

IOBC/wprs Bulletin, Vol. 39, 2008

Working Group "Integrated Plant Protection in Fruit Crops", Sub Group "Soft Fruits". Proceedings of the "Workshop on Integrated Soft Fruit Production" at East Malling (UK), 24-27 September, 2007. Edited by Christian Linder & Jerry V. Cross
(ISBN 978-92-9067-213-5) [x + 224 pp.].

Development of semiochemical attractants, lures and traps for raspberry beetle, *Byturus tomentosus* at SCRI; from fundamental chemical ecology to testing IPM tools with growers.

N. Birch, S. Gordon, T. Shepherd, W. Griffiths, G. Robertson, T. Woodford, R. Brennan 1-3

Abstract: Raspberry beetle adults are attracted to flowers of their hosts primarily by colour and odour (floral volatiles). SCRI scientists have investigated this chemical ecology interaction for several years, using a multi-disciplinary approach involving phytochemistry, insect behaviour, and GC-EAG electrophysiology. We will present a historical overview, explaining how these techniques have allowed us to identify the key flower attractants from a complex mixture of volatiles emitted by raspberry flowers. We will then go on to explain how recent (EU-CRAFT, Horticulture Development Council) and current (Defra HortLINK) work has progressed the optimization of raspberry beetle traps for U.K. growers needing IPM solutions due to demands for zero pesticide residue levels on fruit. We will explain how we are developing and testing slow release lures and different trap designs, together with collaborators at East Malling Research, Natural Resources Institute, AgriSense Ltd and also with Norwegian scientists, testing prototype traps on organic soft fruit farms.

Mass trapping of raspberry beetle as a possible control method - pilot trials in Norway.

N. Trandem, S. Gordon, N. Birch, M. Ekeland, N. Heiberg 5-10

Abstract: Berry damage by the larva of raspberry beetle (*Byturus tomentosus*) is a major risk for growers of organic raspberry. The identification of two volatile compounds in raspberry flowers that are attractive to the beetle by scientists at SCRI has facilitated the idea of mass trapping as an alternative control method to using conventional insecticides. The challenges are to design efficient and user-friendly traps, and to document if and how such traps can reduce the number of ovipositing beetles sufficiently to get a low level of berry damage. These questions are being investigated as part of a large UK project (Defra HortLINK) which is developing IPDM (Integrated Pest and Disease Management) for protected raspberries. We here report the results from a cooperating Norwegian project in which the volatile 'compound B' was used in pilot trials, 2003-2006. A combined collision-funnel trap from SCRI and AgriSense with the compound in a slow release lure attracted and killed a high number of raspberry beetles in the weeks before flowering, but more studies are needed to find a trap strategy that consistently leads to less berry damage. Norwegian organic fields are small, with large populations of raspberry beetle, and usually with wild raspberry growing nearby. A successful mass trapping strategy must therefore pay equal attention to immigrating and resident beetles.

Monitoring raspberry cane midge, *Resseliella theobaldi*, with sex pheromone traps: results from 2006.

J. Cross, C. Baroffio, A. Grassi, D. Hall, B. Łabanowska, S. Milenković, T. Nilsson, M. Shternshis, C. Tornéus, N. Trandem, G. Véték 11-17

Abstract: The sex pheromone of the raspberry cane midge has been identified and synthesised by East Malling Research (EMR) and Natural Resources Institute (NRI) and has proved to be highly attractive and useful for pest monitoring. East Malling Research coordinated a collaborative ring test of standard raspberry cane midge sex pheromone traps in 2006. The aims were to investigate the seasonal temporal pattern of the midge flight in different raspberry production regions of Europe and the relationship between the magnitude of catches and the numbers of eggs and larvae which developed subsequently in artificial splits in the primocane of untreated raspberry plantations. The standard raspberry cane midge sex pheromone trap used for the ring test consisted of a white delta trap containing a 20 x 20 cm sticky base and with a rubber septum lure

impregnated with 10 µg of the raspberry cane midge sex pheromone racemate. Pairs of traps, separated by >20 m, were deployed in the centre of raspberry plantations at a height of 0.5 m in Italy, Hungary, Norway, Poland, Russia, Serbia, Sweden, Switzerland, Norway and the UK. The traps proved effective and easy to use for monitoring the flight of adult male raspberry cane midge. There were very large variations (~ 30 fold) between plantations in total numbers of midges caught over the season indicating plantations which are at comparatively low and high risk from the pest. Three generations of adult flight were apparent in Norway, Russia and Sweden and four generations in the central European countries with possibly 5 generations in Italy, though later generations were often difficult to distinguish. In the northern countries, the 1st generation first and peak flight occurred on Julian days 150 and 165, respectively, whereas in Italy the 1st generation first and peak flight occurred approximately on Julian days 110 and 130 respectively. The 1st generation flights occurred much earlier in polytunnel protected crops than in open field crops. Data obtained on the occurrence of larvae were variable in quality but a linear relationship between the peak numbers of males captured in the pheromone traps per week for a given generation (M) and the peak numbers of eggs and larvae per cm in artificial splits in the primocanes for that generation subsequently (L) was apparent ($L = 0.025 M$; $R^2=0.61$). A nominal threshold of 30 midges per trap per week had been proposed but the linear relationship derived indicates that this threshold, which would result in ~ 0.75 eggs + larvae/cm, is too high. In reality, the degree of larval infestation that occurs and the resultant severity of crop damage will depend on the numbers of natural splits in the crop. The ring test is being continued in several countries in 2007.

Raspberry cane midge – flight dynamics, egg laying and the efficacy of the neonicotinoid insecticide acetamiprid on primocane fruiting raspberry.

B. Łabanowska, J. Cross..... 19-25

Abstract: The raspberry cane midge, *Resseliella theobaldi* (Barnes), is one of the main pests of raspberry plantations in Poland. Larvae damage the primocanes of raspberry. The pest is very dangerous to cultivars fruiting in June-July as well as on primocane fruiting cultivars (August - October harvest). The experiment reported here was as part of the ‘ring test’ coordinated by East Malling Research (UK). The flight of the midges was monitored weekly using standard pheromone traps in untreated commercial raspberry plantations in Poland. The standard white delta traps (20 x 20 cm base) were baited with a rubber septum lure loaded with 10 µg of the raspberry cane midge sex pheromone ‘racemate’ and were placed at a height of 0.5 m above soil. Numbers of eggs and larvae were monitored in artificial splits on primocanes.

The midge developed at least three generation a year in Poland. The flight started at the end of April or at the beginning of May and lasted until beginning of October. In an unprotected raspberry plantation, on cultivar Polka, the first generation of the midge’s intensive flight was noted in the end of April or in the first decade of May with the second generation in the second half of July. The most intensive flight and the highest number of males caught in pheromone sticky traps was noted at the end of August and at the beginning of September. This was thought to be the third generation of the raspberry cane midge. The neonicotinoid insecticide, Mospilan 20 SP (acetamiprid) showed promising results in the control of the raspberry cane midge, similar to the organophosphate malathion.

Interference between raspberry cane midge (*Resseliella theobaldi*) sex pheromone traps – A one season trial in a Swedish raspberry plantation.

T. Nilsson, C. Tornéus..... 27-31

Abstract: Raspberry cane midge is a serious pest in raspberries. Larvae feed under the epidermis of first year canes and in these wounds several fungi can infect. The complex of larval feeding and fungal infection is termed midge blight. Efficient control is difficult to achieve due to the sheltered place of the larval feeding and the short lifespan of adults. Monitoring of the male flight period is possible with sex pheromone traps. A field trial was conducted to see if pheromone traps interfere when hung at a set distance from each other. The results indicate that traps placed in close vicinity (7 and 20 metres) show a decrease in number of trapped midges, thus monitoring traps should be placed more than 20 metres apart to give representative data of the male flight pattern.

Some preliminary investigations into the sex pheromones of mirid soft fruit pests.

M. Fountain, J. Cross, G. Jaastad, D. Hall 33-40

Abstract: The European tarnished plant bug, *Lygus rugulipennis*, is an important pest of soft fruit crops throughout Europe causing fruit deformities in strawberry and raspberry crops. *Lygocoris pabulinus* is often responsible for killing fruiting laterals in raspberry and damaging blackcurrent shoots. Routine sprays of broad-spectrum insecticides, used to control other pests, have kept mirid pests at low levels. However, a reduction and replacement of broad-spectrum pesticides with more selective ones is causing resurgence.

As part of a larger programme to develop practical, long-lived and economic monitoring devices for these pests for use by growers, we report some initial findings and challenges involved in understanding the mechanisms and requirements for monitoring mirids.

We determined that female *L. rugulipennis* attract males between 0500-1030 hours and that green sticky base delta traps were effective. Field tests in 2007 using micro-capillary dispensers with a reservoir, baited with various combinations of the 3 compounds produced by female *L. rugulipennis* and *L. pabulinus* (hexyl butyrate, (*E*)-2-hexenyl butyrate, and (*E*)-4-oxo-2-hexenal) failed to attract males.

Identification of black currant leaf midge *Dasineura tetensi* (Rübsaamen) female sex pheromone.

L. Amarawardana, D. Hall, J. Cross, C. Nagy 41-46

Abstract: The blackcurrant leaf midge, *Dasineura tetensi* (Rübsaamen) (Diptera: Cecidomyiidae), is an important pest of blackcurrant that damages the young leaves and reduces plant growth. The presence of a female-produced sex pheromone was demonstrated previously and work is in progress to identify this to provide growers with new tools for monitoring and control of the pest. Larvae collected from infested plant materials were reared individually in plastic tubes to adulthood. The volatiles from unmated males and females were collected separately by air entrainment. Volatile samples were analysed by gas chromatography (GC) coupled to electroantennographic (EAG) recording from the antenna of a male midge, and by GC coupled to mass spectrometry (MS). In GC-EAG analyses, two consistent EAG responses were observed from male midge preparations. GC-MS analyses and GC retention data of the major component indicated that this is a 17-carbon diacetate with one double bond. Hydrogenation gave a product with mass spectrum consistent with that of 2,12-diacetoxyheptadecane, but no product could be detected after reaction with dimethyl disulphide which would indicate the position of the double bond. No mass spectrum could be obtained for the minor component because of the small amount present. Work is in progress to complete identification of both components.

Biological control of the currant clearwing moth *Synanthedon tipuliformis* by mating disruption.

C. A. Baroffio, Ch. Carlen 47-49

Abstract: The currant clearwing moth *Synanthedon tipuliformis* Clerck is a major pest in *Ribes* ssp. crops, mostly red- and blackcurrants. Two mating disruption trials were conducted between 2002 and 2005 on redcurrant plots in Geneva and Thurgau (Switzerland). In both trials, the number of adults decreased significantly. The density of 600 dispensers per ha showed good efficacy against the clearwing moth.

Notes on the parasitoids of the raspberry cane midge, *Resseliella theobaldi* (Barnes, 1927) (Diptera: Cecidomyiidae) and the rose stem girdler, *Agrilus cuprescens* (Ménétriés, 1832) (Coleoptera: Buprestidae).

G. Véték, C. Thuróczy, B. Péntzes 51-64

Abstract: A wide range of beneficial insects controlling raspberry cane pest populations has been identified since the first surveys on the arthropod fauna of the plant were carried out. As far as the parasitoids of the raspberry cane midge (*Resseliella theobaldi*) and the rose stem girdler (*Agrilus cuprescens*) are concerned, a large number of references on different parasitoid species can be found in the literature dealing with the biology and control of the pests. In some cases, the specimens of the reared or collected parasitoids were identified by former or present-day specialists, but the citation of species names from old publications without checking them also seems to be quite widespread. As it has turned out that in many cases invalid, ambiguous or incorrect names are mentioned in publications, the aim of the authors of this paper was to give a review of the cited parasitoids of the two, above-mentioned raspberry cane pests together with

making their taxonomic status clear so as to help researchers and plant protection engineers use the correct, presently accepted names of these beneficial insects. This work has been carried out within the scope of an international cooperation in which curators and specialists of national insect collections and researchers of plant protection institutes from Europe helped the investigations. On the basis of this study, the most frequently cited natural enemy of raspberry cane midge is *Tetrastichus inunctus*, while those of rose stem girdler are *Tetrastichus heeringi* and *T. agrilorum*. However, the type of *T. inunctus* is lost so this species name is now ambiguous, and the specimens earlier reared from the larvae of rose stem girdler and identified as *T. agrilorum* need to be re-examined. According to the authors' rearing experiments, *Aprostocetus epicharmus* proved to be the primary parasitoid of raspberry cane midge, while it was *Tetrastichus heeringi* which parasitized the larvae of rose stem girdler significantly. Further studies on this topic are in progress.

Open field and laboratory surveys to evaluate the susceptibility of red raspberry genotypes to *Tetranychus urticae* Koch and *Resseliella theobaldi* (Barnes).

A. Grassi, R. Maines, M. Grisenti, M. Eccher, A. Saviane, L. Giongo 65-70

Abstract: Since 2005, a screening aimed to test the susceptibility of florican and primocane raspberry genotypes to the key pests two-spotted spider mite (TSSM) *Tetranychus urticae* and the raspberry cane midge (RCM) *Resseliella theobaldi* was started at Vigolo Vattaro (Trento, Northern Italy). Observations on *T. urticae* susceptibility were carried out by means of leaf inspections (5 terminal leaflets/accession) at 15-30 day intervals from May to August. The burden of TSSM that developed on each variety at the end of each year was expressed as cumulative mites/day. A classification of tolerance to TSSM was proposed using the total of the cumulative mites/day of the two seasons. In 2006, a laboratory test was carried out on 27 genotypes that had in 2005 differently expressed tolerance degrees to TSSM. The tolerance to *R. theobaldi* was evaluated using the technique for scoring midge blight proposed by Williamson & Hargreaves (1979). At the autumn pruning stage in 2005 and 2006, 7-10 canes/accessions were selected. The basal portion (30 cm) was scraped to remove the periderm. A 1-10 disease score was attributed to each cane on the basis of the extension of the vascular lesions beneath feeding wounds of *R. theobaldi*. The average class of damage of the two seasons for each variety was used to develop a classification of tolerance.

Harmfulness of raspberry gall midge, *Lasioptera rubi* Schrank (Diptera, Cecidomyiidae), to some raspberry cultivars.

S. Milenković, S. Tanasković 71-75

Abstract: The raspberry gall midge, *Lasioptera rubi* Schrank (Diptera, Cecidomyiidae) is an economically important pest, especially raspberry plantings where canes are not removed after harvest. The objective of this study was determination of the harmfulness of *L. rubi* in an untreated raspberry cultivar plantation at the Fruit Research Institute, Serbia.

For the assessment, canes were collected from a planting of raspberry cultivars established in 2002. The trial involved five raspberry cultivars planted in a random arrangement with 100 plants in a replicated design. The intra-row and inter-row planting distances were 0.33 m and 2.5 m respectively. The sampling was performed on Willamette, Meeker, Latham, and hybrid K 81-6, and the rows were selected at random. Five meters of each of the chosen rows were marked. Canes displaying morphological changes in gall form were collected from the marked row sections. The samples were taken to the laboratory where cane diameter, length and width were measured, and the numbers of cane galls and larvae were checked.

In the collected canes, galls occurred in different forms i.e. elongated, roundish or canker wound forms. Galls were observed along the entire cane length, at different cane sections (lower, medium and upper parts) as well as on petioles.

Different levels of harmfulness of raspberry gall midge were recorded over the two years of study on the different raspberry cultivars.

Patterns in the within-cane distribution of the gall-like swellings caused by *Agrilus cuprescens* (Coleoptera: Buprestidae) and the rate of raspberry infestation.

M. Váňová, P. Tóth, J. Lukáš 77-84

Abstract: During 2004-2006, a neglected raspberry (*Rubus idaeus* L.) plantation (locality Sazdice) and a private back garden (locality Demandice) were investigated to determine the rate and intensity of raspberry infestation by *Agrilus cuprescens* (Ménétriés, 1832) and within-cane distribution of gall-like swellings caused by the pest larvae in Slovakia. The mean diameter of gall-like swellings ranged from 0.90±0.14 to 1.12±0.22 cm. Although the within cane distribution of gall-like swellings varied between years, the highest densities were observed from ground level up to 60 cm height-above-ground at the both localities. The rate of raspberry infestation fluctuated from 8.5% to 23.9% at Demandice and from 66.5% to 81.5% at Sazdice. The mean of gall-like swellings per cane ranged from 1.25±0.58 to 1.45±0.74 at Demandice, whereas from 1.58±0.81 to 2.7±1.58 per cane at Sazdice. The results show that the neglected plantations are heavily attacked by *A. cuprescens*, while the treated localities, where infested canes are annually removed, are damaged only slightly. Destruction of infested canes seems to be the simplest and a sufficient remedy against *A. cuprescens*.

Post harvest control of the eriophyoid mite *Phyllocoptes gracilis* on raspberries.

Ch. Linder, C. Baroffio, Ch. Mittaz 85-87

Abstract: The eriophyoid mite *Phyllocoptes gracilis* (Nalepa) is an important secondary pest species in Swiss raspberry production. The pending withdrawal of the only registered miticide bromopropylate has created the need to develop alternative control strategies against this mite. In autumn 2006, first efficacy trials were carried out in a heavily infested plot of the variety Glen Ample in Nendaz (Switzerland). Single, post harvest applications of wettable sulphur and of the miticide spiropdiclofen were both very effective and provided excellent pest control. Visual inspection the following spring confirmed the value of the control strategies tested. The costs of post harvest treatments with wettable sulphur are lower than bromopropylate applications and the timing of application does not pose a risk of pesticide residues. This study supports a quick registration of the tested products against *P. gracilis*.

Biological control of two-spotted spider mite with *Phytoseiulus persimilis* in ever-bearer strawberry.

C.A. Baroffio, Ch. Linder 89-92

Abstract: Biological control of two-spotted spider mite *Tetranychus urticae* is an interesting technique in everbearer strawberry production where long harvesting periods prevent a classical acaricide treatment schedule. During a three year study on soilless strawberries, *Phytoseiulus persimilis* gave satisfactory control of *T. urticae* under certain conditions. Predators had to be released as soon as the leaf occupation rate by the pest reached 20% to 30%. Above this threshold, it was necessary to apply a soap treatment before the *P. persimilis* releases. With 10 *P. persimilis* /m², it took two weeks until the pest populations started to decrease. *T. urticae* was usually controlled after four weeks. This strategy did not affect fruit quality and the costs remained affordable for the growers.

Does the presence of multiple phytoseiid species affect biocontrol of *Tetranychus urticae* on strawberry?

J. Fitzgerald 93-96

Abstract: Experiments were undertaken on strawberry leaf arenas and on potted strawberry plants held at 20°C, and in field plantings of strawberries to determine if the presence of multiple species of phytoseiid mites affected biocontrol of the target pest species, *Tetranychus urticae*. In leaf arena and potted plant experiments conducted over 10 and 5 days respectively, no interactions between predators were seen. However, in field experiments conducted over a longer period there was a reduction in control of *T. urticae* when both *Phytoseiulus persimilis* and *Neoseiulus cucumeris* were present on the plants.

Field control of strawberry mite *Phytonemus pallidus*.

B. Gobin, E. Bangels 97-100

Abstract: Belgian soft fruit growing is moving towards full integrated pest management, although it has not yet reached the advanced level of IPM as hard fruit. Only few acaricides are registered for use in strawberry in Belgium. Although alternate use of these products is generally sufficient for spider mite control, achieving tarsonemid mite control is far more difficult. This

paper presents the results of a recent trial on the biological efficacy of various active ingredients and their formulations to tarsonemid mites. Only partial control can be achieved with currently available acaricides, although at low infestation this might be sufficient to limit commercial losses. Growers must use strict hygienic measures in their fields and use clean plant material to minimize the danger of spreading this pest and selective crop protection to allow build-up of predatory mite populations to assist control of *Phytonemus pallidus*.

New generation acaricides for control of two important strawberry pests: The Two-spotted spider mite and the strawberry mite.

B. Łabanowska 101-106

Abstract: The strawberry mite, *Phytonemus pallidus* Zimm. and the two-spotted spider mite, *Tetranychus urticae* Koch, are key pests in strawberry plantations in Poland. Some new acaricides including Floramite 240 SC (bifenazate) and Envidor 240 SC (spirodiclofen), as well as Omite 570 EW (propargite) and Magus 200 SC (fenazaquin) were tested for control of two major pests of strawberry: the two-spotted spider mite and the strawberry mite. These acaricides when used after harvest against the strawberry mite (two treatments at a seven day interval) gave slightly poorer results than endosulfan (also two treatments), but endosulfan has been withdrawn from use.

All the above acaricides were also tested against the two-spotted spider mite (as a single treatment) and they gave good control, similar in efficiency to the standard acaricides Omite 30 WP (propargite) and Nissorun 050 EC (hexythiazox). The results showed that the control of both pests is achievable.

Efficacy of 3 neonicotinoid insecticides for the control of the green leafhopper

Asymmetrasca (Empoasca) decedens Paoli, a new pest on cultivated red raspberry in Trentino, Italy.

A. Grassi, R. Maines, A. Saviane 107-113

Abstract: In 2006, two trials were carried out in Trentino, North Italy, in order to evaluate the efficacy against *Asymmetrasca decedens* of three neonicotinoids, thiametoxam (Actara), thiacloprid (Calypso) and acetamiprid (Epik). The three compounds were compared with an untreated plot and a malathion (Smart EW) treated plot (standard chemical). A single spray was applied before blossom, on the peak of the first generation nymphs population. The effectiveness was assessed 7, 14, 21, 28 and 35 days after treatment, by counting the number of live nymphs on the underside of 60-120 complete leaves/plot. Leaves inspections were carried out in order to evaluate the side effects of the insecticides on *Tetranychus urticae*, *Neotetranychus rubi* and on the indigenous predatory mites *Amblyseius andersoni* and *Euseius finlandicus*. The characteristics of the three tested neonicotinoids in terms of efficacy and side effects, better fulfil the requirements of the *A. decedens* integrated control than the standard chemicals used so far, and deserve our efforts to extend their registration on raspberry in Italy.

Integrated Pest Management in protected strawberry crops: Increased returns, fewer pests and reduced pesticide use.

C. Sampson 115-120

Abstract: Biological Crop Protection Ltd. has developed an Integrated Pest Management (IPM) programme for the main pest species attacking protected strawberry crops. Control of thrips, *Frankliniella occidentalis* and spider mites, *Tetranychus urticae* can be achieved with minimal pesticide input using the programme. The glasshouse whitefly, *Trialeurodes vaporariorum* was an increasing problem in UK protected strawberries. The physical product Eradicoat™, a starch polymer, was tested in a commercial crop. Two treatments of Eradicoat resulted in 99% control when the plants were small and good leaf cover could be achieved, and 55% control when the canopy was dense. Weekly releases of the parasitic wasp *Encarsia formosa* 1/m²/ week maintained low whitefly numbers and prevented crop damage. The use of an IPM programme in a commercial crop, resulted in higher yields and more Class 1 fruit compared to a chemical programme, raising grower returns by 18%.

Integrating biological control measures against strawberry pests – Preliminary results with strawberry tortrix in Denmark.

L. Sigsgaard 121-124

Abstract: A three-year study on biological control of strawberry pests was initiated in 2007. Preliminary results from the first year's study of strawberry tortrix *Acleris comariana* (Lienig & Zeller) are reported. The strawberry tortrix is a common and widespread pest in Danish strawberry production. The practice of spraying with pyrethroids may have negative consequences for natural enemies. *Bacillus thuringiensis* may provide an alternative control option, though temperature requirements for a good effect limit its use in the field in spring. The strawberry tortrix study aims to contribute to the knowledge of the natural enemy complex of this pest and how functional biodiversity may be affected by field margins and farming practices.

Biological control of aphids with *Chrysoperla carnea* on strawberry

M. Turquet, J.-J. Pommier, M. Piron, E. Lascaux, G. Lorin 125-129

Abstract: Aphids cause considerable damage in strawberry crops and intensive applications of insecticides have come to a limit with the appearance of pest resistance. Aphid species such as *Rhodobium porosum* and *Aphis gossypii* are resistant to all chemicals approved on strawberry crops in France. The large variety of aphid species encountered on strawberry crops (about 10 different species), requires the use of non specific beneficial organisms such as lacewings. The lacewing *Chrysoperla carnea* is widely known as a natural beneficial insect against aphids. However, its effective use as a predator introduced in strawberry crops has still to be confirmed. An experiment carried out in 2007 aimed to assess its efficiency as a predator on strawberries. In this experiment, various treatments were compared on soil- and soilless-grown everbearer strawberry crops: 1 lacewing per plant, 5 lacewings per plant, and, in the soil-grown crop only, a control treatment without lacewings. The introductions were repeated every two weeks starting from planting. The results show that aphid infestations were successfully limited by the use of lacewings. The absence of chemical treatment during the release of lacewings was quite encouraging. Control of pest populations differed according to the amount of lacewings introduced: with 5 lacewings per plant, the predatory action could be characterised as both preventive and curative. With 1 lacewing per plant, the increase in aphid populations was limited but it is suggested that several treatments might be necessary to stop this increase. Furthermore, the introduction of 5 green lacewings per plant limited thrips infestation in soilless culture. These experiments indicated that lacewings can be used as an effective biocontrol agent of aphid populations in strawberry crops. Further studies are now required to develop control strategies using lacewing introductions that may be adopted by strawberry growers.

Severing damage by *Anthonomus rubi* populations in the UK.

C. Jay, J. Cross, C. Burgess 131-136

Abstract: The strawberry blossom weevil (*Anthonomus rubi*) is a widespread pest of strawberry. Damage is caused by females severing flower buds. This work looked at different sampling techniques for the pest: suction sampling, beat sampling and sticky traps. Beat sampling and suction sampling could only be used in dry weather. Beat sampling was slightly more effective, both in terms of catch number and ease of use. Yellow sticky traps were more effective than other colours. To investigate the relationship between severed buds and weevil numbers, natural field populations were managed by using different spray programmes and flower bud severing was assessed throughout the season. The intensity of flower bud severing was significantly lower in the sprayed plots. A regression of the total number of severings per plot against the total number of weevils beat sampled per plot showed that at least 4.5 flower buds were severed per blossom weevil caught. Flower bud severing was also assessed on caged plots following artificial inoculation of different weevil numbers. Caged plots with four introduced females had double the number of severings compared with plots with one or two introduced females. This work contains information that can be used when planning Integrated Pest Management programmes.

Studies on control of the vine weevil, *Otiorhynchus sulcatus* using entomopathogenic nematodes.

S. Haukeland..... 137-138

Abstract: Entomopathogenic nematodes (EPNs) are commercially available for control of soil dwelling larvae of the vine weevil (*Otiorhynchus sulcatus*). In Europe several products are available comprising three different species, *Heterorhabditis bacteriophora*, *H. megidis*, and *Steinernema kraussei*. The latter species is for use at low temperatures. Results from several trials using *H. megidis* and *S. kraussei* against vine weevil in strawberry fields indicate that low temperature, soil type and possibly the application method are limiting factors that appear to reduce their efficacy. The use of EPNs against vine weevil larvae in the field will be discussed including results from cold-activity studies and application methods.

Use of entomopathogenic fungi for vine weevil and thrips control

T.M. Butt, F.A. Shah, M.A. Ansari 139

Abstract only

Breeding for durable resistance to the large raspberry aphid, *Amphorophora ideai*, in field and protected raspberry plantations: Co-evolution and IPDM.

N. Birch, S. Gordon, R. Brennan, N. Jennings, C. Mitchell 140

Abstract only

Aphid biology and the development of a programme to manage the spread of *Blueberry scorch virus* in south western British Columbia, Canada.

D.A. Raworth, S. Mathur, M. Sweeney, V. Brookes 141-147

Abstract: *Blueberry scorch virus* (BIScV) was first found in New Jersey, USA in the 1970's associated with Sheep Pen Hill Disease. Various strains of the virus have since been found in the Pacific Northwest, and more recently, the north-eastern United States and Europe. Certain BIScV strains cause severe yield reductions in some cultivars, and the pathogen is considered an important threat to the highbush blueberry (*Vaccinium corymbosum* L.) industry. We undertook studies of the aphid vectors during 2001-2007 and used the information to develop techniques to reduce the spread of BIScV. Here, we consolidate the results of that work and discuss the implications.

Advances in IPM for black currant

A. Harris, J. Cross 149-154

Abstract: Black currant gall mite and leaf midge are the most important pests of black currant in the UK. Until recently, they were controlled by three foliar sprays of the synthetic pyrethroid acaricide fenpropathrin per season. However, fenpropathrin is being withdrawn from use throughout the EU in 2008. The gall mite is the vector of reversion virus, which causes sterility in black currant bushes, and is the principal factor limiting the life of plantations. Fenpropathrin is harmful to a very wide range of arthropods, including the natural enemies of gall mite and leaf midge. We aimed to synthesize and validate IPM methods for black currant gall mite and leaf midge that are compatible with IPM practices for other pests, are safer to humans and the environment and that reduce the occurrence of pesticide residues and to implement them in UK commercial black currant production. A six year replicated experiment at East Malling Research examined the efficacy of combining early season sulphur sprays with a gall mite resistant variety (Ben Hope) or a gall mite resistant, reversion susceptible variety (Ben Gairn) in an integrated gall mite management programme compared to a reversion virus and gall mite susceptible variety (Ben Alder). The IPM programmes, especially the latter, were highly effective in controlling gall mite and reversion virus. Damaging leaf midge populations did not develop but aphids were a severe problem, especially on Ben Gairn, requiring supplementary sprays of pirimicarb.

Sub-lethal exposure of honey bees to crop-protection – Feeding behaviour and flower visits.

B. Gobin, K. Heylen, J. Billen, R. Huybrechts, L. Arckens..... 155-159

Abstract: Production quantity and quality in soft fruit and top fruit depend on optimal bee pollination, but also on the use of crop protection agents. The implementation of strict regulations and pre-flower intervals have greatly reduced acute bee-poisoning incidents. In recent years, concern grew among fruit growers and beekeepers about possible behavioural modifications of residual doses. As part of a research project on sub-lethal effects, we investigated whether some common plant protection products repel bees. We compared consumption of contaminated sugar

solution in the lab and counted bee visits to flowers in a field trial in which test products were sprayed either before or during flowering.

Raspberry certification: How it benefits the raspberry sector?

C. Eckert, C. Calvin 161-163

Abstract: In 2000, a raspberry plant certification scheme was established by Ctifl, under the aegis of the French Ministry of agriculture, in order to provide growers with healthy, quality plants. This project was a success thanks to close cooperation between research and experiment partners, technicians, growers and nurseries. Over the last seven years, the share of certified plants has been on the rise, as has the number of varieties: Meeker and Heritage were the first varieties to be certified. Tulameen followed in 2005, and Polka is scheduled to enter the certification scheme in 2007. Currently, research is focusing on the means to include *Phytophthora fragariae* and crumbly berry in the certifiable production schemes.

Raspberry root rot control in the Scottish raspberry certification scheme.

A. Schlenzig 165-167

Abstract: The Scottish raspberry certification scheme demands freedom from *Phytophthora fragariae* var. *rubi* in all grades of raspberry propagation stocks. This paper compares bait test and nested PCR as test methods for this pathogen and recommends their use for the different grades of the certification scheme.

Biofumigation to control *Verticillium* wilt of strawberry: Potency and pitfalls.

V.V. Michel, S. Dahal-Tscherrig, H. Ahmed, A. Dutheil 169-176

Abstract: The efficacy of biofumigation to reduce the soil inoculum of *Verticillium dahliae*, causal agent of *Verticillium* wilt, was tested in several field and pot experiments. The reduction of the number of microsclerotia ranged from 19 to 85%. This variation is due to the biological nature of this method, several factors can influence its efficacy. Among the most important ones are plant species, incorporation of plants, and soil type.

The influence of weed covering on short-day strawberries in the autumn.

R. Faby 177-179

Abstract: In our strawberry industry we have nearly 1000 ha with so called strong cold stored plants for delaying the harvest in the planting year. The plants stay for a second crop in the following year. Because of the reduced use of soil herbicides weed control becomes more difficult, especially for *Stellaria media*. It covers the whole plant from September until the end of the vegetation period, which leads to reduced light intensity during the period of flower induction and differentiation. To simulate this effect, strawberries were covered with a shading tissue as a single layer and also as a double layer from the 20th of September to the end of November. The trial was carried out for four years (2002 until 2005) with the cultivar Elsanta. The light reduction reduced the yield by 17 to 32% and with the double coverage the reduction ranged between 52 and 65%. There was no effect on the fruit size except for 2006, when the fruits under covering were 2.5 g heavier per fruit.

Evaluation of alternative chemicals for control of botrytis in raspberry.

A. Berrie, T. O'Neill, E. Wedgwood, B. Ellerker 181-187

Abstract: In 2006 and 2007 three replicated experiments were conducted on two sites (Kent 2006 and 2007; Cambridgeshire 2006) in which fungicides and alternative chemicals were evaluated for control of botrytis fruit rot in the summer-fruited raspberry Glen Ample. The experiments were on open field (Kent) and protected (Cambridgeshire) crops. In all three trials the incidence of botrytis at harvest was very low, but rapidly developed in fruit samples post-harvest. In 2006 at both sites fungicides, in particular UKA379, UKA374, Talat (tolylfluanid + fenhexamid), Signum (pyraclostrobin + boscalid), Switch (cyprodonil + fludioxonil), Scala (pyrimethanil), Amistar (azoxystrobin) and Folicur (tebuconazole,) gave the most consistent control of botrytis in post-harvest tests. None of the alternative chemicals evaluated had any effect on botrytis incidence apart from Hortiphyte Plus which showed some reduction in rotting at one pick date at the Kent site. In 2007 in Kent, programmes of Hortiphyte Plus applied alone or in combination with Teldor (fenhexamid) were compared for control of botrytis fruit rot. The least botrytis was recorded in fruit from plots treated with Teldor alone or combined with Hortiphyte Plus. Hortiphyte Plus applied alone at the same timings did not reduce botrytis incidence.

Efficacy of *Metschnikowia fructicola* (Shemer®) against post-harvest soft fruit (berries) rots in northern Italy (Trentino).

D. Prodorutti, A. Ferrari, A. Pellegrini, I. Pertot..... 189-192

Abstract: Shemer® is a commercial formulation of the antagonistic yeast *Metschnikowia fructicola*. It is usually applied to prevent the development of post-harvest rots caused by a wide range of phytopathogenic fungi. Experimental trials were carried out in 2005 and 2006 on berries pre-harvest treated with Shemer® and artificially inoculated with *Botrytis cinerea*. Fruits were stored at 1°C and thereafter at 25°C or kept constantly at 25°C. Efficacy of Shemer® against post-harvest rot of red currants, highbush blueberries, raspberries and strawberries was evaluated. Pre-harvest applications of Shemer® allowed a good control of grey mould on red currant, raspberry and strawberry while partially controlled the pathogen on blueberry. This experiment suggests that Shemer® could be successfully applied on soft fruits (berries), but further tests under commercial growing and storage conditions are necessary to confirm these data and to identify the most effective application method/time for each crop.

Low doses of copper control leaf spot diseases caused by *Mycosphaerella ribis* and *Drepanopeziza ribis* in black currants.

A. Stensvand, A. Dobson, S. Mogan 193-196

Abstract: Low rates of copper fungicides were tested against *Mycosphaerella ribis* and *Drepanopeziza ribis* in black currants in four experiments. Copper oxide (product: NORDOX 75 WG) at rates of 20, 40 and 200 g of the product per 100 litres and copperoxychloride (product: Kopperkalk Bayer) at a rate of 30 g of the product per 100 litres were applied five times in the period from just after bud break until early to mid June (flowering in mid to late May). Rates recommended by the manufacturers are 200 or 250 g per 100 litres of copper oxide or copperoxychloride, respectively. All treatments reduced the attack of both diseases, and there was no difference between 40 or 200 g copper oxide. The lowest rate of copper oxide and the copperoxychloride had a slightly weaker effect. It may be concluded that 1/5 dose (40 g per 100 litres) of copper oxide was as effective as the recommended rate. The low copper doses gave insignificant phytotoxic effects.

Effectiveness of a trifloxystrobin and tolyfluanid mixture for control of blackcurrant diseases.

A. Broniarek-Niemiec, A. Bielenin 197-201

Abstract: A formulated mixture of trifloxystrobin and tolyfluanid (TFS 63 g/kg + tolyfluanid 625 g/kg) was tested for control of blackcurrant diseases. The experiments were conducted in three localities in central Poland. In all experiments, the mixture was highly effective (> 87% control) against American powdery mildew, and it was similar or more effective than the standard fungicides Punch Bis 400 EC (flusilazole, 400 g/l), Nimrod 250 EC (bupirimate, 250 g/l) or Topsin M 500 SC (thiophanate-methyl, 500g/l). The mixture also gave good control of leaf spot and white pine blister rust. Its efficacy against leaf spot ranged from 64 to 83% and it was similar to the fungicides Punch Bis 400 EC, Topsin M 500 SC and Dithane M-45 80 WG (mancozeb, 800 g/kg). The effectiveness of the mixture for control of white pine blister rust varied from 81 to 90% and it was similar to Punch Bis 400 EC and more effective than Topsin M 500 SC or Dithane M-45 80 WG.

Interactions between isolates of powdery mildew (*Podosphaera aphanis*) and cultivars of strawberry, *Fragaria x ananassa*.

X. Xu, J. Robinson, D. Simpson 203-209

Abstract: Experiments were conducted to elucidate the nature of host-pathogen interactions between strawberry cultivars and powdery mildew. Over a period of two years, each of twelve mildew isolates was inoculated against potted plants of a number of commercial cultivars in controlled environmental cabinets. There were considerable differences in the mildew development between repeated inoculations as well as between cultivars. The cultivars Symphony, Rosie and Elsanta appeared to be most susceptible. There were no indications of significant isolate × cultivar (race-specific) interactions, indicating that breeding for partial resistance, instead of complete resistance, may be necessary.

Potential role of cleistothecia in strawberry powdery mildew.

X. Xu, J. Robinson, A. Berrie..... 211-215

Abstract: Experiments were conducted to determine whether ascospores can act as a source of primary inoculum of strawberry powdery mildew. Leaves with cleistothecia were collected from field plants in autumn and then placed outside on bare soil or grass. At a monthly interval, cleistothecia development was monitored from leaf samples. Samples of cleistothecia were checked whether ascospores were full of contents and discharged from asci individually. Mature (discharged as individual ascospores, full of contents) were observed in March and some of these ascospores had germinated on the agar. Experiments were also carried out to determine whether ascospores could lead to infections on strawberry leaves. Over-wintered leaves with cleistothecia were thoroughly wetted first and then immediately hung above healthy strawberry plants inside a controlled environmental cabinet (15°C). Development of mildew on these plants was regularly monitored. In both 2006 and 2007, only one single lesion was observed on these plants. These results so far suggest that ascospores are likely to be an important source of primary inoculum.

Ontogenic resistance against powdery mildew (*Podosphaera macularis*) in leaf tissue of strawberry.

D.M. Gadoury, A. Stensvand, R.C. Seem, M.C. Heidenreich 217

Abstract only

Colletotrichum acutatum: Survival in plant debris and infection of some weeds and cultivated plants.

P. Parikka, A. Lemmetty 219-222

Abstract: *Colletotrichum acutatum* can survive in strawberry residues in nordic conditions over one winter, maybe even for as long as almost two years. Plant debris stored either on soil surface or covered with soil was able to infect young strawberry plants in greenhouse tests still after one winter. Fungal DNA was amplified by PCR of test plants after two winters. Annual and perennial weed species common on strawberry fields were inoculated in greenhouse with *C. acutatum* spore suspension. The fungus sporulated on old leaves of all the artificially infected weed species but not on the young leaves and tops of the respective species. Old leaves of *Tripleurospermum*, *Chenopodium*, *Lapsana*, *Plantago*, *Capsella*, *Viola*, *Epilobium* and *Rumex* were heavily infected while the fungus was not recovered on young parts of *Epilobium*, *Viola*, *Senecio* and *Lapsana*. Infection in young leaves could be superficial, but in old leaves the fungus easily colonized senescent tissues. *C. acutatum* caused necrotic lesions on some plant species like *Plantago major* and *Phacelia tanacetifolia*. The fungus was able to survive in infected weed debris on soil surface over one summer.

Wild and cultivated *Potentilla* spp. may serve as alternate hosts and possible reservoirs of strawberry viruses.

D. Yohalem, K. Lower 223-224

Abstract: Strawberry [*Fragaria x ananassa* Duchesne = *Potentilla x ananassa* (Rozier) Mabb] has accumulated a variety of virus diseases in its relatively short history. *Strawberry crinkle virus*, *Strawberry mild yellow edge virus* and *Strawberry mottle virus* are vectored by the aphid *Chaetosiphon fragaefolii* (Cockerell), which is known to occasionally infest other members of the genus *Potentilla*. Several wild strawberry species have been shown to be hosts of the virus. We grafted material infected with strawberry viruses into plants of UC-5, an indicator strawberry cultivar and then grafted UC-5 leaves into other members of the genus *sensu lato*. Leaves from these plants were subsequently grafted back to UC-5 plants to demonstrate their potential as reservoirs for the virus. UC-5 plants were indexed for strawberry viruses by end-point reverse transcriptase PCR subsequent to back grafting.

Residues of acetamiprid in leaves of *Aesculus hippocastanum* and effects on the horse chestnut leaf miner (*Cameraria ohridella*) following trunk spraying
Schenke, D., Jäckel, B. & Schmidt, H. 1-9

Abstract At the beginning of flowering in 2006, the neonicotinoid acetamiprid was sprayed on trunks of twenty and eighty-year-old horse chestnut trees at different application rates. Sampling took place at the end of the first and second leaf miner generations. To estimate mortality, efficiency and parasitism, living, dead and parasitized leafminers were counted. Acetamiprid residues were only found in the first samples taken after application, which showed high deviations. All variants showed low efficiency of acetamiprid independently of the application rate. The parasitism rate of chalcidoid wasps was generally higher in the treated variants than in untreated trees.

Who benefits from low-input pesticide use within the tritrophic system: crop – aphid – predator?

Schumacher, K. & Freier, B. 10-17

Abstract: Effects of low-input pesticide use on the tritrophic system crop – aphid – predator were investigated in field and laboratory studies. The field study was carried out in a conventional farm of the high-input crop protection area Magdeburger Boerde between 2004 and 2006. The field was divided into two halves during the whole period of investigation representing low- and high-input variants. One half was characterized by 50% reduced pesticide doses and the other one by good plant protection practice (100%). The crop rotation of this field was spring wheat (2004), winter wheat (2005) and peas (2006). Before and after insecticide application densities of aphids and their predators on plants (counts) as well as activity densities and diversity of carabids on ground (pitfall trappings) were investigated. Aphids were insufficiently reduced by insecticides in the low-input variant. In all three years significantly more aphids were found in the low-input variant in comparison to the high-input variant. The abundance of aphid specific predators, e. g. adults and larvae of coccinellids and syrphid larvae, was positively affected by the low-input pesticide use. In all years significantly more aphid predators were observed in low-input-field than in high-input-field. But no clear effect of reduced insecticides use on abundance, structure of dominance, and diversity of carabids was observed. It is concluded, that the potential of natural regulation was enhanced by reducing the insecticide input but the regulation itself was not improved. Thus, aphids were benefited to a greater extent than their predators from reduced insecticide use. The laboratory studies were carried out in climate chambers investigating the tritrophic system weed – aphid – predator by applying different doses of insecticides. In contrast to the field study aphids could be sufficiently reduced by low-input insecticide doses. The doses of insecticide could be reduced even more by utilization of the predator potential to receive a good pest control. But its difficult to transfer the results of laboratory studies to field conditions. It could come to an overestimation of the potential of natural regulation by a predator.

Impact of low-input pesticides usage on spider communities with special regard to accumulated effects

Volkmar, Ch., Schumacher, K. & Müller, J. 18-25

Abstract: Reduction programs are designed to reduce chemical plant protection to a minimum. The intensity of plant protection can be measured by the treatment frequency index (BI). This study focused on the ecological impact of a long-term reduction of chemical plant protection in commercial crop cultures and investigated the effects of a 50% reduction on *Araneae* at three fields in Ochtmersleben (Saxony-Anhalt). Each field was divided into two halves representing a 100% and a 50% application variant. The analysis was based on qualitative and quantitative parameters such as activity density, species diversity, pattern of dominance as well as other computed parameters. The results indicate that the impact of insecticides on the spider population was the strongest when the insecticides were applied the earliest. There were no significant shifts in dominance structures between both variants. Some endangered spider species were only sampled in the 50% variant. In summary, a 50% long-term reduction of chemical plant protection has positive effects on spider coenoses.

- Effects of different control measures against the olive fruit fly (*Bactrocera oleae* (Gmelin)) on beneficial arthropod fauna. Methodology and first results of field assay
 González-Núñez, M., Pascual, S., Seris, E., Esteban-Durán, J. R., Medina, P., Budia, F., Adán, Á. & Viñuela, E. 26-31
Abstract: Beneficial arthropod fauna was monitored in test plots of an olive grove in Madrid under four different control strategies against the olive fruit fly: trichlorfon bait sprays (trichlorfon + protein hydrolysate Nu-Lure[®]), spinosad bait sprays (Spintor Cebo[®]), kaolin sprays and mass-trapping (Easy-trap[®] + Nu-Lure[®]). A beating method was used to sample arthropods from the five plots along 2005. Bait treatments (spinosad or trichlorfon) and mass-trapping did not cause significant effects on populations of beneficial arthropods, but a reduction of parasitoids and predators was observed in samples from plots sprayed with kaolin. However, a longer time period of study will be necessary to confirm the effect of the different control strategies on the evolution of arthropod populations.
- Impact of Success Bait (a.i. spinosad) against *Rhagoletis cerasi* on insect fauna in field test (Abstract) Barić, B., Pauković, M., Bertić, D. & Pajač, I. 32
 Abstract only
- Effects of bait sprays to control the European cherry fruit fly (*Rhagoletis cerasi* L.) on aphid predators (Abstract)
 Vogt, H. & Köppler, K. 33-34
 Abstract only
- Earwigs in fruit orchards: phenology predicts predation effect and vulnerability to side-effects of orchard management
 Gobin, B., Moerkens, R., Leirs, H. & Peusens, G. 35-39
Abstract: Earwigs, *Forficula auricularia*, are important natural enemies of a variety of orchard pests. In recent years, numbers of earwigs have declined in both organic and IPM orchards. To understand what factors affect earwig population dynamics, we conducted a detailed phenological survey of earwigs in orchards. Earwigs were counted in artificial refuges in orchard trees. Earwigs appear in the trees from the beginning of June onwards as third instar nymphs, moult into fourth instar nymphs 3 weeks later and reach adulthood early July. At this point, earwigs show an inexplicable reduction in population. Adults remain present until end of October. In most orchards, a small second brood is produced in summer, and this has a positive impact on population size in fall. Comparison of earwig and pest phenologies show that earwigs play important roles in controlling summer pests rather than spring pests. Earwigs are at risk for side-effects of foliar spray applications from June to October, and for soil management or herbicide treatments in winter and early spring.
- Side effects of pesticides on the European earwig *Forficula auricularia* L. (Dermaptera: Forficulidae) Peusens, G. & Gobin, B. 40-43
Abstract: Earwigs are key predators of orchard pests, but show large inter-orchard differences in population dynamics and numbers. In apple and pear orchards, only sufficiently large earwig populations can contribute to pest control. As earwigs have a single generation per year, a potential effect of pest management is likely to influence population dynamics. In an extended lab test the side effect of dried residue of 37 registered plant protection products (twenty-seven insecticides, 1 biological insecticide, 2 oils, 1 surfactant, 1 protectant and 1 herbicide) were evaluated on adult *F. auricularia* L.. Classified upon their Mode of Action (MoA) 9 of the 17 tested classes of insecticides proved to be harmless, 7 slightly and 1 moderately harmful. For various test products sub-lethal effects such as reduced co-ordination, spastic behaviour were noticed shortly after application. Depending on the active ingredient the earwigs either recovered or died eventually. We still need to verify the validity of our results in a replicated trial and hope to extend the test to juvenile stages and field test.

About the presence and abundance of beneficials in overwintering sites of *Anarsia lineatella* (Lepidoptera: Gelechiidae) in peach orchards of northern Greece

Damos, P. & Savopoulou-Soultani, M. 44-50

Abstract: A report is given about the presence and abundance of beneficials in overwintering sites of *Anarsia lineatella* Zeller (Lepidoptera, Gelechiidae). The study was conducted in two important regions of peach production in Northern Greece (Veria 40.32°N and Velvendo 40.16°N). For 3 years (2005-2007) hibernacula of overwintering larvae were collected from conventional and IPM peach orchards and transferred to the laboratory in order to ascertain the level and type of beneficial activity. The presence of two Braconid parasitoids was high, causing a significant high larval mortality. In some cases almost 57% of inspected samples were parasitized. In addition, a comprehensive number of beneficial mites were also observed inside the hibernacula. Despite the fact that some of them are not directly linked to the predation of *A. lineatella*, they had a high presence during the years. Moreover, most of the observed species belonged to the families Phytoseiidae, Pyemotidae and Tydeidae. The observations attest the fact that the overwintering sites of *A. lineatella* constitute an important microenvironment of beneficial activity. Considering the increasing interest in biological control and that all the above-mentioned beneficials are subjected to mortality induced by pesticides, the different strategies for the control of *A. lineatella* in Northern Greece peach orchards are discussed.

Is the use of some selected insecticides compatible with two noctuid endoparasitoids: *Hyposoter didymator* and *Chelonus inanitus*?

Medina, P., Morales, J.J., González-Núñez, M. & Viñuela, E. 51-59

Abstract: Studies were conducted in the laboratory to evaluate the toxicity of three insecticides (imidacloprid, fipronil and natural pyrethrins+piperonyl butoxide) at field rates on pupae and adults of *Hyposoter didymator* and *Chelonus inanitus*, both of them solitary endoparasitoids of several noctuid larvae. Topical application on pupae and residual, topical and ingestion bioassays on adults of the two parasitoid species were used to assess percentages of adult emergence and life-span, in case of treated pupae and life-span for adults. Out of the three compounds tested, only fipronil significantly reduced the life-span of emerged adults, after topical treatment of *H. didymator* and *C. inanitus* pupae (90 and 75%, respectively). The life-span of treated adults was significantly reduced in both parasitoid species by all the insecticides tested irrespective of the uptake route, with the exception of *C. inanitus* adults treated with imidacloprid. Fipronil was clearly the most toxic insecticide.

The extended laboratory test guideline for *Aphidius rhopalosiphii*: some areas of debate relating to the methodology

Mead-Briggs, M. 60-65

Abstract: After several years of slow evolution, a final draft version of the extended laboratory test guideline was put forward by the *Aphidius* Ring-Test Group in 2006. However, upon wider circulation, some proposals made in the guideline were challenged. These related to a) why only female wasps were being evaluated; b) the relevance of the repellency assessments and what happens where settling rates on the treated plants were poor; c) which of the surviving wasps should be selected for the reproduction assessments; only those classed as 'alive and unaffected', or also those appearing to be 'affected'? It is hoped that by explaining the reasons behind certain decisions that were made and by presenting additional data, we can now move forward and finalise the long-overdue publication of the guideline.

Pesticides selectivity list to beneficial arthropods in four field vegetable crops

Jansen, J.P., Hautier, L., Mabon, N. & Schiffers, B. 66-77

Abstract: Selectivity of pesticides to beneficial arthropods is a key data for the implementation of IPM program. In the context of field vegetable crops, a set of 16 fungicides, 16 herbicides and 13 insecticides commonly used in Belgium were tested on 5 indicator species: the parasitic hymenoptera *Aphidius rhopalosiphii* (De Stefani-Perez) (Hym., Aphidiidae), the aphid foliage dwelling predators *Adalia bipunctata* (L.) (Col., Coccinellidae) and *Episyrphus balteatus* (Dipt., Syrphidae) and the ground-dwelling predators *Aleochara bilineata* (Col., Staphylinidae) and *Bembidion lampros* (Col., Carabidae).

Pesticides were tested according to a testing scheme including a first assessment on inert substrate and, for products that were toxic, a second assessment on natural substrate. The effects of the product were assessed on basis of onion fly pupae parasitism reduction for *A. bilineata* and on

basis of corrected mortality for the 4 remaining species. According to the final results obtained at the end of this testing scheme, the products were listed in toxicity classes: green list if effect $\leq 30\%$, yellow list $30\% < \text{effect} \leq 60\%$ and orange list $60\% < \text{effect} \leq 80\%$. Products with toxicity higher than 80% on plants or on soils, or that reduce parasitism more than 80% on soil were put in the red list and are not recommended for IPM.

Results showed that all fungicides and herbicides were included in the green list except tebuconazole and boscalid + pyraclostrobin that were labeled as yellow for *A. bipunctata*. In opposite, no foliar insecticide was totally selective for all beneficial tested. However some products are in green list for one or several species. Soil insecticides were all very toxic for ground dwelling arthropods and classed in red list.

In conclusion, fungicides and herbicides tested are compatible with IPM programs. For foliar insecticides, some treatments can be used carefully according to the selectivity. But for soil insecticide treatments, their toxicity raise the question of their use in IPM programs in vegetables and the need of new compounds or development of alternative pest control programs.

Concerns and solutions in non-target arthropod regulatory risk assessment of plant protection products

Chaton, P.F., Vergnet, Ch. & Alix, A.78-84

Abstract: According to the Directive 91/414/EC, the risks of plant protection products to non-target arthropods have to be assessed in the field and outside the field (off-field area). For the products that require a refined risk assessment, an evaluation of all risk types relies on many extrapolations from available experimental data, especially for the off-field assessment. Due to these extrapolations, some concerns could occur in the assessment, like the questionable relevance of the tested species. The introduction of off-field specific topics in the existing tests and the use of model could be helpful to solve these concerns.

Toxicity of certain pesticides to the predatory mite *Euseius finlandicus* (Acari: Phytoseiidae)

Broufas, G.D., Pappas, M.L., Vassiliou, G. & Koveos, D.S.85-91

Abstract: The acute and residual toxicity of certain widely used pesticides in plum orchards in Greece to the predatory mite *Euseius finlandicus* were determined with laboratory and semi-field experiments. The acute toxicity of the tested products was evaluated under laboratory conditions using detached bean leaf disks which were sprayed with a Potter spraying tower calibrated to approximately 1.5 mg wet deposit per cm². Protonymphs of *E. finlandicus* were transferred on the sprayed leaf disks and subsequently pre-imaginal survival, adult survival and fecundity were determined according to the IOBC protocols. Based on mortality and fecundity, the pesticides carbaryl, cypermethrin, acetamiprid, methomyl and deltamethrin were considered as harmful, diflubenzuron slightly harmful and *Bacillus thuringiensis* as harmless to *E. finlandicus*. The residual toxicity of the tested pesticides to *E. finlandicus* was evaluated using 3 year old potted plum trees (cv. Vanilia) which were sprayed till run-off with a hand sprayer and maintained in the field. At regular time intervals of 3, 7, 10, 15, 20 and 25 days after spraying, leaves were detached from the plants and protonymphs of *E. finlandicus* were transferred on them. Based on the mortality percentages, the pesticides carbaryl, cypermethrin, acetamiprid and methomyl were highly toxic to the predator for more than two weeks, whereas diazinon for 7 to 10 days. These results could be useful for the selection of suitable pesticides for use in integrated pest management programs in orchards in northern Greece.

Side effects of pesticides used in vineyards in the Aegean region on the predatory mite *Typhlodromus perbibus* Wainstein & Arutunjan (Acari: Phytoseiidae) under laboratory conditions

Göven, M.A. & Güven, B.92-95

Abstract: In this study the side-effects of pesticides on predatory mite *Typhlodromus perbibus* Wainstein et Arutunjan were tested under laboratory conditions during the period 2002-2004. The susceptible life stages of *T. perbibus* were exposed to fresh residues on glass of five commonly used pesticides in vineyards. The tests were conducted according to the standard laboratory test method of the IOBC/WPRS working group "Pesticides and Beneficial Organisms" (Blümel et al., 2000). In laboratory tests, Thiovit (a.i. sulphur) was the only compound demonstrating moderately toxic effect. Ekalux (a.i. quinalphos), Folidol M (a.i. parathion-methyl), Korvin (a.i. carbaryl) and Antracol (a.i. propineb) showed harmless effect.

Effects of ten pesticides to *Anystis baccharum* (Acari: Anystidae)

Bostanian, N.J. & Laurin, M.-C. 96-100

Abstract: *Anystis baccharum* (L.) (= *Anystis agilis* (Banks)) is a common predatory mite recently identified in apple orchards and in vineyards of Quebec, Canada. Studies of its susceptibility to pesticides used in these crops need to be carried out to encourage integrated pest management programs in these crops. A laboratory evaluation of the following insecticides: methoxyfenozide (Interprid® 2F), acetamiprid (Assail® 70WP), thiamethoxam (Actara® 25WG), imidacloprid (Admire® 24%), spinosad (Tracer® 44.1%), λ -cyhalothrin (Warrior® T), and carbaryl (Sevin® XLR) showed that residues of λ -cyhalothrin, and carbaryl were highly toxic to *Anystis baccharum* in 48 h Petri dish bioassays. The label rate of λ -cyhalothrin is 9.9 g A.I. /ha applied in 540 liters of water (0.0184 g A.I./L) which would be 26 fold the estimated LC₅₀ (0.0007 g A.I./liter) for this predator. The field rate for carbaryl is 1.06 kg A.I. / ha again applied in 540 liters of water (1.960 g A.I./liter) and it would be 784 fold the estimated LC₅₀ (0.0025 g A.I./liter). The other five insecticides, evaluated were non-toxic. Among the three fungicides evaluated mancozeb (Dithane® M-45) was slightly to moderately toxic. Whereas kresoxim-methyl, (Sovran® 50WG) and sulphur, (Microscopic sulphur® 92WP) were non toxic.

Influence of some insecticides and acaricides on beneficial mites and on *Coccinella septempunctata* (Coleoptera; Coccinellidae) larvae

Olszak, R. W. & Sekrecka, M. 101-108

Abstract: During the period 2004-2007 several experiments have been conducted under laboratory and field conditions to assess the influence of a broad range of insecticides and acaricides on different beneficial mites and on *Coccinella septempunctata* larvae.

In the laboratory the toxicity of the insecticides spinosad, methoxyfenozide and triazamate were investigated on the predatory mite *Typhlodromus pyri* (Phytoseiidae). In other laboratory experiments the influence of the pesticides spiroticlofen, thiamethoxam, spinosad, propargite and novaluron were investigated on *Coccinella septempunctata* larvae.

In the field, the side-effects of triazamate, thiacloprid, pirimicarb, novaluron, spinosad, indoxacarb and fenitrothion were studied on the population of *Typhlodromus pyri*. Additionally, in the field, the toxicity of the acaricides hexythiazox and fenpyroximate were investigated on the predatory mite *Zetzellia mali* (Stigmaeidae). In a third experiment, carried out in an abandoned orchard, the influence of propargite, pyridaben, cyhexatin, and fenitrothion were studied on the population of beneficial mites belonging to the families Phytoseiidae, Tydeidae, Stigmaeidae and Tarsonemidae.

The results of investigations indicate that most of used insecticides were harmless to the predatory mite *Typhlodromus pyri* and to the larvae of *Coccinella septempunctata*, with the exception of spinosad being harmful to phytoseiid mites. Similar data were received when the acaricide fenpyroximate was used on population of *Zetzellia mali*.

In the field experiment, carried out in an abandoned apple orchard, all the used chemicals were toxic to beneficial mites.

Effect of the entomopathogenic fungus *Lecanicillium muscarium* on the predatory mite *Phytoseiulus persimilis* as a non-target organism

Donka, A., Sermann, H. & Büttner, C. 109-112

Abstract: To combine different beneficial organisms in biological control systems with entomopathogenic fungi, it is necessary to examine their compatibility. Regarding the entomopathogenic fungus *L. muscarium*, the objective of the study was to determine the potential risk of our strain V 24 for the most important antagonist *Phytoseiulus persimilis*. In standardised trials in petri dishes and on potted plants, the effect of the fungus on predatory mites at different spore densities (2×10^6 and 2×10^7 sp./ml) was assessed.

We could show that predatory mites can indeed pick up spores from the leaf surface. At spore densities of 2×10^6 and 2×10^7 sp./ml however, only few predatory mites died on plants (4,2 respectively 12,7%). There were no differences to the control regarding the development of the mite population on the plant.

Effects of *Beauveria bassiana*, *Heterorhabditis bacteriophora*, *H. megidis* and *Steinernema feltiae* on the Mediterranean fruit fly *Ceratitis capitata* and the very sensitive braconid *Psytalia concolor* in the lab

Medina, P., Corrales, E., González-Nuñez, M., Smagghe, G. & Viñuela, E. 113-121

Abstract: Laboratory experiments were set up to measure the susceptibility of the pest *Ceratitis capitata* and the braconid *Psytalia concolor* (very sensitive to pesticides), to three commercial nematodes available in Spain [maximum field recommended rate (MFRC): 100 infective juveniles (IJ)/cm²]: *Steinernema feltiae*, *Heterorhabditis bacteriophora*, *H. megidis* and the entomopathogenic fungus *Beauveria bassiana* (MFRC 1000 ml cp/hl; 2.3 x 10⁹ conidia/ml cp). The neurotoxic malathion, used worldwide for the control of *C. capitata* was used as positive standard (150 ml ai/hl).

When nematodes were applied to the pupation medium of *C. capitata* (vermiculite, 10% humidity), *S. feltiae* and *H. bacteriophora* were as effective as malathion, inhibiting practically 100% of adult emergence at a 2-fold MFRC and 75% r.h. Efficacy of nematodes was much higher at 75% r.h. than at 30% r.h. irrespective of the dose used. The three nematodes decreased the progeny size of *P. concolor* when the parasitoid parasitized *C. capitata* L₃ larvae, treated with the MFRC under 75% r.h., but significant reductions were only scored for *S. feltiae*.

The fungus *B. bassiana* was tested on adults of the pest and the parasitoid (75% r.h.; 25°C) by residual contact, topical application and ingestion, as well as by treatment of the oviposition gauze and direct spray on the pest, and *via* contaminated hosts on the parasitoid. It did not cause mortality at 3 days or affected reproduction of *C. capitata* (malathion gave 100% mortality), except when applied at a 10-fold MFRC at the oviposition gauze (significantly decreased fertility by 21.7%). The biopesticide did not cause mortality on *P. concolor* in contrast with malathion (100%), but it significantly decreased its beneficial capacity by residual contact or *via* treated host larvae (lower progeny size) or by ingestion (lower number of attacked hosts).

Aged-residue method for evaluating toxicity of plant protection products to *Stethorus punctillum* (Weise) (Coleoptera: Coccinellidae)

Nienstedt, K.M. & Miles, M. 122-127

Abstract: *Stethorus punctillum* (Weise) (Coleoptera: Coccinellidae) is known as an obligate predator of spider mites. Currently there are no widely recognised laboratory methods for testing the effects of plant protection products (PPP) to this species. Here we present a method for evaluating the toxicity of PPP under extended laboratory conditions or as a persistence (aged residue) study, combining field applications with laboratory bioassays. *S. punctillum* larvae were exposed to treated apple leaf disks and their development through to pupation and adult emergence monitored. An assessment of reproduction was also performed. Example data corresponding to control, methoxyfenozide and fenoxycarb treatments are presented.

Chlorantraniliprole (DPX-E2Y45, DuPont™ Rynaxypyr®, Coragen® and Altacor® insecticide) - a novel anthranilic diamide insecticide - demonstrating low toxicity and low risk for beneficial insects and predatory mites

Dinter, A., Brugger, K., Bassi, A., Frost, N.-M., Woodward, M.D. 128-135

Abstract: Chlorantraniliprole (DPX-E2Y45, DuPont™ Rynaxypyr®) is a new anthranilic diamide insecticide with a novel mode of action. Rynaxypyr® activates insect ryanodine receptors causing impaired regulation, paralysis and ultimately death of sensitive species at rates of 10 to 60 g Rynaxypyr®/ha. In worst-case Tier 1 glass plate tests the two indicator species, *Aphidius rhopalosiphii* and *Typhlodromus pyri*, were not sensitive to either Coragen® or Altacor® at up to 750 g Rynaxypyr®/ha, the maximum rate tested indicating low risk for non-target arthropods. Low risk for non-target arthropods was confirmed in a wide range of tests with several other species. Overall, DuPont™ Rynaxypyr® and the formulations, Coragen® and Altacor®, were demonstrated to be safe to numerous beneficial non-target arthropod species or to have a rather low and transient impact and therefore will be excellent tools for use in integrated pest management (IPM) programmes.

- Influence of organic matter on bio-availability of two pesticides and their toxicity to two soil dwelling predators (Abstract)
Hautier, L., Mabon, N., Schiffers, B. & Jansen, J.-P. 136
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- Different methods of application – Different laboratory test strategies (Abstract)
Norr, C., Baier, B. & Schenke, D. 137
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- Assessment of side-effect of water-soluble nitrogen fertilizers applied as foliar spray on the parasitic wasp *Aphidius rhopalosiphi* (DeStefani-Perez) (Hym.; Aphidiidae)
Dantinne, D. & Jansen, J.P...... 138-142
Abstract: In several crops, nitrogen fertilizers can be routinely applied as foliar spray at period when beneficial arthropods are active and, thus, exposed to these products in a same way as pesticides. If side-effects of pesticides on beneficial arthropods are well documented, little is know about possible negative impact of nitrogen formulations on beneficial arthropods. In this research, the effects of 3 nitrogen fertilizers applied as foliar spray were tested on the parasitic wasp *A. rhopalosiphi* in the laboratory on glass plates and on plants. This species was selected because it is very sensitive to pesticides and used as "standard species" for ecotoxicological tests in the context of registration at European level. It is also a key beneficial arthropod for aphid control. The nitrogen formulations tested were a nitrogen solution (nitrate, urea and ammoniac in solution), pearled urea (liquid urea) and Nutriforce®. These fertilizers are widely used in crops such as cereals or potatoes. They were tested at their maximum recommended field rate, corresponding to an application of 15-20 N units/ha according to the product.
 The nitrogen formulations were first tested on glass plates, according to the IOBC Tier I testing scheme. All formulation exhibit a high toxicity, mainly due to mechanical effects, with re-crystallization of urea and high hygroscopicity of residue. Results clearly showed that Tier I test methodology was not adapted for nitrogen formulation at field rate.
 Nitrogen formulations were further tested on plants in the laboratory, according to IOBC Tier II testing scheme. Fertilizers were applied on barley seedlings infested with cereal aphids. Both mortality and repellence were followed through a 48h period and aphid mummies were left to developed 10-12 days. They were counted by plants and assessed for parasite emergence. Both lethal (mortality) and sublethal effects (aphid mummies production and emergence) were used to calculate reduction in beneficial capacity, compared to a water-treated control. When they were applied on barley seedlings, the three nitrogen formulation were only slightly toxic for adult wasp, with a minimum of 14% corrected mortality with the nitrogen solution and a maximum of 44% with pearled urea. However, a strong reduction in female capacity was observed with 50.4 aphid mummies/female for control and only 13.4, 9.0 and 17.8 aphid mummies/female with pearled urea, nitrogen solution and Nutriforce®, respectively. Emergence rate of the mummies were comparable to control values. Due to effects on reproduction, the reduction of beneficial capacity were comprised between 69.8% and 85.4%.
 According to IOBC toxicity classes, Nutriforce® was considered as moderately harmful (class 3) and pearled urea and nitrogen solution as harmful (class 4). Magnitude of the effects was similar than for classical insecticides, indicating that foliar nitrogen application can have a biological signification for beneficial arthropods and probably also on other organisms exposed to foliar spray.
- Field toxicity of four acaricides on the predatory mites *Amblyseius andersoni* (Chant) and *Euseius stipulatus* (Athias-Henriot) (Acari: Phytoseiidae) in apple orchard at Northwest of Portugal (Abstract)
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- Influence of teflubenzuron residues on the predation of thrips by *Iphiseius degenerans* and *Orius laevigatus*
Scott Brown, A., Simmonds, M. & Blaney, W. 144-145
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Study on the side-effects of three pesticides on the predatory mite, *Phytoseius plumifer* (Canestrini & Fanzago) (Acari: Phytoseiidae) under laboratory conditions

Noji, S., Talebi, K., Saboori, A., Allahyari, H., Sabahi, Q. & Ashouri, A. 146-151

Abstract: The predatory mite, *Phytoseius plumifer* is one of the most abundant natural enemies of phytophagous pests and mites especially in the north of Iran. Experiments were carried out to assess the compatibility of commonly used pesticides against phytophagous pests in order to determine pesticides which have the least side-effects on the predator and are more suitable for using in integrated control programs. In this study the side-effects of three pesticides (abamectin, malathion and phosalone) were evaluated in laboratory. The laboratory tests were done using the 'detached leaf' method. Percentages of predator mortality and oviposition rate were assessed. The effect of the pesticides at the maximum field rates on *P. plumifer* adults was above the upper tolerance threshold. All three tested pesticides caused 100% mortality within 24 hours after treatment and were classified as harmful for the predator. Therefore they are not compatible with the predator within an integrated control program. Effects of abamectin, malathion and phosalone even at 0.1 recommended field rates were above the upper tolerance threshold. The residue test revealed that these pesticides caused 100% mortality within 3, 10 and 15 days after treatment. According to a dose-response test, the LR₅₀ of phosalone amounts to 1.48 µg a.i./cm² for the adult predator. The rate of fecundity decreased as the rate phosalone increased. These results suggested that *P. plumifer* can be used as a biological indicator in the safe shelters.

Special Topic

The need for taxonomists of pest and beneficial organisms - results of an inquiry at the meeting of the IOBC working group "Pesticides and Beneficial Organisms" in Berlin in October 2007

Schmitt, G. 152-156

Abstract: An inquiry has been carried out on the meeting of the IOBC working group "Pesticide and Beneficial Organisms" in October 2007 to record the international need for taxonomists of pest and beneficial organisms by specialists on phytopathology and biocontrol. The questionnaire consisted of 5 questions on 19 proposed taxonomic groups at different taxonomic level. The outcome of the inquiry includes a list of the taxonomic groups ranked by the numbers of asked persons working with and showing on which groups taxonomic support is needed. Most of the respondents require the support of professional taxonomists from external institutions. According to the statements, the presence of taxonomists has been summarized for each of the countries the respondents came from. Overall, taxonomists were frequently missed or not known, and the majority of the asked persons agreed with the claim for more permanent positions for taxonomist.