the greenhouse.

**An overview of invasive species on vegetables in greenhouses in southern part of Montenegro**

*Sanja Radonjić, Snejžana Hrnčić* .......................................................... 153-157

**Abstract:** In the last ten years vegetable production increased rapidly in greenhouses in southern part of Montenegro. It created conditions for introduction and appearance of new pests. The main vegetable production areas are surroundings of the city of Podgorica (Zeta and Bjelopavlići) and the Montenegrin seacoast.

In the period 2006 to 2010, surveys of pest status in greenhouses, resulted in detection of several new species: the broad mite *Polyphagotarsonemus latus* Banks in 2006 on peppers, the agromyzid leafminer *Liriomyza bryoniae* Klbt. in 2006 on tomato, the western flower thrips *Frankliniella occidentalis* Pergande in 2008 on cucumber (*Cucumis sativus*), pepper (*Capsicum annuum*) and mangold (*Beta vulgaris* subsp. *vulgaris* var. *vulgaris*), and the carmine spidermite *Tetranychus cinnabarinus* Boisd. in 2009 on tomato. In addition to these new pests, the presence of some of the previously known pest was also confirmed in the survey: the cotton bollworm *Helicoverpa armigera* Hb. in pepper and tomato fruits, the European corn borer *Ostrinia nubilalis* Hb. in pepper fruits, and very polyphagous aphids (*Myzus persicae* Sulz., *Aphis gossypii* Glover and *Aphis fabae* Scop.), the greenhouse whitefly *Trialeurodes vaporariorum* West. and the two spotted mite *Tetranychus urticae* Koch.

**Immersion treatments for imported poinsettia cuttings to control sweetpotato whitefly,**

*Bemisia tabaci* (Gennadius) biotype “B” in greenhouses

*Wendy Romero, C. D. Scott-Dupree, G. Murphy, T. Blom, C. R. Harris* .......... 159-162

**Abstract:** Hot water, insecticidal soap and horticultural oil immersion treatments were assessed for phytotoxicity and their efficacy in controlling sweetpotato whitefly (SPW) [*Bemisia tabaci* (Gennadius) biotype “B”] on poinsettia cuttings. The efficacy of the entomopathogenic fungus *Beauveria bassiana* also was examined. Acetamiprid was evaluated as a comparison.

Hot water treatments provided 0-20% mortality of SPW life stages; insecticidal soap 93-100% mortality; horticultural oil 99-100% mortality; and *Beauveria bassiana* 3-30% mortality. Acetamiprid provided 5-63% mortality.

Various treatments identified in this study can be considered as moderate to highly efficacious, and have potential to be incorporated into a pest management program to control SPW on poinsettia cuttings, with minimal harm to plant material and reduced impact on biological control agents (BCA).

**Immersion treatments for imported chrysanthemum cuttings to control western flower thrips,**

*Frankliniella occidentalis* (Pergande) in greenhouses

*Wendy Romero, C. D. Scott-Dupree, G. Murphy, T. Blom, C. R. Harris* .......... 163-167

**Abstract:** In Ontario, preliminary assessments suggest that substantial numbers of western flower thrips (WFT) [*Frankliniella occidentalis* (Pergande)] are introduced on imported chrysanthemum cuttings. Because of the difficulty in detecting thrips at this stage of production and controlling them as needed, an alternative approach is to treat all cuttings before they enter the greenhouse. This study evaluates the strategy of immersing cuttings prior to propagation using various treatments considered as reduced risk.

Hot water, insecticidal soap and horticultural oil immersion treatments were assessed for phytotoxicity and their efficacy in controlling WFT. The efficacy of the entomopathogenic microbes *Beauveria bassiana* and *Steinernema feltiae* also was examined. Spinosad was evaluated as a comparison.

Hot water treatments provided 67-98% mortality of WFT life stages; horticultural oil 67-100% mortality; *B. bassiana* 93-95% mortality; and *S. feltiae* 53-63% mortality. Spinosad provided 27-58% control of larvae and adults.
Comparing *Aphidius colemani* and *Aphidius matricariae* on *Myzus persicae* ssp. *nicotianae* in sweet pepper

Jeroen van Schelt, Hans Hoogerbrugge, Nik Becker, Gerben Messelink, Karel Bolckmans .......................................................... 169-172

**Abstract:** The performance of the aphid parasitoids *Aphidius colemani* and *Aphidius matricariae* was compared on *Myzus persicae* ssp. *nicotianae*. The number of mummies produced per female was significantly higher at 15°C for *A. matricariae*. At 20, 25 and 30°C no differences were found. On sweet pepper plants, *A. matricariae* was significantly faster in controlling aphids compared to *A. colemani*.

Monitoring of western flower thrips under supplemental lighting conditions for greenhouse mini cucumbers
 Les Shipp, Yun Zhang, Hong-Hyun Park ............................................................ 173-176

**Abstract:** The natural infestation levels of *Frankliniella occidentalis* were monitored weekly using yellow sticky cards for greenhouse mini cucumbers grown under supplemental lighting using high pressure sodium lights (HPS) and light emitting diodes (LED) lights. The presence of LED lights alone increased the number of *F. occidentalis* collected. With respect to the LED treatments, blue was generally the most attractive.

Quality of *Myzus persicae* (Hem.: Aphididae) as host for *Praon volucre* (Hym.: Braconidae: Aphidiinae)

**Abstract:** *Praon volucre* parasitizes several species of aphids in Brazil, mostly belonging to the tribe Macrosiphini. This study aimed to evaluate the quality of *Myzus persicae* as host for *P. volucre*. Experiments were conducted in a climatic chamber at 22±1°C, RH 70±10%, and a 12-h photophase. One 24h-old *P. volucre* female, mated and without previous oviposition experience was released into a Petri dish containing a *Nicandra* leaf disk (5cm diameter) on an agar/water solution (1%) and 20 second- and third-instar *M. persicae* nymphs during 90 minutes. The developmental time of the parasitoid was 16.8 days. Immature mortality was 36.5%, parasitism 57.5%, and emergence rate was 63.5%. The sex ratio expressed as fraction females was 0.37. The longevities of male and female were 16.3 and 20 days, respectively. The tibia length of parasitoids was on average 0.6mm (females) and 0.54 mm (males). These results show that *M. persicae* is parasitized by *P. volucre*. However, the low sex ratio and the high immature mortality indicate that *M. persicae* is not a good quality host for *P. volucre*.

Change Laboratory for developing collective management strategies for an established and a potential alien pest species
 Irene Vänninen, Marco Pereira-Querol, Jenny Forsström, Yrjö Engeström ........ 181-184

**Abstract:** Change Laboratory, a developmental work research methodology that stands at the crossroad of education, knowledge management and knowledge creation, is presented as a meta-tool for involving growers in transforming the innovation process of pest management. The tool was used in Finnish Ostrobothnia greenhouse cluster to develop collective management strategies against the greenhouse whitefly in the current conditions and in anticipation of the potential invasion of *Bemisia tabaci*. We present how the whitefly problem and its ramifications were analysed and modelled in the Change Laboratory process, and introduce the initial solution concept that was developed in collaboration with growers, local advisors and researchers.

*Nesidiocoris tenuis* as an invasive pest in Finnish tomato crops: attempt to eradicate the bugs with nicotine-based programmes
 Irene Vänninen, Matias Rönnqvist, Mikael Dahlqvist, Jenny Forsström .......... 185-188

**Abstract:** The effect of nicotine smoke treatment was tested against adult and nymphal stages of *Nesidiocoris tenuis* (Heteroptera: Miridae) in greenhouse conditions by exposing the bugs to the
smoke in mesh bags and counting mortality 15 hours post-treatment. Nicotine was highly efficient against adult bugs, causing mortality of 91.4-97.7%. Nymphs were more resistant as it took longer for them to die, and due to the low number of nymphs available and higher control mortality than with adults the efficacy results were less conclusive for nymphs.

**Evaluation of potential Orius insidiosus banker plants for western flower thrips biocontrol in ornamental crops**

*Megan O. Waite, C. D. Scott-Dupree, M. Brownbridge, R. Buitenhuis, G. Murphy* .......................................................... 189-192

**Abstract:** Successful use of biological control agents for control of western flower thrips (*Frankliniella occidentalis* (Pergande)) (WFT) has been documented in greenhouse vegetables, such as sweet peppers, but thus far has provided inconsistent results for ornamentals. The objective of this study was to identify an optimal banker plant (BP) species to improve the performance of the biological control agent – *Orius insidiosus* (Say), against WFT in greenhouse ornamental crops. Potential BP were placed into cages and exposed to 5 female (<1w) *O. insidiosus* for 48h; the number of eggs and oviposition location was recorded. Development and survival was recorded by placing (<24h) nymphs into cages with a cutting from a flowering BP plant species. Nymphs were observed until the adult stage was reached or the nymph died. Assessments of oviposition indicated that all plants were acceptable for *O. insidiosus* to reproduce. Based upon nymphal development and survival, castor bean and gerbera may be suitable BPs respectively; sunflower and marigold would not be acceptable BPs.

**Pest and disease control in sustainable greenhouse production systems**

*Sacha White, John Clarkson, Dave Skirvin* .......................................................... 193

**Abstract only**

**Development of a new banker plant system to control aphids in protected culture**

*Eizi Yano, Hiroaki Toyonishi, Keisuke Inai, Junichiro Abe* ........................................ 195-198

**Abstract:** To establish a new banker plant system of an indigenous strain of *Aphidoletes aphidimyza* as a control agent of pest aphids on solanaceous fruit vegetables under high temperature conditions, we conducted life history studies of *A. aphidimyza* reared on *Melanaphis sacchari* on sorghum banker plants. We examined the effect of temperature on development and lifetime fecundity and calculated the intrinsic rate of natural increase. The survival rate from egg to adult eclosion was 0.8-0.87 at 20-30°C. The lifetime fecundity and intrinsic rate of natural increase of *A. aphidimyza* reared on *M. sacchari* were higher than values for *A. aphidimyza* reared on *Rhopalosiphum padi*. The efficiency of the banker plant system of *A. aphidimyza* and *M. sacchari* was evaluated on sweet pepper plants in greenhouses. The density and frequency of occurrence of pest aphids on sweet pepper plants were more effectively suppressed in greenhouses using the system of *A. aphidimyza* and *M. sacchari* on sorghum plants than in those using the system of *Aphidius colemani* and *R. padi* on barley plants.