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# Foreword

Dear Colleagues

It is with the great pleasure we welcome you to the 7th IOBC conference on Integrated Fruit Production here at Avignon in 2008.

The programme for this meeting is exceptionally rich and diverse and contains many interesting and exciting contributions. The numbers of offered oral and poster presentations (>200) is quite exceptional and well beyond our expectations. It demonstrates that Integrated Plant Protection in Fruit Crops remains an area of strong interest in the WPRS and beyond. We greatly appreciate the strong representation at the conference by delegates from the USA and Canada. We are sorry that we have not been able to accommodate all the offered oral papers in the programme. This has meant that we have requested >30 offered oral papers to be presented as posters. Furthermore, the number of posters is so great that 2 separate poster sessions are necessary.

This is the 4 yearly meeting of our whole IOBC Working Group which comprises 5 sub-groups (pome fruit arthropods, pome fruit diseases, soft fruits, stone fruits and IFP guidelines). The decision to have parallel sessions for pests and diseases was taken to ensure that both entomologists and pathologists attended this conference. We hope the arrangement will be successful and that moderators and speakers will adhere strictly to the timetable to allow delegates to move between sessions.

Our working group, formerly named the 'Orchards Working Group' is near to celebrating its 50<sup>th</sup> anniversary. Our group was a pioneer in Integrated Pest and Disease Management and has come a long way from its historical roots. We welcome Ernst Boller, Honorary member of the IOBC, and a person with a strong interest in and with good links with our past, who has kindly agreed to give a historical review of our Working Group's origins, founder members and activities.

The IOBC council has provided substantive funds to support this conference and we have used these funds mainly to support the attendance of 8 students and young persons starting their career at this conference who otherwise would have been unlikely to attend. We welcome them and hope this conference will cement their interest in our subject.

Finally, we are especially indebted to our colleagues from INRA Avignon who have agreed to host this conference. We extend our grateful thanks to all our French hosts.

And we wish you all a very fruitful, interesting and memorable conference

Jerry Cross (convenor), Claudio Ioriatti, Christian Linder, Fabio Molinari, Carlo Malavolta, Jesus Avilla, Arne Stensvand, Benoît Sauphanor.

Conference scientific committee

## Proceedings and publication

Two options of publication of the communications will be offered, *ie* the IOBC bulletin or a special issue of the refereed international journal *Agriculture Ecosystems and Environment*.

The IOBC bulletin is the usual support for publishing the proceedings of the working group meetings, study group meetings and commission activities. The guidelines for the manuscripts are available at <http://www.iobc-wprs.org/pub/>. The length of a manuscript will be limited to 4 pages; the **deadline for submission is on 31 January 2009**.

In addition, all the abstracts of the oral communications and posters that will have been presented at IFP 2008 will be available on the open archives of INRA, with author and key word indexation, and the full texts distributed as pdf files. As an example, see the proceedings of the last EUCARPIA International Meeting on Cucurbitaceae (Avignon 21-24 May 2008) at <https://w3.avignon.inra.fr/dspace/handle/2174/164>

Agriculture Ecosystems and Environment (AEE), as a special issue entitled “New prospects in Integrated fruit Production”. The authors choosing this publication option will have to confirm their choice to the scientific committee the week following the conference (**before 8 November 2008**), and keep in mind that the submissions will go through rigorous peer review and are not assured of being accepted. There will be a strict requirement for ensuring quality of the manuscripts and fitting the journal's scope, *ie* dealing with at least two of the tree items agriculture, ecosystems, environment. The instructions to authors are available at [http://www.elsevier.com/wps/find/journaldescription.cws\\_home/503298/authorinstructions](http://www.elsevier.com/wps/find/journaldescription.cws_home/503298/authorinstructions).

The **deadline for submission is on 31 January 2009**. The abstracts of the communications published in this issue of AEE will also be included in the IOBC bulletin and in the digital proceeding.

# IFP 2008 Program

## Monday 27 October

Registration 16:00-18:00; Salle des gardes

## Tuesday 28 October

Registration 08:30-09:15; Salle des gardes

### Plenary Session 1:

09:15-12:30; Cellier Benoit XII

Session organiser and moderator: Jerry Cross

Time	Abstract no.	Presenting author	Title
09:15	1	Convenor, scientific committee and local organiser	Conference welcome and announcements
09:30	2	Jesus Avilla	Integrated Production: where is it and where is it going?
10:00	3	Marc Trapman	Disease management in organic apple orchards is more than applying the right product at the correct time.
10:30	4	Françoise Lescourret	Designing cropping systems to achieve Integrated Fruit Production goals Subtitle:
11:00	5	W. Harvey Reissig	Developing a Protocol and a Marketing Niche for EcoApples in NY State
11:30	6	Mark Brown	Analyzing the Results of Biodiversity Experiments: Enhancing Parasitism of Tufted Apple Budmoth
12:00	7	Cesare Gessler	Genetic modification of apple to control diseases:

Lunch: 12:30-14:00; Espace Jeanne Laurent

### Entomology Session 1: Arthropod pests- tree fruits

14:00-15:30; Cellier Benoit XII

Session organiser: Claudio Ioriatti Session moderator: Heidrun Vogt

14:00	8	Frank Pierre	Genetic inference of the dynamic of codling moth fecundated females in a French farm
14:15	9	Herman Helsen	Observations on the phenology of codling moth in untreated orchards in the Netherlands and Belgium
14:30	10	Valeria Malagnini	Differences among <i>Cacopsylla melanoneura</i> Förster (Homoptera: Psyllidae) insight from molecular markers
14:45	11	Arthur Agnello	Whole-farm infestation trends and management programs for obliquebanded leafroller in apples
15:00	12	Petros Damos	Population dynamics of <i>Anarsia lineatella</i> and their relation to crop damage in Northern Greece IPM peach orchards: toward the development of EIL

Discussion

### Pathology Session 1: Brown spot of pear and modelling of pear scab

14:00-15:30; Chambre du trésorier

Session organiser: Arne Stensvand; Session moderator: Vittorio Rossi

14:00	13	Emilio Montesinos	An update on brown spot of pear
14:30	14	Isidre Llorente	New strategies in integrated control of brown spot of pear ( <i>Stemphylium vesicarium</i> , teleomorph <i>Pleospora allii</i> )
14:45	15	Stijn Vanlaer	Drought and oxidative stress determine the sensitivity of the pear towards Brown spot infections
15:00	16	Håvard Eikemo	Evaluation of ascospore maturity models to estimate seasonal ascospore discharge of pear scab ( <i>Venturia pirina</i> )

Discussion

Break: 15:30-16:00; Paneterie

### Poster Session 1: 16:00-17:00; Paneterie

Note: Posters from Poster Session 1 to be removed by 11.00 am on Wednesday 29 October to make way for posters for Poster Session 2.

<b>Entomology Session 2: Arthropod pests – soft fruits</b> 17:00-18:00; Cellier Benoit XII Session organiser and moderator: Christian Linder			
17:00	17	Michelle Fountain	Developing an effective trap and lure to monitor mirids in UK horticultural crops
17:15	18	Jean Fitzgerald	Interactions among predatory insects in strawberry production
17:30	19	Amelie Boullenger	Developing Integrated Pest Management programmes for protected strawberry crops in Southern France
17:45			Discussion
<b>Pathology Session 2: Storage diseases</b> 17:00-18:00; Chambre du trésorier Session organiser: Arne Stensvand Session moderator: Imre Holb			
17:00	20	Jorunn Børve	Alternative means to reduce storage decay in organic apple production; time of harvest and calcium applications
17:15	21	Arne Stensvand	Sources of inoculum for <i>Colletotrichum acutatum</i> in cherry and apple
17:30	22	Angela Berrie	Early season control of storage rots of apple
Guided tour of Pope's Palace: 18: 30			
<b>Wednesday 29 October</b>			
Time	Abstract no.	Presenting author	Title
<b>Entomology Session 3: Semiochemicals</b> 08:30-10:30; Cellier Benoit XII Session organiser and moderator: Fabio Molinari			
08:30	23	Greg Krawczyk	Utilization of Mating Disruption and Codling Moth Granulosis virus (CMGV) in Conventional Commercial Apple Orchards in Pennsylvania, USA.
08:45	24	Tracy Leskey	Pheromone-Based Management Strategies for the Dogwood Borer, <i>Synanthedon scitula</i> (Harris) (Lepidoptera: Sesiidae)
09:00	25	Gunnhild Jaastad	Volatiles initiate egg-laying in common green lacewings
09:15	26	Sylvie Derridj	Use of semiochemicals in fruit protection
09:30	27	Nelia Varela	Attractiveness of Mixtures of Pheromone and Host Plant Volatiles to <i>Cydia molesta</i> (Busck) (Lepidoptera: Tortricidae)
09:45	28	Larry Gut	Improving the effectiveness of mating disruption for tree fruit pests
10:00	29	Marco Tasin	Assessing efficacy of mating disruption in apple orchard by release and recapture of males in net-cages
10:15			Discussion
<b>Pathology Session 3: Organic and integrated disease control in apple orchards</b> 08:30-10:30; Chambre du trésorier Session organiser: Arne Stensvand; Session moderator: Marc Trapman			
08:30	30	William E. MacHardy	Recent progress in integrated sanitation practices to manage apple scab
09:00	31	Peter Triloff	Fungicide sprays during the window of germination. A special tool for control of apple scab in organic and integrated apple production
09:15	32	Laurent Brun	Assessment of fungicide protection strategies in experimental apple orchards
09:30	33	Imre Holb	Brown rot disease development and management perspectives in organic apple orchards
09:45	34	Bart Heijne	RepcO results on the control of scab in organic apple cultivation
10:00	35	Jürgen Köhl	Development of novel biocontrol agents for apple scab control in organic farming
10:15			Discussion
Break: 10:30-11:00; Paneterie Posters from Poster Session 1 to be removed by 11.00 am			
<b>Entomology Session 4: Biocontrol, biodiversity</b> 11:00-12:30; Cellier Benoit XII			

Session organiser: Jesus Avilla; Session moderator: Mark Brown			
11:00	36	Delphine Juan	Biological control strategy of codling moth with entomopathogenic nematodes in organic and conventional farming
11:15	37	Daniel Cormier	Mass releases of <i>Trichogramma minutum</i> to control the obliquebanded leafroller, <i>Choristoneura rosaceana</i> , (Lepidoptera: Tortricidae) in apple orchards
11:30	38	Chris Bergh	Assessing the role of <i>Syrphidae</i> in the suppression of woolly apple aphid in Virginia, USA
11:45	39	Lene Sigsgaard	Habitat and prey preferences of the two predatory bugs <i>Anthocoris nemorum</i> (L) and <i>A. nemoralis</i> (Fabricius) (Anthocoridae: Hemiptera-Heteroptera)
12:00	40	Mario Baldessari	Does windborne pollen mediate the effects of pesticides on predatory mites?
12:15	Discussion		
<b>Pathology Session 4: Sooty blotch and flyspeck, and fire blight</b> 11:00-12:30; Chambre du trésorier Session organiser: Arne Stensvand; Session moderator: Peter Triloff			
11:00	41	Mark Gleason	A new view of the sooty blotch and flyspeck fungal complex on apples
11:45	42	Vincent Phillon	Fireblight research: Warming up to new ideas and solutions
12:15	Discussion		
Lunch: 12:30-14:00; Espace Jeanne Laurent Posters for Poster Session 2 to be displayed in the Paneterie by 14:00 Technical excursion; 14:00- 18h ; IFP Farm in Alpilles Banquet; 20:00- ; Grand Tinel			
<b>Thursday 30 October</b>			
Time	Abstract no.	Presenting author	Title
Entomology Session 5a: <b>Earwigs</b> 08:30-10:00; Cellier Benoit XII Session organiser: Bruno Gobin; Session moderator: Jesus Avilla			
08:30	43	Bruno Gobin	The complex life history of a predator: sibling species, variability of side-effect and enigmatic disappearances of the earwig
08:45	44	Gertie Peusens	Side effects of pesticides on the European earwig <i>Forficula auricularia</i> L. (Dermaptera: Forficulidae)
09:00	45	Heidrun Vogt	First field test of the impact of four insecticides on European earwig, <i>Forficula auricularia</i> , in an apple orchard
09:15	46	Ina Touns	Control of the woolly apple aphid ( <i>Erisoma lanigerum</i> Hausm.) by releasing earwigs ( <i>Forficula auricularia</i> L.) and support oil applications
09:30	47	Rob Moerkens	Population modelling of the European earwig as a decision tool for orchard management
09:45	Discussion		
Entomology Session 5b: <b>Pesticide resistance</b> 10:00-11:00; Cellier Benoit XII Session organiser and moderator: Benoit Sauphanor			
10:00	48	James Walgenbach	Codling Moth Insecticide Resistance Management in North Carolina Apples
10:15	49	Marie Berling	A new CpGV isolate overcoming <i>Cydia pomonella</i> resistance to Granulovirus: improvement of the virus efficiency by selection pressure on resistant hosts
10:30	50	Andrea Bassi	Resistance Management: A Global Industry Response from the Insecticide Resistance Action Committee
10:45	Discussion		
Pathology Session 5: <b>Fungicide resistance, disease resistance, and diseases of small fruits</b> 08:30-11:00; Chambre du trésorier Session organiser: Arne Stensvand; Session moderator: David Gadoury			
08:30	51	Kerik Cox	Molecular aspects of QoI and DMI fungicide resistance in NY

			populations of the apple scab pathogen <i>Venturia inaequalis</i>
08:45	52	Kerik Cox	Practical aspects of QoI and DMI fungicide resistance in Northeastern US populations of the apple scab pathogen <i>Venturia inaequalis</i>
09:00	53	Luciana Parisi	Can <i>Venturia inaequalis</i> populations show a reduced sensitivity to a multisite fungicide? The case study of captan in French orchards
09:15	54	Vincent Phillion	Validation of an apple scab fungicide spray action threshold to help reduce captan residue levels on fruits
09:30	55	Markus Kellerhals	Breeding high quality disease resistant apple varieties
09:45	56	David Gadoury	Recent advances in epidemiology of strawberry powdery mildew
10:00	57	Agostino Santomauro	Integrated protection of table-grape from powdery mildew in Southern Italy
10:15	58	David Yohalem	A multiphasic approach to evaluating the effects of biofumigation for management of wilt in strawberries
10:30	59	Daniele Prodorutti	Armillaria root rot on highbush blueberry in Northern Italy
10:45	Discussion		
Break: 11:00-11:30; Paneterie			
Poster Session 2: 11:30-12:30; Paneterie			
Lunch: 12:30-13:45; Espace Jeanne Laurent			
<b>Plenary Session 2: 50<sup>th</sup> Anniversary lecture and IOBC business</b> 13:45-14:45; Cellier Benoit XII Session organiser and moderator: Jerry Cross			
13:45	60	Lene Siggsgaard	IOBC
14:00	61	Ernst Boller	The Working Group „Integrated Protection of Fruit Crops“ is celebrating its 50 <sup>th</sup> Anniversary
14:30	62	Jerry Cross	Election of new WG Convenor and Scientific Secretary Arthropods Sub-group; future meetings
<b>Entomology Session 6: Integrated Fruit Production</b> 14:45-15:30; Cellier Benoit XII Session organiser and moderator: Carlo Malavolta			
14:45	63	Servane Penvern	Peach orchard management strategies: aphid communities as a case study
15:00	64	Howard Thistlewood	Adapting to New Control Strategies and Area-Wide Management for Cherry Fruit Flies in British Columbia, Canada
15:15	65	Mariano Vilajeliu	Plant protection in organic apple production of two North-East Spanish regions
<b>Pathology Session 6: <i>Nectria</i> Canker</b> 14:45-15:30; Chambre du trésorier Session organiser: Arne Stensvand; Session moderator: Angela Berrie			
14:45	66	Bart Heijne	Field efficacy of slaked lime against European fruit tree canker and introduction into practice
15:00	67	Peter Frans de Jong	Relation of duration of wet period and number of <i>Nectria</i> cankers for leaf scars and pruning wounds
15:15	68	Marcel Wenneker	Detection of latent infections of fruit tree canker ( <i>Nectria galligena</i> ) in planting material of apple
Break: 15:30-16:00; Salle des gardes			
<b>Plenary Session 3:</b> 16:00-17:15; Cellier Benoit XII Session organiser and moderator: Jerry Cross			
16:00	69	Nick Birch	From chemical ecology to IPM in raspberry
16:30	70	Pierre Ricci	Prospect for crop protection in Europe: vision from the ENDURE Network
17:00	71	Convenor past & present	Farewell and thanks
Revision of IFP Pome Fruit Guidelines: 17:15-18:30 Chambre du trésorier Session organiser: Carlo Malavolta			

**Poster Session 1**

Tuesday 28 October 16:00-17:00; Paneterie

Note: Posters from Poster Session 1 to be removed by 11.00 am on Wednesday 29 October to make way for posters for Poster Session 2.

**Poster Session 1 : Arthropod Pests**

Abstract no.	Presenting author	Title
72	Jesus Avilla	State of the Art of Control Strategies of Codling Moth, Apple Scab and Brown Spot in Europe
73	Hazir Adalet	Investigations on the bark beetle species (Coleoptera: <i>Scolytidae</i> ) in cherry and peaches in the East Mediterranean Region of Türkiye.
74	Ilze Apenite	The incidence and control of cranberry tipworm <i>Dasineura vaccinii</i> S. and its control in cranberry plantations in Latvia
75	Valentina Baratella	Preliminary trials for a continuous rearing of <i>Bactrocera oleae</i> (Rossi) on its natural host <i>Olea europaea</i> L. in laboratory and future perspectives
76	Božena Baric	The current issue Codling moth control in the Croatian apple orchards
77	Refik Bozbuga	Loquat and pomegranate thrips in the eastern Mediterranean region of Türkiye
78	Bu-Keun Chung	Macroscopic Approaches to Two Spotted Mite, <i>Tetranychus urticae</i> Emerged as a New Pest in Persimmon Orchards, to Reduce its Density
79	Jerry Cross	Autumn control of aphid pests of tree and bush fruit crops
80	Daniele Demaria	New infestation outbreaks of <i>Panonychus ulmi</i> Koch (Acari: Tetranychidae) in apple orchards of North-West Italy
81	Daniele Demaria	<i>Ostrinia nubilalis</i> Hübner (Lepidoptera, Pyralidae) as a threat for apple
82	Alois Egartner	Investigations on the occurrence of the quarantine fruit fly species <i>Rhagoletis cingulata</i> and <i>Rhagoletis indifferens</i> on <i>Prunus avium</i> and <i>Prunus cerasus</i> in Austria
83	Adriana Escudero-Colomar	Population evolution of <i>Ceratitis capitata</i> (Wied.) in the NE of Spain and its implications in the establishment of control methods
84	Claudio Ioriatti	Preliminary studies about the effect of ' <i>Candidatus Phytoplasma mali</i> ' on the psyllid <i>Cacopsylla melanoneura</i> (Homoptera: Psyllidae)
85	Aziz Kharazi-pakdel	New insights into management of the white grub <i>Polyphylla olivieri</i> in fruit orchards of Iran
86	Christa Lethmayer	First evidence of the walnut husk fly ( <i>Rhagoletis completa</i> ) in Austria
87	Remigiusz.W. Olszak	The occurrence of leaf rollers in Polish apple orchards and possibilities of their integrated control
88	Jana Ourednickova	Control of <i>Cacopsylla pyri</i> L. (Sternorrhyncha, Psyllidae) in pear orchards in the Czech Republic
89	Nikos Papadopoulos	Geographical distribution and population dynamics of the European cherry fruit fly, <i>Rhagoletis cerasi</i> (Diptera: Tephritidae) in Greece
90	Josip Razov	Population Dynamics and Damage Analysis of <i>Cetonia aurata</i> / <i>Potosia cuprea</i> in Croatian peach orchards
91	J.Raul Rodrigues	Spatial patterns and Sampling of predatory mites (Acari: Phytoseiidae) on apple orchards
92	Patrick Sjöberg	An inventory of tortricids (Lepidoptera, Tortricidae) in Swedish apple orchards as a basis for future management strategies
93	Rosemarie Tedeschi	Spread of European stone fruit yellows in Piedmont (northwestern Italy) and presence of <i>Cacopsylla pruni</i> Scopoli in plum and apricot orchards
94	Heidrun Vogt	Observations of <i>Rhagoletis cingulata</i> , an invasive species from North America, on cherry in Germany

<b>Poster Session 1 : Biocontrol Agents</b>		
95	César Carvalho	Impact of insecticides utilized in citrus crop in Brazil for <i>Chrysoperla externa</i> (Hagen, 1861) (Neuroptera: Chrysopidae)
96	Petros Damos	First record of the parasitoid <i>Copidosoma varicornis</i> (Nees) (Hymenoptera: Encyrtidae) in Greece
97	Alberto Grassi	Behaviour and biological control of two-spotted spider mite ( <i>Tetranychus urticae</i> ) in floriculture red raspberry plantations
98	Hazem Dib	Natural regulation of the rosy apple aphid ( <i>Dysaphis plantaginea</i> ) in organic apple orchards
99	Lino Monteiro	Pest management practices and environmental factors affect natural regulation of the codling moth
100	Edison Pasqualini	A geostatistical approach to evaluate the side effects on non target species using a non repeated plot.
101	Sylvaine Simon	Rosy apple aphid and beneficial insect dynamics: effect of the situation within the orchard
102	Jitka Stará	Susceptibility of codling moth populations originated from Czech Republic to <i>Cydia pomonella</i> granulovirus (CpGV)
<b>Poster Session 1 : Biodiversity</b>		
103	Benoit Sauphanor	Indicators to assess the environmental impact of protection practices in apple orchards
<b>Poster Session 1 : Pathology</b>		
104	Angela Berrie	Potential new storage rot problems in UK Cox apples
105	Laurent Brun	Is it possible to predict the aerial concentrations of <i>Venturia inaequalis</i> ascospores in apple orchards?
106	Valerie Caffier	Efficiency of association of scab control methods on resistance durability of apple
107	Hristina Kutinkova	Control of Oriental Fruit Moth, <i>Cydia molesta</i> Busck., by Isomate OFM-Rosso Dispensers in Peach Orchards of Bulgaria – Preliminary Results
108	ImreJ. Holb	An Integrated Approach for Reducing Fungicide Sprays Against Scab in Organic Apple Orchards
109	Jürgen Köhl	Searching inoculum sources of brown spot of pear
110	Andrea Patocchi	The project: Monitoring of <i>Venturia inaequalis</i> virulences
111	Vincent Phillon	Late winter climatic conditions influence ascospore production and release in <i>Venturia inaequalis</i>
112	Regina Rancane	Efficacy of fungicides mixtures to avoid apple scab fungus resistance in integrated apple orchards
113	Vittorio Rossi	Use of the A-scab model for rational control of apple scab
114	Radek Vávra	Monitoring of <i>Venturia inaequalis</i> strains sensitive to strobilurin fungicides and occurrence of apple scab on resistant cultivars in the Czech Republic
115	Robert Wiedmer	Apple Proliferation phytoplasma in South Tyrol – an Integrated Approach
<b>Poster Session 1 : Pesticides &amp; Resistance</b>		
116	Johannes Jehle	Development and validation of a rapid method testing of CpGV susceptibility in codling moth populations
117	Tuomo Tuovinen	Effect of a rape seed oil based growth enhancer on mites and natural mite enemies in apple
118	Slobodan Milenkovic	Biological Efficacy of Botanical Insecticides in the Control of Green Apple Aphid ( <i>Aphis pomi</i> De Geer)

119	Nadia Lombarkia	Evolution of apple surface metabolites throughout the season and codling moth ( <i>Cydia pomonella</i> L.) egg-laying behaviour.
<b>Poster Session 1 : Population Modelling</b>		
120	Françoise Lescourret	Evaluation of integrated management scenarios of the peach tree- <i>Myzus persicae</i> system using a crop-pest model.
121	Benoît Ricci	Modelling codling moth damage as a function of adult monitoring and crop protection
<b>Poster Session 1 : Semiochemicals</b>		
122	F. Olzem Altindisli	A Comparative Study on Auto-Confusion by Exosex2 Gvm-Lb and Mating Disruption by Isonet-L against European Grapevine Moth, <i>Lobesia botrana</i> Den.-Schiff. (Lep.: Tortricidae) in Turkey
123	Lakmali Amarawardana	Identification of the female sex pheromone of the pear midge, <i>Contarinia pyrivora</i>
124	Catherine Baroffio	Raspberry beetle <i>Byturus tomentosus</i> : flight monitoring with semiochemical traps
125	Roberto Bruni	Control of the Plum Fruit Moth, <i>Cydia funebrana</i> (Treitsch.) (Lepidoptera, Tortricidae), by false-trail following
126	Cristina Carlos	Eight years of practical experience with mating disruption to control grape berry moth, <i>Lobesia botrana</i> , in Porto Wine Region
127	Enzo Casagrande	Use of Sprayable Pheromone Formulations in Europe
128	Antonio De Cristofaro	Cells responding to pheromone components and plant volatiles could affect semiochemical based control strategies of insect pests in agriculture ecosystems
129	Alan Knight	Integrating pear ester into direct management programs for codling moth
130	Vasiliy Dzhuvinov	Control of oriental fruit moth, <i>Cydia molesta</i> Busck., by isomate ofm-rosso dispensers in peach orchards of Bulgaria. preliminary results
131	Tracy C. Leskey	Using Insect Behavior to Facilitate Precision Agriculture: Odor-Baited Trap Trees For Management of the Plum Curculio, <i>Conotrachelus nenuphar</i> (Herbst) (Coleoptera: Curculionidae)
132	Fabio Molinari	Cage test to assess the mating disruptant activity for different pheromone blends and formulations on Peach Twig Borer ( <i>Anarsia lineatella</i> Zeller) in the orchards
133	Denis Pasquier	Comparison of different pheromone lures to monitor the flight of <i>Cydia pomonella</i>
134	Penka Peeva	Effectiveness of mating disruption and granulovirus against codling moths in Central Bulgaria
135	Barbara Schildberger	Control of codling moth ( <i>Cydia pomonella</i> ) under the aspects of active mating disruption, different application systems and varieties
136	Peter Shearer	Mating disruption across the peach/apple interface
137	Mitch Trimble	Exploring the potential for using peripheral treatments with pheromone dispensers for controlling the grape berry moth (Lepidoptera: Tortricidae) by mating disruption
138	Federica Trona	Control of codling moth, <i>Cydia pomonella</i> (L.) (Lepidoptera Tortricidae), with EcoTape pheromone dispensers
<b>Poster Session 2</b>		
Thursday 30 October 11:30-12:30; Paneterie Posters for Poster Session 2 to be displayed by 14:00 on Wednesday 29 October		
<b>Poster Session 2 : Arthropod Pests</b>		
139	Bu-Keun Chung	Two Spotted Mite, <i>Tetranychus urticae</i> Koch, Emerged as a New Pest in Persimmon Orchards and Approaches to Their Control
140	Marc Trapman	Observations on the relation between the induction and termination of diapause in codling moth in Dutch and Belgian populations

141	Marc Trapman	Practical results of a Stacked Control Strategy for Codling Moth ( <i>Cydia pomonella</i> L.) management
<b>Poster Session 2 : Biocontrol Agents</b>		
142	César Carvalho	Predatory capacity and biological aspects of <i>Chrysoperla externa</i> (Hagen, 1861) (Neuroptera: Chrysopidae) fed <i>Planococcus citri</i> (Risso, 1813) (Hemiptera: Pseudococcidae)
143	Hazem Dib	The Effect of Floral Strips on the Abundance of Hymenopteran Parasitoids in Apple and Olive Organic Orchards
144	Jitka Stará	Side effect of selected insecticides on <i>Aphidius colemani</i> , <i>Amblyseius cucumeris</i> and <i>Neoseiulus cucumeris</i> as model species of natural enemies
<b>Poster Session 2 : Biodiversity</b>		
145	Jean-Charles Bouvier	Avian biodiversity: impacts of phytosanitary practices and landscape in South-Eastern French apple orchards
146	Jean-François Debras	Is the distribution of beneficial arthropods influenced by mixed hedgerows
147	Vladan Falta	Changes of entomofauna in orchards under different pest management regimes
148	Alessandra Martorana	Arthropods and mycorrhizal fungi associated to the rhizosphere of grapevine in Sicily
149	Csaba Nagy	Mixed deciduous hedgerows as sources of anthocorids and other predators of pear psyllid in the UK
150	Nionka Velcheva	Species diversity, dominance and frequency of leaf-eating Lepidoptera in plum biocenose in Bulgaria
<b>Poster Session 2 : IFP</b>		
151	Valerio Cristofori	Hazelnut quality and sensory evaluation in organic and conventional growing systems
152	David Epstein	Flash grazing of hogs in apple orchards for pest management
153	Andrew Jessup	The sterile insect technique as a component of area-wide integrated pest management
154	Christian Linder	Survey on the use of pesticides and biocontrol agents in soft fruits
155	Slobodan Milenkovic	Organic Raspberry Production in Serbia
156	Barbara Pancino	Is organic hazelnut cultivation profitable?
157	Alessandro Roversi	Further observation on hazelnut yielding and fruit quality under organic and conventional management.
158	Benoit Sauphanor	Codling moth proof hail nets
159	Sylvaine Simon	Building up, management and evaluation of orchard systems: a three-year experience in apple production
160	Tuomo Tuovinen	Effect of different type row mulches on the success of biological control of strawberry tarsonemid mite
<b>Poster Session 2 : Pathology</b>		
161	Lorraine Berkett	Organic disease management in orchards with 'newer' apple cultivars
162	Angela Berrie	Investigation on survival and viability of cankers of <i>Nectria galligena</i> following removal from apple trees and pulverisation on the orchard floor
163	Boysen Bengt	Inventory of European canker in southern Sweden and <i>Nectria galligena</i> as a soil pathogen.
164	Valérie Caffier	Integrating scab control methods with partial effects in apple orchards: the association of cultivar resistance, sanitation and reduced fungicide schedules
165	Mirosława Cieslinska	Application of thermo- and chemotherapy in vitro for elimination of some viruses infecting fruit trees and small fruits

166	Gaetano Conigliaro	<i>In vivo</i> antagonism of <i>Acremonium byssoides</i> , endophyte in <i>Vitis vinifera</i> , towards <i>Plasmopara viticola</i>
167	Valeria Ferraro	Fungal and bacterial endophytes in <i>Olea europaea</i> L.
168	Nick Harvey	Population variability of strawberry powdery mildew ( <i>Podosphaera aphanis</i> ) in different geographical regions
169	Markus Kellerhals	Evaluation of fruit genetic resources for disease resistance
170	Beata Meszka	Activity of Physpe (laminarin) in control of strawberry diseases
171	Vittorio Rossi	Prediction of <i>Xanthomonas harboricola</i> pv. <i>pruni</i> infection on peaches
172	Lubos Talacko	Monitoring of virus and phytoplasma diseases by laboratory diagnostic methods (PCR, RT-PCR, DAS-ELISA) in apple and pear after sanitation process
173	Marcel Wenneker	Eutypa dieback as an important disease in red currant ( <i>Ribes rubrum</i> ) and gooseberry ( <i>Ribes uva-crispa</i> ) in the Netherlands
<b>Poster Session 2 : Pesticides and Resistance</b>		
174	Andrea Bassi	Chlorantraniliprole (DPX-E2Y45, Rynaxypyr®) (Coragen®20SC and Altacor®35WG) - a new diamide insecticide for control of codling moth ( <i>Cydia pomonella</i> ) and other top fruit Lepidoptera. Product features with regards to IFP criteria.
175	Johannes Jehle	No evidence in codling moth for cross-resistance between chemical insecticides and <i>Cydia pomonella</i> granulovirus
176	Patrik Kehrli	Overview of insecticidal resistance in <i>Cydia pomonella</i> and <i>Adoxophyes orana</i> in Switzerland
177	František Kocourek	<i>Cydia pomonella</i> (Lep: Tortricidae) resistance and cross-resistance to various classes of insecticides in Central Europe
178	Barbara Labanowska	Efficacy of chlotianidyna (neonicotinoid group) in the control of the strawberry root weevil ( <i>Otiorhynchus ovatus</i> ) on strawberry
179	Christa Lethmayer	Trials for the development of alternative control strategies against the codling moth ( <i>Cydia pomonella</i> ) in pome fruits in Austria in 2007
180	Emanuele Mazzoni	Microencapsulation and PBO: a tool in resistance management of the green peach aphid
181	Xavier Miarnau	Susceptibility to abamectin of pear psylla, <i>Cacopsylla pyri</i> (L.) (Hemiptera: Psyllidae) in pear orchards of north-east Spain
182	Sophie-Joy Ondet	Plant infusions to limit the development of pests or diseases : results on <i>Aphis pomi</i>
183	Salah Oukil	Comparison of susceptibility and nyctemerals rhythms between reared insects of Mediterranean fruit fly ( <i>Ceratitis capitata</i> ) and wild population of Algeria treated with a fenthion insecticide
184	Edison Pasqualini	Preliminary resistance screening of abamectin on pear psylla (Hemiptera: Psyllidae) in Northern Italy
185	Daniel Plénet	Strategies and timing of protection practices against <i>Cydia pomonella</i> (L.) in apple orchards
186	Marcela Rodriguez	Insecticide Resistance of <i>Cydia pomonella</i> (L.) (Lepidoptera: Tortricidae) Eggs and First Larval Instars in Spanish Field Populations
187	Myriam Siegwart	Molecular detection of pest resistance to insecticides
188	Daniel Zingg	New isolates of CpGV overcome virus resistance of codling moth
<b>Poster Session 2 : Plant-Pest Interactions</b>		
189	Caroline Gibert	A virtual fruit model simulating quality and storage potential for the peach-brown rot system: design and use to define technical scenarios meeting IFP guidelines
190	Nadia Lombarkia	Codling moth ( <i>Cydia pomonella</i> L.) egg-laying behaviour on two <i>Malus</i> sp. preferred and non preferred for egg-laying and leaf surface metabolite signals

191	Karsten Mody	Apple resistance to arthropod herbivores: genetic basis and modification by environmental factors
192	Thierry Pascal	Peach breeding for multiple resistances to pests and diseases contributes to integrated fruit production
<b>Poster Session 2 : Plant-Pest Interactions</b>		
193	Jesus Avilla	GEP, a tool for helping decision making for pest control advisers in Lleida (Spain)
194	Alda Butturini	MRV-Carpocapsa: a phenological model as decision support system for Codling Moth ( <i>Cydia pomonella</i> L.) in Emilia-Romagna (Italy)
195	Marc Trapman	Development of a dynamic population model as a decision support system for Codling Moth ( <i>Cydia pomonella</i> L.) management
196	Françoise Lescourret	COSMOS, a spatially explicit model to simulate the epidemiology of <i>Cosmopolites sordidus</i> in banana fields
197	Ana Scomparin	Effects of thermoperiodic conditions on the developmental rate of the codling moth larvae of resistant and non-resistant strains to chemical and viral (CpGv) insecticides
<b>Poster Session 2 : Semiochemicals</b>		
198	Catherine Baroffio	Raspberry cane midge <i>Resseliella theobaldi</i> : 3 years of flight monitoring in Swiss raspberry cultures
199	Daniele Demaria	Management of Oriental Fruit Moth and Codling Moth with spray application of microencapsulated sex pheromone
200	Hristina Kutinkova	Isomate C Plus Dispensers as an Alternative Means for Control of Codling Moth, <i>Cydia pomonella</i> L., in Apple Orchards of Bulgaria
201	Federica Trona	A field unit for automatic monitoring of insect behaviour

## **Abstracts - Oral Sessions**

## **Plenary Session 1**

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**Convenor, Scientific committee and local organiser : Conference welcome and announcements**

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- 2 -

**Integrated Production: where is it and where is it going?**

Jesús Avilla, Ernst Boller, Carlo Malavolta, Frank Wijnands, Robert Baur

*IOBCwprs Commission "Integrated Production: Guidelines and Endorsements"*

The objective of this presentation is to give an overview of the present status of Integrated Production worldwide, from a conceptual rather than from a quantitative approach, and to present some ideas for discussion on the future of IP. There is no doubt that Integrated Production systems are now well established worldwide, and implemented and applied by growers, from the "old Europe", where the first attempts began in the 1970s, to the "new world", with Brazil probably being the best example of a very dynamic organization. Brazilian IP guidelines and projects, based on IOBC guidelines, do not only cover most of the crops grown, but also animal production. In many European countries, IP has become the minimal standard for an agriculture that is considered sustainable enough to be eligible for state subsidies. However, are IP-based commodities certified and sold as such and known by the consumer? The answer to this question might be "not enough". IP has always had a problem of communication. The implementation of IP has not only enhanced the sustainability of agricultural cropping systems (but, as yet, not of animal husbandry), but has also facilitated the acceptance of techniques and processes that increase human health, food safety, and respect for environmental and ethical issues. These achievements, however, are not perceived by the public. Recently, the impact on production of controlling systems developed by private stakeholders, such as GlobalGAP, has been very strong. Is there a need and a future for IP under these circumstances? From the scientific point of view, it is clear that the answer is positive, as IP will continue to be a driving force to improve cropping systems. From the commercial point of view, the answer is not so clear, unless it becomes clear to the consumer in the future that IP is a label of total quality, not only taking into account extrinsic or intrinsic quality, but also environmental, social and ethical quality.

*Integrated Production, Present status, Perspectives*

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**Disease management in organic apple orchards is more than applying the right product at the correct time.**

Marc Trapman

*Bio Fruit Advies, Dorpsstraat 31, Zoelmond, the Netherlands*

The relative importance of diseases of apple varies with cultivar, management, time, and climate. Many aspects of the cropping system influence the development of diseases and offer possibilities for management. The choice of the variety determines the disease management for the lifetime of the orchard. As apple scab is the dominant disease, the choice to plant commercially attractive Vf resistant and low susceptible varieties is a logical step in more arid production regions. In 2008, Vf resistant varieties made up 30.8 % of the Dutch organic apple production, and 10.7 % of the European organic apple production. Cultural practices affect the growth and nutritional status of the tree, and therewith directly and indirectly influence the susceptibility to diseases. Sanitation measures are common practise for most organic fruit growers and help to make other measures more effective by reducing infection inoculums. Hot water treatment is embraced as an effective technique to reduce losses by storage diseases. Despite all preventive measures, disease control in organic orchards at an economically feasible level still largely depends on the application of fungicides. Decision support systems like RIMpro are an important tool for growers to optimize the application of fungicides. Measures that allow reduction of fungicidal applications on key diseases can lead to the development of a secondary disease complex that can cause severe losses when not managed effectively. In research, advisory and practical decision making and disease management in organic orchards should always be seen in the perspective of the management of the total growing system. With all factors that contribute to disease management optimized, we are able to successfully implement new materials and methods that may not be as effective as common fungicides in themselves, but add to the effectiveness of the disease management system as a whole. This total system approach makes organic fruit growing what it is.

*Apple, Organic production, Disease management, Vf resistance*

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## **Designing cropping systems to achieve Integrated Fruit Production goals**

Françoise Lescourret, Benoît Sauphanor

*INRA, French National Institute for Agricultural Research, UR 1115 Plantes et Systèmes de culture Horticoles (Plants and Cropping Systems in Horticulture), Domaine Saint-Paul, site Agroparc, F-84914 Avignon cedex 9*

Orchards encounter strong protection problems, because of both the demand of high standards of visual quality that requires an intensive use of pesticides, and the current adaptation of pests and diseases to those pesticides. Facing these problems while preserving production and quality and being attentive to the preservation of the environment supposes to conceive cropping systems for integrated fruit production. In this contribution, we expose the two ways of this design: experimental design and model-based design. Then we illustrate the various ingredients of the design of cropping systems. The first is the analysis of the current protection practices, which can question on the follow-up of the recommendations and on the compatibility between ecological value and effectiveness. The second is the development of rules of cultural choices (when and how to act using which indicator). The third is the study of the effect of practices like tree training, irrigation, pruning and fertilization, on pest or diseases development. The fourth is evaluating the cost of technical systems and their impact on biodiversity. The fifth is the modelling of populations in interaction. We conclude on the main aspects to develop further: relationships between tree architecture and pests/diseases, comprehension of complex trophic networks, pest/disease distribution and natural control at the “landscape” scale.

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## **Developing a protocol and a marketing niche for ecoapples in NY state**

H.W. Reissig, A. Agnello

*Department of Entomology, NYSAES, Cornell University, D. Cooley, Microbiology Department, University of Massachusetts, J. Clements, Extension, University of Massachusetts, M. Rozyne, Red Tomato, and T. Green, IPM Institute of North America*

In 2007, Cornell University, University of Massachusetts, ‘red tomato’ (a non-profit produce marketing corporation), and the IPM Institute of North America, Inc received a 2-year grant to develop a protocol for producing and marketing “eco apples” in the Northeast. Red tomato’s mission is connecting farmers and consumers through marketing, trade and education and a belief in family-farms, and a locally-based, ecological, fair trade food system. The goal is to create a market niche for “eco apples” that will resulting in premium prices and access to high quality, markets such as Whole Foods, and Trader Joe’s. Red tomato’s apple sales grew from \$130,000 in 2004 to \$600,000 in 06. The program grew from 6 New England growers with 441 acres in 2006 to 771 acres and 12 growers in 07. Participating growers complete a self-assessment, pay an annual certification fee and submit scouting and pesticide application records. The protocol is adjusted annually by red tomato employees, participating growers, and university personnel. Pesticides are classified into 3 categories: green, use with justification; yellow, use when green materials are not available or effective; and red, do not use. In 2007, pest control in eco apple orchards was generally as effective as that in growers’ standard blocks. Economic costs and returns to participating growers have not yet been calculated.

*IPM, Reduced risk pesticides, Marketing apples, Red Tomato, Eco-Apple*

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## **Analyzing the results of biodiversity experiments: enhancing parasitism of tufted apple budmoth**

Mark. W. Brown<sup>1</sup>, Clarissa R. Mathews<sup>2</sup> and Greg Krawczyk<sup>3</sup>

*1 Appalachian Fruit Research Station, 2217 Wiltshire Road, Kearneysville, WV 25430 USA; fax: 304-728-2340; mark.brown@ars.usda.gov; 2 Institute for Environmental Science, Shepherd University, Shepherdstown, WV 25443 USA; cmathews@shepherd.edu; 3 The Pennsylvania State University, Department of Entomology, Fruit Research and Extension Center, Biglerville, PA 17307, USA; gxk13@psu.edu*

A common goal of conservation biological control experiments is to enhance biodiversity in an effort to increase abundance and effectiveness of predators and parasitoids. Although many of these studies do report an increase in abundance of natural enemies, it has been difficult to document increases in rates of biological control. We attempted to enhance parasitism of the leafroller, *Platynota idaeusalis* (Tortricidae), by its dominant parasitoid in West Virginia,

*Goniozus floridanus* (Bethylidae). To provide alternate food sources we interplanted peaches that produce extrafloral nectar into apple orchards. Laboratory studies showed that the presence of nectar increased parasitoid longevity but not parasitism rates. In orchard studies we found the total number of Hymenopteran parasitoids was higher on peach trees than on adjacent apple trees but parasitism rates were not affected by the presence of nectar. In previously reported results we were also unable to detect differences in biological control of aphids (*Aphis spiraecola* and *Dysaphis plantaginea*) as a result of interplanting peach trees. Data collected on fruit at harvest showed that fruit from orchards with interplanted peach trees had less injury from San Jose scale (*Quadraspidiotus perniciosus*) and stink bugs (Pentatomidae) than fruit from an apple monoculture. Although the interplanting with peach trees did not have the expected result of increased biological control the experiment did have beneficial results for pest management. These results demonstrate the importance of collecting data on variables beyond the targeted species when evaluating ecosystem-level experiments.

*Tortricidae, Biological control, Bethylidae, Habitat manipulation, Apple, Ecosystem*

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### **Genetic modification of apple to control diseases:**

Cesare Gessler<sup>1</sup>, Giovanni Brogginì<sup>1</sup>, Gabriella Parravicini<sup>1</sup>, Paolo Galli<sup>1</sup>, Iris Szankowski<sup>2</sup>, Roberta Paris<sup>3</sup>, Andrea Patocchi<sup>4</sup>

<sup>1</sup>Plant Pathology, Institute of Integrative Biology, ETH-Z, Universitaetstrasse 2, CH 8092 Zurich, Switzerland <sup>2</sup>Gottfried Wilhelm Leibniz University of Hannover, Institute of Biological Production Systems, Fruit Science Section, Herrenhaeuser Str. 2, D-30419 Hannover, Germany <sup>3</sup>Dipartimento Colture Arboree, Università degli Studi di Bologna, Via Fanin, 46, 40127 Bologna, Italy <sup>4</sup>Agroscope Changins-Wädenswil (ACW), P.O. Box 185, CH-8820 Wädenswil, Switzerland

Apple scab is controlled by a high number of fungicide applications. Fireblight control is difficult and in some situations and up to three Streptomycin applications are necessary. The application of such pesticides is highly questioned because of their potential environmental impact and residues. Classical breeding has produced scab resistant cultivars and in the near future also fireblight resistant cvs. However, their popularity is limited as the traditional market dominant cvs have quality characteristics for producers, storage and consumers difficult to equal, and contrary to most other crops, apples are recognized as a cultivar, e.g. Gala, Golden Delicious, and not as a crop e.g. Bananas. In order to maintain the cultivar, single genes coding for enzymes and other proteins which can inhibit or at least reduce the development of scab and fireblight can be introduced by DNA-technology. A large range of foreign genes e.g. encoding lysozymes from bacteriophages, fungi and animals have been used and in some cases reduce fireblight and /or scab susceptibility. Pathogen derived genes or pathogen induced promoters may also contribute. In all cases, all of the incorporated genes and control sequences are foreign and the marker genes needed for the selection of the transformed cells are antibiotic (e.g. nptII) or herbicide resistance genes (Bar). However such transgenic plants are currently unacceptable in Europe, especially as apple is mostly a fresh consumed product and consumers are highly sensitive to the issue. Even if legislation would permit such transgenic apple cultivars, no producer will take the risk of not being able to sell his product. Moreover, his personal profit includes the reduction of the number of treatments. Objection of the consumers, opinion makers and sometime policy makers are very broad,

ranging from ethical issues (we should not manipulate genes in a way which nature does not, e.g. across natural barriers) to potential risks of outcrossing, vertical gene transfer and others. Therefore an approach which delivers to plant only genes (including promoters and terminators) originating from a crossable donor plant avoids most of the product oriented objection and could be an interesting alternative to transgenesis. This, however, does not eliminate the general objections to the technology itself. Such plants are defined as cisgenic. To create a cisgenic plant, firstly the apples own resistance genes and promoter sequences need to be cloned, and, secondly, a technology which eliminates the selection genes needs to be implemented. Both are currently available. We introduced HcrVf2, one of the open-reading-frames present in the genomic region introgressed in *Malus x domestica* from *Malus floribunda* 821, conferring Vf resistance against scab into the cvs. Gala and Elstar. The gene is constitutively expressed at a high level under the control of its own promoter and gives full resistance to an equal level and interaction as the Vf resistance introgressed by classical breeding. For the development of cisgenic plants, marker genes are necessary as they are for the development of transgenic plants. However, a system of post selection elimination of the marker genes has been implemented in strawberry and is currently applied to apple. A further system is reported to deliver 'marker gene free' in tomato and tobacco plants. We are currently testing the two systems and developing a third, all using, as a target, the HcrVf2 gene with its own promoter. The final result will be a plant of the target cv. into which the HcrVf2 has been introduced by DNA-recombinant technology corresponding to the definition of cisgenic. Concurrently, we are identifying further scab resistance genes and fireblight resistance regions with the final scope of obtain a cisgenic apple cv. with fireblight resistance and scab resistance based on several functional different resistances. Plants of popular cvs. with resistance to the two diseases can contribute to a reduction of environment contamination and fruit residues avoiding the major critics against transgenic plants.

*Cisgenic, Transgenic, Malus*

**Entomolgy Session 1 :**  
**Arthropod pests - tree fruits**

## **Genetic inference of the dynamic of codling moth fecundated females on a French farm**

Pierre Franck<sup>1</sup>, Jérôme Olivares<sup>1</sup>, Sylvaine Simon<sup>2</sup>, Claire Lavigne<sup>1</sup>

*1 INRA, UMR 1115 Plantes et Systèmes de culture Horticoles, Agroparc, F-84914 Avignon Cédex 9, France ; 2 INRA, UE de recherches intégrées, Gotheron F-26320 Saint-Marcel-les-Valence, France*

So far, population dynamics of Lepidoptera pests have been, mainly, inferred from the monitoring of adult males using pheromone traps. Here, we analysed the dynamic of fecundated codling moth females (dispersal, population size) with genetic inferences of full-sibs among their offspring, which is more connected with the agronomic attacks. We collected 6824 larvae using geo-referenced band traps in nine orchards (differing in host-plants and insecticide practices) from an experimental station (90 ha) along five generations (2003-2006). Heterogeneity in the densities of larvae was mainly explained by inter-generation (two times higher for the diapausing larvae generation) and inter-orchard (50 times higher in untreated apple orchard) differences. A sub-sample of 1150 individuals was genotyped with a set of 13 microsatellite loci for kinship inferences. 334 pairs of individuals were unambiguously determined as full-sibs. 96% of the full-sibs were collected within a same orchard, either on the same tree or on relatively distant trees. The remaining 4% pairs of full-sibs were collected at all the inter-orchard distances (80 to 700 m) including different host-plants. The collected larvae in the nine orchards were the offspring of around 120 and 230 fecundated females at the first and the second generations, respectively. These results confirm the relatively sedentary behaviour of codling moth females in spite of their ability to disperse at very long distances and the progressive increase of the population sizes all along the year.

*Cydia pomonella, Population dynamic, Kinship inferences, Dispersion, Population size*

## **Observations on the phenology of codling moth in untreated orchards in the Netherlands and Belgium**

Hermann Helsen<sup>1</sup>, Matty Polfliet<sup>2</sup>, Marc Trapman<sup>3</sup>

*1 Wageningen UR, PPO, Sector Fruit, Postbus 200, NL-6670 AE Zetten 2 Fruit Consult, Zetten, The Netherlands 3 Bio Fruit Advies, Zoelmond, the Netherlands*

Effective control of codling moth, *Cydia pomonella*, requires a good knowledge of the periods of egg laying and hatching of the larvae. Observations were done in a large number of untreated apple orchards in the Netherlands and Belgium to get an insight in the egg laying behaviour. At regular intervals all codling moth damaged fruits were collected from marked plots in insecticide-free orchards. Larvae were removed from the fruits and the age of each larva was determined from its length and the width of the head capsule. For the individual larvae their approximate date of egg deposition was back-calculated from temperature records. In this way, frequency distributions of egg laying and hatching of successful codling moth larvae in local populations could be generated. Egg laying and subsequent egg hatch

showed patterns with distinct peaks. Egg laying in different regions showed similar patterns within years. The consequences of these patterns for effective codling moth control strategies will be discussed.

*Codling moth, Cydia pomonella, Apple, Phenology*

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### **Differences among *Cacopsylla melanoneura* Förster (Homoptera: Psyllidae) insight from molecular markers**

Valeria Malagnini<sup>1</sup>, Federico Pedrazzoli<sup>1</sup>, Chiara Papetti<sup>2</sup>, Valeria Gualandri<sup>1</sup>, Elisa Bozza<sup>1</sup>, Federica Fiamingo<sup>1</sup>, Rosaly Zasso<sup>1</sup>, Claudio Ioriatti<sup>1</sup>.

*IFEM-IASMA Research Centre, Plant Protection Department, via E. Mach, 1, 38010 San Michele all'Adige (TN), Italy; 2University of Padua, Department of Biology, via U. Bassi, 58/B, 35121 Padova, Italy*

The psyllid *Cacopsylla melanoneura* (Föster) is one of the vectors of ‘*Candidatus Phytoplasma mali*’, the causal agent of apple proliferation disease (AP). In northern Italy, overwintering adults of *C. melanoneura* can be found both on apple (*Malus domestica* L.) and on hawthorn (*Crataegus monogyna* L.) from the end of January. Eggs are laid on the two host plants around March and the neanids complete their development at the end of April. Around mid-June the new generation adults move to shelter plants. Adults of the new generation can be found on conifers (especially *Picea abies* L.) at high altitudes from the end of the summer to the winter. The presence of AP phytoplasma was assessed by PCR in overwintering adults collected on the three host plants (apple, hawthorn and Norway spruce). The genetic variations among populations of *C. melanoneura* collected on the different host plants and in different localities were analyzed using microsatellites markers developed for *C. melanoneura* and COI sequences. ‘*Candidatus Phytoplasma mali*’ was found in most of *C. melanoneura* populations with differences in the percentage and titre. Data obtained from microsatellite analyses indicate differences among populations, which could explain the differences in the efficiency of acquisition and transmission of AP phytoplasma by the different populations.

*Psyllids, Apple, Hawthorn, Microsatellites, DNA markers*

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### **Whole-farm infestation trends and management programs for obliquebanded leafroller in apples**

Arthur Agnello, Harvey Reissig

*Department of Entomology, Cornell University, New York State Agricultural Experiment Station, Geneva, NY, USA 14456*

Because of an incomplete understanding of the role of habitat, alternate hosts, and adult movement in NY fruit infestations by obliquebanded leafroller (OBLR), we wished to obtain a temporal and spatial picture of summer larval re-infestation patterns. In 2007, an unrealistically aggressive early season spray program was used to eradicate overwintered larvae on 3 commercial farms (7-13 ha) with a history of OBLR injury. Summer generation

adults were monitored using a network of pheromone traps located at different orchard strata on all 4 ordinal sides. Weekly terminal and fruit samples were taken at each station. Although large numbers of adults were caught, larval terminal infestations and fruit damage remained low in all blocks. There were no substantial differences in adult catches, larval infestations or fruit damage in the different orchard strata. This suggested the utility of developing a sampling plan for the summer OBLR generation based on fruit damage rather than the traditional sampling of larvae on growing terminals. In 2008, methods above were repeated on 6 farms (8-16 ha) and participating growers agreed to leave small plots untreated with no sprays against summer larvae until the first damaged apple was observed. These small plots and at least two other areas being treated with standard programs were sampled 2 times/week until damage was detected. After a recommended spray, sampling continued but additional sprays were not recommended unless fruit damaged exceeded 1.5%. Fruit damage will be compared at harvest, and a partial budget analysis will be conducted to determine grower returns in the standard vs. research plots.

*Obliquebanded leafroller, Choristoneura rosaceana, Pheromone trap monitoring, Larval infestation, Fruit damage inspection, Apple*

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## **Population dynamics of *Anarsia lineatella* and their relation to crop damage in Northern Greece IPM peach orchards: toward the development of EIL**

Petros Damos, Matilda Savopoulou-Soultani

*Aristotle University of Thessaloniki, Faculty of Agriculture, Laboratory of Applied Zoology and Parasitology, 54 124, Thessaloniki, Greece*

Sustainable agriculture integrates three main goals: environmental health, economic profitability, and social and economic equity. In plant protection, sustainable approaches are those that are the least toxic and least energy intensive, and yet maintain productivity and profitability. It is common sense that the application of insecticides only when economically justified would lead also to better pest management, and to decreasing cost of production. However, early warning and forecasting systems, which are indispensable in pest management strategies, have not been fully developed for numerous pests. What is unclear, is the population intensity of these species necessary to cause economic injury to the plant. Under this framework, field studies were conducted for three successive years (2005-2007) in peach orchards of Northern Greece in order to examine relationships between densities of *Anarsia lineatella* populations and peach (*Prunus persica* L.) yields. Moreover, the observation of natural population's experimental approach was followed in order to assess crop response to the presence of the pest. Field population dynamics of *A. lineatella* were evaluated by using indirect measures (i.e. adult moth flight using pheromone traps), while injury on plant and fruit damage were estimated by absolute measures (i.e. counting injury on shoots as well as on fruits caused by larvae during the season). Linear and non-linear regression analysis was used; first to determine if injury and crop damage could be predicted from *A. lineatella* males captured on pheromone traps and second, if early shoot flagging caused by larvae of first generation was correlated with fruit damage of the forthcoming generations. Results suggest that relative damage on fruits caused by *A. lineatella* can be estimated using male trap captures and, to some extent, by observing early shoot flagging symptoms. Consequently, statistically significant relationships were indicated in most cases

between first generations and yields during all years. Additionally, pesticides should not be applied if populations of *A. lineatella* causing damage are lower than management cost. Developing a relationship between pest abundance and damage to crops is essential for the calculation of economic injury (EIL) leading to informed management decisions.

*IPM, Anarsia lineatella, Peach twig borer, Pest management, EIL*

## **Pathology Session 1 :**

**Brown spot of pear and modelling of pear scab**

## **An update on brown spot of pear**

Emilio Montesinos, Isidre Llorente

*Institute of Food and Agricultural Technology- CeRTA-CIDSAV, University of Girona, Av. Lluís Santaló s/n, 17071 Girona (Spain)*

Brown spot of pear is caused by the fungus *Stemphylium vesicarium* (Wallr.) Simmons. (f. asc. *Pleospora allii*) and cause severe economic losses in pear-growing areas in Europe. Pear cultivars differ in susceptibility to the disease, being the most affected Abate Fetel, Passe Crassane, Alexandrine and Conference. Disease control is achieved with several fungicides (mainly dithiocarbamates, dicarboximides and strobilurins) at fixed spray schedules from petal fall to preharvest, and often 10 to 24 treatments are needed. A forecasting system has been developed (BSPcast) and validated as an advisory tool to schedule fungicide sprays, maintaining efficacy of disease control as in the fixed spray schedule, but with savings of fungicide treatments from 20 to 70%. However, disease control is still insufficient under high inoculum pressure or favorable conditions. Since the fungus overwinters as *P. allii*, in fallen infected leaves or fruits, factors affecting pseudothecia development were studied to refine control programs addressed to decrease the primary inoculum. A forecast model (PAMcast) which related the proportion of mature pseudothecia to cumulated degree-days was developed and validated in field trials, and used to forecast the development of the ascigerous state that ends in the subsequent spring with the release of ascospores. Control of the primary inoculum is critical for management of brown spot of pear because a reduction of levels or a delay in its production decrease considerably disease intensity in the subsequent year. Biological, chemical, and mechanical methods for decreasing overwintering inoculum of *P. allii* and disease intensity have been evaluated, and different efficacies have been obtained. Future research should be focused to key stages of the biological cycle, quantitative specific analysis of inoculum, and novel control methods, including biological control, in order to develop an efficient integrated system for disease management.

KEYWORDS?

## **New strategies in integrated control of brown spot of pear (*Stemphylium vesicarium*, teleomorph *Pleospora allii*)**

I. Llorente, C. Moragrega, L. Ruz, G. Santamaría, A. Vilardell, P. Vilardell, E. Montesinos

*Institute of Food and Agricultural Technology- XaRTA-CIDSAV, University of Girona, Av. Lluís Santaló s/n, 17071 Girona (Spain)*

Brown spot of pear is caused by the fungus *Stemphylium vesicarium* (Wallr.) Simmons, and produces high economical losses in several pear-growing areas in Europe including Spain, Italy, France, The Netherlands, Belgium and Portugal. The management of the disease is based on protective fungicides applied at fixed schedule or according to the BSPcast model.

But, the efficacy in disease control is limited, especially when disease pressure is high. In order to reduce the disease pressure additional methods focused to reduce the inoculum may be incorporated in integrated control. Populations of *S. vesicarium* from different pear orchards in Girona (Spain) were characterized for their pathogenical activity. Additionally, the dynamics of *S. vesicarium* inoculation under natural conditions and the viability of these conidia and their capacity to infect were determined. On the other hand, *S. vesicarium* overwinters on pear in fallen infected leaves or fruits as pseudothecia of its teleomorph *Pleospora allii*. The effect of overwintering inoculum reduction on brown spot progress was also evaluated in experimental orchards in Spain. Biological (*Trichoderma sp.*) and mechanical methods (leaf shredding and removing) used alone or in combination with fungicide applications were tested. This research was supported by grant AGL2006-04987/AGR from MEC (Spain).

*Inoculum, Pathogenical activity, Biological control*

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## **Drought and oxidative stress determine the sensitivity of the pear to Brown spot infections**

S. Van Laer<sup>1</sup>, M. Höfte<sup>2</sup>, P. Creemers<sup>1</sup>

(1) Proefcentrum Fruitteelt v.z.w., Fruittuinweg 1, 3800 Sint Truiden, Belgium (2) University Gent, Laboratory of Phytopathology, Faculty of Agricultural and Applied Biological Sciences, Coupure Links 653, B-9000 Gent, Belgium

A survey among Belgian fruit growers carried out in 2006 revealed that Brown Spot is not equally spread in Belgium. The absence of Brown Spot is linked to the presence of loam. It is thought that the specific drainage properties of a loam soil are responsible for the absence of Brown Spot. An epidemiological study carried out in 2005 and 2006 supports this idea. In this study different orchards with a wide range of infection intensities were examined. An analysis of the soils in those orchards revealed that soil drainage conditions play a role in determining the sensitivity of the tree for *Stemphylium* infections. During the growth season of 2005, 2006 and 2007 actual *Stemphylium* infection risk was determined by means of window treatment experiments and fruit encapsulating experiments. An in-depth analysis of the occurrence of the actual *Stemphylium* infection risk moments revealed a close relation with the occurrence of drought stress during these growth seasons. The sensitivity of the pear towards brown spot infections is not only linked to drought stress, but also to high radiation, ozone and temperature. In the 2008, chlorophyll fluorescence measurements were performed to determine the relative importance of the different factors that contribute to the oxidative stress on pears during the growing season. Non photochemical quenching (NPQ) was used as a measure of oxidative stress damage and protection against this type of stress. A correlation analysis indicates that ozone is probably the largest contributor to oxidative stress damage on pear.

*Brown spot, Oxidative stress, Drought*

## Evaluation of ascospore maturity models to estimate seasonal ascospore discharge of pear scab (*Venturia pirina*)

H. Eikemo<sup>1</sup>, D. M. Gadoury<sup>2</sup>, R. A. Spotts<sup>3</sup>, O. Villalta<sup>4</sup>, P. Creemers<sup>5</sup>, A. Stensvand<sup>1</sup>

*1*Norwegian Institute for Agricultural and Environmental Research, Plant Health and Plant Protection Division, 1432 Ås, Norway ; *2*Department of Plant Pathology, Cornell University, New York State Agricultural Experiment Station, Geneva, NY 14456, USA ; *3*Oregon State University Mid-Columbia, Agricultural Research and Extension Center, Hood River, OR 97031, USA; *4*Primary Industries Research, Victoria, Department of primary industries, Victoria 3180, Australia; *5* Proefcentrum Fruitteelt – Applied Scientific Research, Department of Mycology, B-3800 Sint-Truiden, Belgium

Estimates of ascospore maturity generated by models developed for *Venturia pirina* in Victoria, Australia (V-NV, V-SV), Oregon, USA (S), or for *Venturia inaequalis* in New Hampshire, USA (NH-1 and NH-2) were compared to observed ascospore release of *V. pirina* in 21 site/yr combinations. When plotted against degree-days, the lag phase and slope of all model estimates differed from observed release. The S model and V-SV model fitted well with the data from Southern Victoria, while the data from Norway, Belgium and most years from Northern Victoria showed a lag phase at the beginning of the season. In particular, data from the high-rainfall region of southern Victoria showed more variation between years than the other sites. Identifying the precise biofix (bud break) to initiate degree-day accumulation for the NH-2 model was problematic at both Australian sites, as regions with warm winters and minimal chilling exhibit protracted bud break. Linear regressions generated similar R<sup>2</sup> values for the various models in many cases, but where differences were noted they more often favoured the most recent model developed for *V. inaequalis* (NH-2). The NH-2 model also provided the most accurate estimates of 95% ascospore depletion (a key event in many disease management programs) for Norway, Belgium, and the higher rainfall areas of southern Victoria. Although developed for use in management of apple scab, the NH-2 model appears a reasonably accurate tool for predicting the release of ascospores by the pear scab pathogen, in particular in regions with moderate rainfall and colder winters.

*Pear scab, Venturia pirina, Maturity model, Apple scab, Biofix, Bud break*

**Entomolgy Session 2 :**  
**Arthropod pests – soft fruits**

## **Developing an effective trap and lure to monitor mirids in UK horticultural crops**

Michelle Fountain<sup>1</sup>, Jerry Cross<sup>1</sup>, Gunnhild Jaastad<sup>1</sup>, David Hall<sup>2</sup>

*1*East Malling Research, New Road, East Malling Kent ME19 6BJ UK, Jerry.Cross@emr.ac.uk *2*Natural Resources Institute, University of Greenwich, Central Avenue, Chatham

Three mirids of horticultural importance in the UK have been studied to ascertain the chemicals involved sexual attraction of males to females. *Lygus rugulipennis*, the European tarnished plant bug, is an important pest of strawberries and raspberries causing malformation of fruit. *Lygocoris pabulinus*, the common green capsid, is primarily of concern on blackcurrant, but increasingly damaging on raspberry shoots. Finally, *Liocoris tripustulatus*, the nettle capsid, causes surface scarring on peppers and aubergines. Ordinarily mirids are controlled with sprays or chlorpyrifos. However, increasing demand for zero residues fruit and the eradication of effective pesticides from IPM programmes is rendering crops more susceptible to attack from mirids. The aim of this project is to develop a long-lived, practical lure, attractive to these species, in order to monitor populations so that effective timings of spray applications can be made to control the pests in fruit crops. It has been demonstrated that adult male *L. rugulipennis* are attracted to traps baited with live virgin females. Volatiles produced by virgin female *L. rugulipennis* have been identified as, hexyl butyrate, (E)-2-hexenyl butyrate, and (E)-4-oxo-2-hexenal and elicit electroantennographic (EAG) responses from males in analyses by linked gas chromatography–electroantennography (GC-EAG). We will report results of laboratory and field experiments with blends of the three compounds released from a range of dispensing systems including microcapillary tubes and a piezo-electric dispenser. We have also investigated the effects of various host-plant volatiles on attractiveness and made improvements to trap design and laboratory bioassay procedures.

*Miridae, Capsid, Strawberry, Lygus*

## **Interactions among predatory insects in strawberry production**

Jean Fitzgerald, Jay Chantelle

*East Malling Research, New Road, East Malling Kent ME19 6BJ UK*

A range of pest species are important in strawberry and can cause serious damage to the plants and the fruit. Several species of thrips are found on strawberry, and western flower thrips, *Frankliniella occidentalis*, is particularly difficult to control as it is resistant to most available insecticides. The strawberry aphid, *Chaetosiphon fragaefolii*, is a virus-vector and honeydew produced by the aphids also causes fruits to become sticky and unmarketable. Feeding by the capsid *Lygus rugulipennis* on developing fruits causes severe malformation of the fruit. Many predatory insects found in strawberry plantations consume a range of prey species and can thus contribute to biocontrol of pests. However, the availability of ‘alternative’ prey species may affect the degree of control the predators exert over particular

pest species. In this project we examined the interactions among aphid, capsid and thrips and predatory arthropods in strawberry, to provide the basic information needed to optimise the biological components of pest management systems, thus reducing pesticide use. In laboratory experiments to determine the biocontrol potential of predators, 1st instar *C. carnea* larvae and adult female *O. laevigatus* consumed similar numbers of 3rd instar *C. fragaefolii*. 1st instar *C. carnea* consumed fewer *F. occidentalis* than did *O. laevigatus* adults. *C. carnea* and *O. laevigatus* consumed similar numbers of 1st instar *L. rugulipennis*. The potential of *C. carnea* and *O. laevigatus* to significantly reduce numbers of *C. fragaefolii*, *F. occidentalis* and *L. rugulipennis* when each pest was presented alone was demonstrated in laboratory experiments. However, when combinations of predators were present, biocontrol of pest species was reduced in some cases due to predator interactions.

*Frankliniella occidentalis*, *Chaetosiphon fragaefolii*, *Lygus rugulipennis*, *Biocontrol*

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## **Developing Integrated Pest Management programmes for protected strawberry crops in southern France.**

Amélie Boullenger, <sup>2</sup>Marion Turquet, <sup>3</sup>Stéphanie Girou, <sup>4</sup>Clare Sampson

*marion.turquet@hortis.fr* <sup>4</sup> BCP Certis, Occupation Road, Wye, Kent, TN25 5EN, UK  
*sampson@certiseurope.co.uk* <sup>2, 3</sup> Hortis Aquitaine, Maison Jeannette, 24 140 Douville, France

Integrated Pest Management (IPM) strategies that have been effective in the UK were tested in tunnel grown strawberry crops at Hortis Aquitaine, southern France, from March to October 2008. The cost and pest control effect of two IPM strategies were compared in separate tunnels, one equipped with a misting system and the other not. Thrips, *Frankliniella occidentalis*, were effectively controlled by either *Amblyseius cucumeris* combined with *Orius laevigatus* in the misted tunnel or *A. swirskii* and *Orius laevigatus* in the non-misted one. Neither tunnel required chemical intervention against thrips, and control was very good compared with chemical programmes. Spider mites, *Tetranychus urticae*, were effectively controlled in both tunnels by *Phytoseiulus persimilis* together with a single treatment of hexythiazox (Nissorun®). Four different aphid species occurred in the trials. *Aphidius colemani* achieved some control of *Aphis gossypii* but *Aphidoletes aphidimyza* failed to establish and a single pirimicarb (Pirimor G®) was used. Further trials are recommended to develop effective aphid control. The use of selective chemicals in the IPM programmes allowed the invasion of naturally occurring predators which helped control pests. All pests were effectively controlled in the IPM tunnels and fruit quality was good. The number of chemical treatments was significantly reduced in comparison to an adjacent tunnel where plants were grown in a conventional method. In this tunnel, pest numbers increased rapidly and ten insecticide treatments were required over two months to achieve some control. Different rates and timings were proposed to ensure an economic programme for growers.

*Biological Control, Protected strawberries, France, Thrips, Spider mites, Aphids, Integrated Pest Management*

**Pathology Session 2 :**  
**Storage diseases**

## **Alternative methods to reduce storage decay in organic apple production; time of harvest and calcium applications**

Jorunn Børve<sup>1</sup>, Dag Røen<sup>2</sup>, Arne Stensvand<sup>3</sup>

*1 Norwegian Institute for Agricultural and Environmental Research, Ullensvang, 5781 Lofthus, Norway 2 Graminor, Njøs, Njøsavegen 5, 6863 Leikanger, Norway 3 Norwegian Institute for Agricultural and Environmental Research, Plant protection Division, 1432 Ås, Norway*

In Norway, organic apple growers only have sulphur available as a protective fungicide. When organically grown apples are stored, growers must thus rely entirely on alternative means to reduce the amount of storage decay. It is known that harvest time and calcium content may affect fruit rots in apple. The effect of harvest time was assessed during three years. After storage there was a clear increase in fruit decay from the earliest to the latest picking times, both recorded as total decay and for the important storage diseases bitter rot (caused by *Colletotrichum acutatum*) and lenticell rot (caused by either *Phlyctaena vagabunda* or *Cryptosporiopsis curvispora*). The results of three years experiments on apples of cv. Aroma harvested 2 or 1 week prior to normal harvest time, at normal harvest or 1 or 2 weeks afterwards and stored for three months in a ventilated cold store, showed respectively means of 6, 14, 35, 33 and 35% bitter rot, and total rot was respectively 21, 37, 58, 68 and 74%. Similar results were obtained for lenticell rot (mean of two years) and were 6, 10, 11, 16 and 24% respectively. Applications of calcium at different times prior to harvest reduced the amount of storage decay in some trials, but not consistently.

*bitter rot, lenticell rot*

## **Sources of inoculum for *Colletotrichum acutatum* in cherry and apple**

Arne Stensvand<sup>1</sup>, Jorunn Børve<sup>2</sup>

*1 Norwegian Institute for Agricultural and Environmental Research, Høgskoleveien 7, 1432 Ås, Norway 2 Norwegian Institute for Agricultural and Environmental Research, Ullensvang, 5781 Lofthus, Norway*

*Colletotrichum acutatum* is the causal agent of anthracnose/bitter rot in cherry and apple in Norway. It is the most important fruit decay in sour cherry in the country and may give severe losses also in sweet cherry and apple. Single spore isolates frequently develops the ascigerous stage of the fungus (*Glomerella acutata*) in culture, but it has not yet been detected on apple or cherry plant material. We thus anticipate that the predominant inoculum source is conidia (formed in acervuli). The fungus overwinters in old infected fruits and fruit stalks, in bud shells and in wood of cherry and apple. Infected flowers and leaves may serve as additional inoculum for fruit infections during the growing season. If still attached to the tree, fruits and fruit stalks of sour cherry infected the previous year may produce inoculum of *C. acutatum* throughout the entire following season. Up to 80% of the fruit spurs on sweet cherry may have buds infected with *C. acutatum* in spring. Apple buds may also contain the fungus. More than 90% of the sweet cherry leaves may contain *C. acutatum* around harvest in heavily

infected orchards. The entire leaf surface may be infected, but visible infections never appear. We frequently also find such asymptomatic leaf infections in apples. Most of the inoculum seems to be present on the fruit trees themselves. However, initial inoculum in newly planted, disease free plantings may come from older fruit trees, ornamentals and weeds in or in close vicinity to the orchards.

*anthracnose, bitter rot, Glomerella acutata*

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### **Early season control of storage rots of apple**

A.M. Berrie, B.E. Ellerker, K. Lower, J.D. Robinson

*East Malling Research, East Malling, Kent, ME19 6BJ, UK*

Fungal rots cause significant losses in stored apples. Until recently rotting in stored apples was controlled primarily in the UK by post harvest fungicide drenches. This practice is no longer acceptable because of the likely presence of a fungicide residue in the fruit, which, although usually below the MRL, is not acceptable to consumers. In addition, *Nectria* and other rots are poorly controlled by post-harvest fungicide drenches. Alternative approaches for control of *Nectria* rots are based on identifying rot risks. Fruits are stored only short term whenever a high risk is predicted. Alternatively, protectant fungicides are applied in July/August, which may also lead to detectable residues in fruit. The results of limited orchard trial in the 1990s, however, indicated that application of carbendazim during blossom and petal-fall significantly reduced the incidence of *Nectria* rot in store. The mechanism for this is not understood but could be due possibly to the reduction in *Nectria* inoculum from cankers or to the protection of fruit at a key infection stage. The purpose of this work was to understand this mechanism and examine whether other potential rots (e.g, *Gloeosporium* or *Botryosphaeria*) could also be controlled similarly. Orchard trials were also established to identify alternative fungicides to carbendazim. Effective control of *Nectria* and other rots by application of fungicides at blossom and petal fall would also minimise the risk of residues in fruit at harvest.

*Apple, canker, Nectria galligena, storage rot, fungicide*

**Entomolgy Session 3 :**  
**Semiochemicals**

## **Utilization of mating disruption and codling moth granulosis virus (CMGV) in conventional commercial apple orchards in Pennsylvania, USA.**

Greg Krawczyk, Larry A. Hull, Eric W. Bohnenblust, Faruque Uz Zaman

*The Pennsylvania State University, Department of Entomology, Fruit Research and Extension Center, Biglerville, 290 University Drive, PA 1730. E-mail: gxk13@psu.edu*

During the last five years the codling moth, *Cydia pomonella* L., re-established itself as the dominant direct fruit pest in most apple orchards in Pennsylvania, USA. Together with the Oriental fruit moth *Grapholita molesta* (Busck) and the eastern USA leafroller complex, this group has become the driving force for insecticide treatments applied in orchards. When the codling moth developed resistance to the older insecticides (i.e., organophosphates and/or pyrethroids), it forced growers to adopt new methods of control for this pest such as mating disruption or bio-rational compounds (i.e., granulosis virus) to provide acceptable control. Although both tactics have been used for a long time in organic orchard settings, no experience with these new tactics existed in conventional orchards in Pennsylvania. Therefore, a multi-year project was initiated to evaluate the efficacy of both methods in conventional orchard settings where both methods were incorporated into standard pest control practices. For four consecutive growing seasons various rates and combinations of the codling moth granulosis virus CMGV (Cyd-X from Certis, LLC) and mating disruption (Isomate CM/OFM TT or CheckMate Duels) were utilized in orchards and provided excellent control of internal fruit feeding pests. Additionally, laboratory and field bioassays with CMGV conducted on fruit (apples and nectarines) and artificial diet revealed partial lethality of this virus towards neonate larvae of the Oriental fruit moth.

*Codling moth, Mating disruption, Granulosis virus, Oriental fruit moth*

## **Pheromone-based management strategies for the dogwood borer, *Synanthedon scitula* (Harris) (Lepidoptera: Sesiidae)**

Tracy C. Leskey<sup>1</sup>, J. Christopher Bergh<sup>2</sup>, James F. Walgenbach<sup>3</sup>, Aijun Zhang<sup>4</sup>

*1 USDA-ARS, Appalachian Fruit Research Station, 2217 Wiltshire Road, Kearneysville, WV 25430-2771 2 Virginia Polytechnic Institute and State University, Alson H. Smith, Jr. Agricultural Research and Extension Center, Winchester, VA 22602 3North Carolina State University, Mountain Horticultural Crops Research and Extension Center, Fletcher, NC 28732 4USDA-ARS, Invasive Insect Biocontrol and Behavior Laboratory, BARC-W, 10300 Baltimore Ave, Beltsville, MD 20705*

The dogwood borer is a serious wood boring pest of apple in eastern North America. The increased severity of dogwood borer infestations in apple orchards is similar to that of the apple clearwing moth, *S. myopaeformis* Brkh, which became serious pest of apple following the introduction of size-controlling rootstocks in Europe. These rootstocks promote the formation of burr knots on exposed portions of the rootstock and on the trunk and scaffold limbs. Burr knots are an excellent food resource for *S. myopaeformis* larvae and also serve as

the primary point of infestation by dogwood borer. Historically, the organophosphate insecticide chlorpyrifos has been the material growers have relied upon for control of dogwood borer in apple orchards. However, interest in promoting more sustainable management practices and recent restrictions and cancellations of organophosphates within the USA highlight the importance of developing alternative management tactics for this pest. Our recent identification of the sex pheromone and a behavioral antagonist of dogwood borer provided us with the opportunity to evaluate pheromone-based management strategies such as mass trapping and mating disruption. We evaluated the potential of pheromone-based mass trapping of males to reduce dogwood borer infestations and evaluated an antagonist-based pheromone blend for disruption of dogwood borer mate-finding in commercial apple orchards in North Carolina, Virginia, and West Virginia. The most promising approach for pheromone-based management of dogwood borer appears to be mating disruption. We are currently evaluating the efficacy of disruption formulations for dogwood borer based on the sex pheromone blend and the antagonist.

*Dogwood borer, Clearwing borer, Sesiidae, Mating disruption, Mass trapping*

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### **Volatiles initiate egg laying in common green lacewings**

Gunnhild Jaastad<sup>1</sup>, Liv Hatleli<sup>2</sup>, Geir K. Knudsen<sup>3</sup>, Miklos Toth<sup>4</sup>

1G. Jaastad, Norwegian Institute of Agricultural and Environmental Research – Bioforsk Ullensvang, N-5781 Lofthus, Norway 2L. Hatleli, The Norwegian University of Life Sciences, N-1432 Ås, Norway 3G.K. Knudsen, Norwegian Institute of Agricultural and Environmental Research – Bioforsk Plantehelse, N-1432 Ås, Norway 4M. Toth, Plant Protection Institute, HAS, Budapest Pf 102, H-1525 Hungary

Adults and larvae of the common green lacewing *Chrysoperla carnea* feed on many pest species and are important predators in biological control of many crop plants. Previous work has shown that adults are attracted to chemicals occurring in scent of flowers, and that the presence of aphids on crop plants enhances the oviposition by adults. In the present study the effect of a three compound blend of phenylacetaldehyde, acetic acid and methyl salicylate were tested for its effect on oviposition by *C. carnea* in two areas in Norway. In both 2007 and 2008 a significant higher number of *C. carnea* eggs were laid inside delta traps with the ternary blend compared to control traps. From 16th May to 15th June 2007 a total of 110 and 177 eggs were found inside 5 baited delta traps in each of two orchards in Western Norway, respectively. No eggs were found in control traps. Similar results were obtained in two orchards in Eastern Norway. When lures with the ternary blend were attached directly to the tree, the effect was variable. A higher number of lacewing eggs were found on leaves close to a dispenser compared to leaves further away in Eastern Norway, whereas in Western Norway no clear effect was found. Use of attractive volatiles to enhance egg laying, and to increase biological control by lacewings are discussed.

*Green lacewing, Attractive volatiles, Oviposition, Biological control*

## **Use of semiochemicals in fruit protection**

Sylvie Derridj, Gilles Clément, François Moulin, Eric Ferré, Hubert Gally, Arnaud Bergougoux, Ingrid Arnaud, Jacques Auger

*INRA, UMR 1272: Insect Physiology, signals and communication. Route de St Cyr, 78026 Versailles, France.; INRA, Plant Nitrogen*

Studying plant signalisation for insect pests, we showed that the exudation of plant metabolites onto the leaf surfaces and their re-penetration into the plant acts as a natural plant protection against pests. Soluble carbohydrates and sugar alcohols from the leaf surfaces influence *Cydia pomonella* L. egg-laying and neonate larval behaviour. Their pattern and quantities explain the apple tree resistance to egg-laying. Our present study carries on the technology transfer of this knowledge. We examined the effects of spraying sucrose solutions on damaged apple trees. This was done in several orchards and varieties, over three years and in association with chemicals or biological controls. We reduced damage to the same order as an organophosphate by spraying 100 ppm sucrose alone. At 10 ppm associated with treatments, sucrose increased the reduction of damage compared to treatments alone. The mean of practical efficiency = (% of damage on the treatment reference - % of damage with sucrose addition)/% of damage on the treatment reference, over three years and four varieties was 22%, 3.22 for chemicals and could reach 50% for biological control. Year, apple variety, variation within tree and insect flight were variation factors in the analysis. Metabolome analysis from leaf surfaces discriminated the sucrose treated plants and sugar alcohols were dramatically modified. These results open a research field on pesticide alternatives and on improvement of biological controls. Enhancement of this technology should be obtained for studies of dose effects, duration and period efficacy. Knowledge of genes concerned in this induction would be helpful for resistance selection.

*Cydia pomonella, Sucrose, Sugar alcohols, Resistance induction*

## **Attractiveness of mixtures of pheromone and host plant volatiles to *Cydia molesta* (Busck) (Lepidoptera: Tortricidae)**

Nélia Varela, Jesús Avilla, César Gemenó

*Department of Crop and Forest Sciences, and Center UdL-IRTA for R+D, University of Lleida, Av. Rovira Roure 191, 25198 Lleida, Spain.*

In the Oriental Fruit Moth (*Cydia molesta*) the role of the female pheromone blend has been very well studied in the behaviour of males, but only a little in the behaviour of females. On the other hand, the role of host plant volatiles has been recently studied in the behaviour of females, but it has not yet been studied with respect to male behaviour. From these recent studies, a blend of five host volatiles - three green leaf volatiles and two aromatics - has been shown to affect female behaviour. In this work we studied the effect of the five host volatiles on the behaviour of *C. molesta* males. By doing wind tunnel experiments we have demonstrated that there is an effect of host plant volatiles on male behaviour but only when

mixed with a sub-optimal dose of pheromone. No effect was found when the blend was tested alone. A variety of responses were found when one compound was removed from the five host volatile blend, or when the host plant volatile was placed alone. Nonetheless, male landing was always higher when exposed to the mixtures than with the pheromone alone. We could also see that when the aromatic compounds were removed from the blend, male landing was lower and no difference was found when removing any of the green leaf volatiles. The best landing response was achieved when the sub-optimal dose of pheromone was mixed with the complete blend of five host volatiles that is known to affect the behaviour of females.

*Cydia molesta, Wind tunnel, Plant volatiles, Pheromone*

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### **Improving the effectiveness of mating disruption for tree fruit pests**

Larry Gut, Peter McGhee, Piera Siegert, Michael Reinke, James Miller

*Department of Entomology, Michigan State University, East Lansing, Michigan, USA, 48824*

Over the past five years, we have been exploring ways to achieve mating disruption of tortricid moth pests of fruit superior to that provided by current formulations. Different release devices, distributions, and active ingredients may be called for, depending upon the mechanism(s) of disruption to which a particular pest species or population size is most vulnerable. Several lines of evidence indicate that competition between pheromone dispensers and females is the primary mechanism of communicational disruption of tortricid moths in the field, especially for hand-applied formulations. From a practical standpoint, the best disruption will be achieved when dispensers are highly attractive and numerous point sources are distributed uniformly within the orchard. Wax formulations applied at high point source densities have provided outstanding disruption of some key fruit pests, including Oriental fruit moth. However, achieving a very high level Codling moth (CM) disruption has proved more challenging. Recent efforts to develop more effective and economical disruption formulations for CM have been guided by a series of experiments conducted in replicated plots consisting of large field cages constructed over 12 apple trees. A series of experiments using various types of dispensers revealed that attraction alone was insufficient for achieving a high level of disruption. Outstanding results were only achieved when CM males were prevented from making multiple orientations to pheromone sources. The high cost of mating disruption is often cited as a major impediment to broader adoption of the tactic. Attract-and-kill technologies offer the possibility of a cost-effective option for CM disruption. The economics of point-source dispensers could be improved through more efficient use of the precious active ingredient.

*IPM, Codling moth, Mating disruption, Apple, Pheromone*

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### **Assessing efficacy of mating disruption in an apple orchard by release and recapture of males in net-cages**

Marco Tasin, Carmela Sicher, Stefano Contrini, Silvia Schmidt, Claudio Ioriatti

The efficacy of pheromone mating disruption in the control of codling moth *Cydia pomonella* L. was evaluated through a modified CIRCE field test. A pheromone treated plot and an untreated area were equipped with four 2 mc net-cages each. No plants were included in the cage. Codling moth males were released in the cages and caught in unbaited or female baited delta trap. In each of the four cages, a fixed number of males (5, 10, 15, 20) was released with the aim to evaluate the effect of male density on trap catch. The efficacy of the pheromone formulation was calculated by comparing the fraction of males caught by female baited traps in the treated and control plot. Inhibition of captures in the pheromone plot was 63% on average. Unbaited traps caught on average 23% of the released males. By subtracting the catches in unbaited traps from the catches in female baited traps, inhibition of catch in the treated plot increased to 77% on average. This parameter was largely affected by the number of males released in the cage. From these preliminary results, factors such as density of released males, cage characteristics, presence of apple tree in the cage and type of trap and lure will be discussed with the aim to propose a common guideline to be used as official protocol for the field evaluation of pheromone methods.

*Codling moth, Cydia pomonella, Field test, Pheromone*

## **Pathology Session 3 :**

### **Organic and integrated disease control in apple orchards**

### **Recent progress in integrated sanitation practices to manage apple scab**

William E. MacHardy

*University of New Hampshire, 34 Woodridge Road, 03824 Durham, USA*

The main intent of the objectives of this IOBC subgroup on pome fruit diseases, established at its first workshop in 1987, is to reduce fungicide through an integrated approach that includes biological control agents, resistant cultivars and compatible chemical and non-chemical (sanitation) methods guided by pathogen and disease assessment methods, disease damage and action thresholds, and disease forecasting and warning systems. Several sanitation methods aimed at reducing the primary inoculum and, consequently, foliar and fruit scab have been tested: mechanical (shredding or vacuuming the leaf litter), chemical (applying chemicals to the trees or leaf litter, physical (pruning), and biological (applying a biological agent to trees). Each method has substantially reduced the primary inoculum and scab incidence, sometimes when fungicide was reduced, but few scab management programs have successfully incorporated these methods into practice, even in organic orchards where it is difficult to achieve desired low levels of scabbed fruit with fungicides. Several methods have reduced the ascospore inoculum by > 90%, but this reduction may not always be achieved due to weather and other circumstances. Recent studies that tested combinations of sanitation practices on moderate and resistant cultivars in traditional and organic orchards will be discussed. The rationale for integrating sanitation methods is that it provides several opportunities to achieve the targeted >90% reduction in primary inoculum. The results are promising, but what is needed to convince growers that an integrated sanitation program coupled to a reduced fungicide program will not increase the risk of failure to control scab?

*Apple scab, Venturia inaequalis, Sanitation, IPM*

### **Fungicide sprays during the window of germination: A special tool for control of apple scab in organic and integrated apple production**

Peter Triloff

*Marktgemeinschaft Bodenseeobst eG, Friedrichshafen, Germany*

The most frequent factors responsible for failures in control of apple scab (*Venturia inaequalis*) are the inoculum, a poor fungicidal strategy and the intrinsic, incomplete efficacy of the fungicides. Despite the progress made in most of these aspects, fungicides remained a risk because their efficacy in the orchard is below 100%, often resulting in poor control as the inoculum increases. A sufficient control of primary apple scab in high inoculum orchards requires a multiple increase of the efficacy of the fungicides, never obtained by higher dose rates or more applications. At Lake Constance, severe primary infections in high inoculum orchards have been controlled by a protectant before the onset of rain and a curative fungicide after a successful infection. The curative compound controlled the surviving spores, resulting

in an improved efficacy compared to just the protectant. When curatives are not available, the window of germination offers an alternative, based on the observation that during every day with an ascospore release there is a period of some hours, starting when release is almost terminated, and ending, when the percentage of spores completing infection increases. During this time window the vast majority of the spores of the day's release are germinating and highly susceptible to fungicides. To prevent the spores surviving the regular protectant and causing infection, a second protectant is applied during this window of germination irrespective of the actual weather. The effect of both sprays is an accumulation of efficacy. After having become standard in OFP, the method is also used in IFP because, since the development of resistance to Anilinopyrimidines, no more curative compounds are available.

*KEYWORDS?*

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### **Assessment of fungicide protection strategies in experimental apple orchards**

L. Brun, J. Guinaudeau, C. Gros, L. Parisi, S. Simon

*INRA (National Institute of Agricultural Research), UERI, Domaine de Gotheron, 26320 Saint-Marcel-lès-Valence, France lbrun@avignon.inra.fr*

In order to protect apple trees from attacks of scab, powdery mildew and post-harvest diseases, a large number of fungicide applications are carried out in apple orchards from green-tip stage to harvest. To satisfy society's demand to decrease the number of pest control treatments, innovative protection strategies were assessed over four years in experimental orchards. In the case of apple scab, fungicide protection management takes the primary inoculum level and the means for reducing this inoculum, as well as the cultivar susceptibility, into account, in order to define a climatic risk level (according to Mills) as the intervention threshold. The decision to use fungicides to treat powdery mildew is based on the control of disease levels present in the orchard (use of a percentage threshold of leaves with powdery mildew). The application of these decision rules for orchards managed using integrated plant protection makes it possible to reduce the number of fungicide applications against scab and/or powdery mildew by more than 50%, while keeping these two diseases under control. In organic farming systems, the cultivar most susceptible to scab had scab damage on fruits despite careful reduction of the inoculum in the fall and a large number of fungicide treatments during the season. No fungicide protection treatment for post-harvest diseases was applied for organically farmed orchards or for the two cultivars considered not to be very susceptible to these diseases. These different protection strategies are assessed in terms of the control of the various diseases and the economic costs.

*Apple orchard, Disease, Fungicide, Protection strategy, Sanitation practice, Cultivar susceptibility*

## **Brown rot disease development and management perspectives in organic apple orchards**

Imre J. Holb

*University of Debrecen, Centre for Agricultural Sciences and Engineering P.O. Box 36, H-4015 Debrecen, Hungary and Plant Protection Institute, Hungarian Academy of Sciences, P. O. Box 102, H-1525 Budapest, Hungary*

Brown rot of apple, caused by *Monilinia fructigena*, is a serious disease in organic orchards especially if preceded by severe fruit injuries caused by codling moth. Therefore, the aims of this three-year study were firstly, to monitor and analyze summer disease development of brown rot in time; secondly, to investigate environmentally friendly disease control approach against brown rot; and thirdly, to develop an overall brown rot management strategy for organic apple production. Brown rot monitoring showed that epidemics started 3 to 4 weeks earlier on the ground than in the tree and then continued to increase up to harvest. Analyses of disease progress curves showed that the three-parameter logistic function gave the best fit to brown rot over four non-linear growth functions. Data analyses demonstrated an overall description of fruit rot development by relative rate of disease increase, area under disease progress curve (AUDPC), and final disease incidence (Yf). Yf in the tree was highly correlated with incidence on dropped fruit on the orchard floor, showing strong evidence on vertical inoculum movement from the orchard floor to the tree. Based on this result, efficacy of fruit drop removal on fruit rot incidence was studied in integration with *Bacillus thuringiensis* treatments against codling moth and/or reduced use of sulphur fungicide compounds. Treatments with integrated control approach resulted in a significantly lower fruit rot incidence on all cultivars compared with general brown rot management schedules. Above epidemiological and control results were incorporated into a novel brown rot management strategy for organic apple orchards.

*Organic production, Brown rot, Apple, Epidemiology, Management strategy*

## **RepcO results on the control of scab in organic apple cultivation**

Bart Heijne, Peter Frans de Jong

*Wageningen UR/Applied Plant Research (PPO), P.O. Box 200, 6670 AE Zetten, The Netherland*

Apple scab, caused by *Venturia inaequalis*, is mainly controlled by sulphur and copper containing products in organic cultivation of apple. It is EU policy to phase out the use of copper products. Therefore, the aim of the EU project Repco was to find alternatives for copper in organic cultivation of apple. Three years of field experiments were done on the scab susceptible cultivar Jonagold. We report on the efficacy of potassium bicarbonate and yucca-extracts in comparison with sulphur and copper. Applications were made according to the RimPro warning system and the weather forecast during the ascospore season. Then all plots were treated weekly with sulphur till harvest. The efficacy of the treatment schedule of 6 to 7.5 kg potassium bicarbonate plus 4 kg sulphur as a tank mix was as effective as 0.2 kg copper in two years and even as effective as 0.5 kg copper in a third year of experiments.

Similarly, the treatment schedule of 7.5 l yucca extract plus 4 kg sulphur as a tank mix was as effective as the copper schedules. It is concluded that both potassium bicarbonate and yucca extract both in combination with sulphur can replace copper treatments to control apple scab in organic cultivation.

*Apple scab, Copper, Organic culture, Potassium bicarbonate, Venturia inaequalis, Yucca extract*

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## **Development of novel biocontrol agents for apple scab control in organic farming**

Jürgen Köhl, Wilma Molhoek, Lia Groenenboom-de Haas, Helen Goossen-van de Geijn

*Plant Research International, Droevendaalsesteeg 1, 6700 AA Wageningen, The Netherlands*

Apple scab caused by *Venturia inaequalis* is a major disease in apple production. In organic farming disease control often depends on multiple sprays of copper fungicides. Their use is restricted by EU Council Regulation 2092/91. The objective of our study was to select antagonists suppressing conidia production of *V. inaequalis* during summer epidemics. The development of a novel biocontrol product as alternative for copper applications was envisaged. A collection of fungal isolates was obtained from scab colonies on leaves originating from 216 apple orchards and standard trees. In a first selection round, such isolates were excluded which did not meet minimum criteria regarding mass production, cold tolerance, drought tolerance and safety issues. Subsequently, spores of candidate antagonists were sprayed on scab-infected apple seedlings and the number of *V. inaequalis* conidia produced on leaves was counted. Four out of 63 isolates reduced *V. inaequalis* sporulation by more than 80%. A few selected antagonists were tested under orchard conditions on young shoots (2006) or whole trees (2007). *Cladosporium cladosporioides* H39 significantly reduced *V. inaequalis* sporulation in both years. It can be concluded that the novel antagonist *C. cladosporioides* H39 showed promising results on seedlings and under orchard conditions. Future studies will focus on an improvement of the used pilot formulation of the antagonist. Furthermore, the effect of *C. cladosporioides* H39 on scab epidemics will be tested in additional orchard experiments. The study has been funded by the European Commission (Project 501452 REPCO) and the Dutch Ministry of Agriculture, Nature and Food quality.

*Venturia inaequalis, Biological control*

## **Entomology Session 4 :**

### **Biocontrol, biodiversity**

## **Biological control strategy of codling moth with entomopathogenic nematodes in organic and conventional farming**

Delphine Juan, Jean-Baptiste Rouvière, Sandrine Mouton, Philippe Coulomb<sup>2</sup>

*1 Enigma, Hameau de Saint Véran, F-84190 Beaumes de Venise, France*

The emergence of resistant codling moth strains to the *Cydia pomonella* Granulosis Virus is a threat to control this pest in organic farming. The research of new biocontrol agents is a high stake to propose alternative solutions to farmers. On one hand, the efficacy of two entomopathogenic nematode species (*Steinernema feltiae* and *Steinernema carpocapsae*) was evaluated using different exposure methods, against various life stages of the codling moth. In order to simulate the exposure of larvae in apple, young apples were soaked in solutions of several concentrations of each nematodes species at several dates after the sting of 1st instar larvae. This study was completed in 2008 with a test under natural conditions on codling moth larvae in apple. 5th instar larvae in cocoon were exposed within cardboard strips on which nematode solutions were sprayed under laboratory conditions to verify the incidence of temperature on the control of codling moth with entomopathogenic nematodes. This test under laboratory conditions was completed with a spraying on the ground in an orchard, in which 5th instar larvae in cardboard strips had been buried. *S.feltiae* has caused a higher mortality on larvae in apples under laboratory and natural conditions. On fifth instar larvae and at temperature <20°C, *S.feltiae* has caused a higher mortality (55%) compared with the one observed with *S.carpocapsae*(40%). The application on an orchard ground confirmed the higher efficacy of this species. On another hand, the toxicity of several plant protection products used in orchard has been evaluated using the method developed by the IOBC working group of “Pesticides and Beneficials”. Three insecticides including Carpovirusine® and two fungicides have been evaluated. The Carpovirusine exhibited the lower toxicity level beyond the other products tested. The main life history parameter of nematodes affected by the tested products was the fecundity. However, nematodes mortality and infectivity were not reduced significantly. These trials allow considering integration of entomopathogenic nematodes in a codling moth control strategy, with foliar and ground application. The selected nematodes species would be in that case *S.feltiae*. As a “cruiser” it has significantly controlled the target stages of the codling moth under natural conditions. This organism can be used in parallel with other plant protection products of orchard farming taking care of the contact duration and of the exposure level.

*Entomopathogenic nematodes, Steinernema feltiae, Steinernema carpocapsae, Codling moth, Cydia pomonella, Side effects, Plant protection products*

### **Mass releases of *Trichogramma minutum* to control the obliquebanded leafroller, *Choristoneura rosaceana*, (Lepidoptera: Tortricidae) in apple orchards**

Daniel Cormier, Gérald Chouinard, Francine Pelletier, Franz Vanoosthuysse

*Institut de recherche et de développement en agroenvironnement, 335, chemin des Vingt-cinq Est, Case postale 2,4 Saint-Bruno-de-Montarville (Québec) J3V 4P8, Canada*

Control of the obliquebanded leafroller (OBLR) represents a challenge for apple growers because all stages of this multivoltine pest can be simultaneously present on apple fruits and leaves during summer. In order to establish a new control strategy that targets the pest eggs, we evaluated the impact of repeated mass releases of the egg parasitoid, *Trichogramma minutum*, on OBLR populations and damage compared to conventional (chemical) and control treatments. Approximately, 1 million egg parasitoids/ha/week were released during 11 weeks in high-density plots of commercial apple orchards. More than 80% of sentinel egg masses were parasitized in the release plot from the second week after the first release. Sentinel egg masses in trees in which *T. minutum* were released were not more frequently parasitized than those placed at mid-distance between two trees but the number of parasitized eggs/egg mass differed significantly between those trees. The impact of treatments was evaluated by sampling 100 annual shoots and 200 apples per treatment plot. An average of 8.7 larvae per sampling unit was observed in the release plot and was not significantly different from the chemical treatment (11 larvae) and the control (10 larvae) plots. Damage made by OBLR larvae on apples was similar between treatments but damage made by total tortricids was significantly lower in the release (1.8%) and the chemical control (2.1%) plots than in the control (3.1%) plot. Results suggest that mass releases of *Trichogramma minutum* should be used with a complementary control measure to significantly reduce OBLR population and damage.

*Mass release, Egg parasitoid, Trichograms, Biological control, Oblique banded leafroller*

### **Assessing the role of *Syrphidae* in the suppression of woolly apple aphid in Virginia, USA**

Christopher Bergh

*Virginia Polytechnic Institute and State University, Alson H. Smith, Jr. Agricultural Research and Extension Center, Winchester, VA 22602*

The fate of arboreal woolly apple aphid colonies on potted apple trees deployed in an experimental and a commercial orchard or held in a screened cage was recorded at 2-day intervals over 14 days in Virginia, USA. Colony decline in the orchards began within 4-8 days following tree deployment and colonies either became extinct or were severely disrupted by predation by day 14. Colonies in the cage showed no decline, despite the presence of the

parasitoid, *Aphelinus mali*. Two syrphid species were the predominant arthropod predators recorded in colonies. On day 2, syrphid eggs were observed in 44% of colonies (5/tree) on trees in both orchards and in 100% of colonies during the study. Colonies were excised and examined on day 14, revealing that eggs of *Heringia calcarata* comprised 60.8% and 79.6% of eggs on trees in the experimental and commercial orchards respectively. Eggs of *Eupeodes americanus* comprised 39.2% and 13.9% of those in the experimental and commercial orchards, respectively, while eggs of *Syrphus rectus* represented 6.5% of those from the commercial orchard. The mean total number of hatched and unhatched eggs per colony recorded on day 14 ranged from 1.4 to 2.6 and from 2.0 to 5.4 in the experimental and commercial orchard, respectively. Recovery of adult *A. mali* from the excised colonies revealed significantly higher numbers of parasitoids per tree from colonies on caged trees ( $358.6 \pm 24.2$  SEM) than from colonies on trees in the experimental ( $2.6 \pm 1.7$  SEM) or commercial ( $36.6 \pm 13.1$  SEM) orchards.

*Eriosoma lanigerum*, *Heringia calcarata*, *Eupeodes americanus*, biological control

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### **Habitat and prey preferences of the two predatory bugs *Anthocoris nemorum* (L) and *A. nemoralis* (Fabricius) (Anthocoridae: Hemiptera-Heteroptera)**

Lene Sigsgaard

*University of Copenhagen, Faculty of Life Sciences, Department of Agriculture and Ecology, Thorvaldsensvej 40, 1871 Frederiksberg C, Denmark*

The annual occurrence and distribution of the predatory bugs *Anthocoris nemorum* and *A. nemoralis* between apple, pear and herbal vegetation was assessed. In the laboratory anthocorid prey preference was assessed in two-choice experiments with key pests of apple and pear including pear psyllid, apple psyllid, green apple aphid, rosy apple aphid and red spider mites. Anthocorids were the dominant early season predatory bugs, co-occurring with spiders. *Anthocoris nemorum* dominated in apple, while *A. nemoralis* dominated in pear. *A. nemorum* was also common in herbal vegetation, especially in midsummer. Anthocorid numbers were correlated with numbers of collembola, psyllids and aphids in apple, and with numbers of psyllids in pear. *A. nemoralis* preferred pear psyllid to green apple aphid, while *A. nemorum* preferred green apple aphid. Both species preferred psyllids to spider mites. In the two years studied, *A. nemorum* had two generations proving that it can be bivoltine under Danish climate conditions. In the mid summer the higher density of annual vegetation, simultaneous with lower density in trees, suggests that herbal vegetation may maintain *A. nemorum* in orchards at times of low prey numbers in the trees. Habitat and prey preferences of the two anthocorid species identify *A. nemorum* as a biological control agent of special importance in apple, whereas *A. nemoralis* is of importance in pear.

*Anthocoris nemorum*, *Anthocoris nemoralis*, Voltinism, Orchard, Psyllids, *Cacopsylla pyri*, *Cacopsylla mali*, *Aphis pomi*, *Dysaphis plantaginea*, *Panonychus ulmi*, Preference, Behaviour

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## **Does windborne pollen mediate the effects of pesticides on predatory mites?**

Mario Baldessari<sup>1</sup>, Gino Angeli<sup>1</sup>, Vincenzo Girolami<sup>2</sup>, Alberto Pozzebon<sup>2</sup>, Paola Tirello<sup>2</sup>, Carlo Duso<sup>2</sup>

*AD: 1 FEM-IASMA Research Center, Plant Protection Department, Via E. Mach 1. I-38010 - San Michele all'Adige (TN) Italy ; 2 Department of Environmental Agronomy and Crop Science, University of Padova, 35020 Legnaro, Padova, Italy*

Generalist predatory mites belonging to the family Phytoseiidae can persist in European apple orchards when prey is scarce by feeding on pollen and other alternative foods. It has been reported that grass management can affect pollen availability on apple leaves with implications for phytoseiid persistence. The use of pesticides is a major factor affecting phytoseiid abundance in apple orchards. In this study we compared the effects of a number of pesticides on populations of *Kampimodromus aberrans* in two apple orchards with a different grass management, i.e. a high or a low grass mowing frequency. Reducing grass mowing frequency resulted in higher predatory mite numbers probably because of a higher pollen availability on apple leaves. A laboratory study was planned to demonstrate the role of pollen availability in mediating interactions between pesticides and phytoseiids.

*Phytoseiidae, Pollen, Pesticides, Kampimodromus aberrans, Grass management*

**Pathology Session 4 :**  
**Sooty blotch and flyspeck, and fire blight**

## **A new view of the sooty blotch and flyspeck fungal complex on apples**

Mark Gleason, Jean Batzer

*Department of Plant Pathology, Iowa State University, Ames, Iowa 50011, U.S.A.*

Fungi in the sooty blotch and flyspeck (SBFS) complex blemish the epicuticular wax layer of apple fruit. Recent studies combining molecular techniques with morphological characterization revealed that the SBFS complex is far more diverse than previously realized. Surveys of orchards in 14 eastern U.S. states in 2000 and 2005 uncovered 62 SBFS species in five taxonomic orders. Orchards with fungicide-spray programmes had lower diversity in their SBFS assemblages than non-sprayed orchards. Some SBFS species occurred in almost all orchards, whereas other species were regional in distribution or were found in only one or two orchards. Collaborations with other laboratories have revealed patterns of SBFS diversity in Germany, Serbia and Montenegro, Brazil, China, Florida, and Costa Rica, and have led to the discovery of many new species. Using an RFLP method for HaeIII digests of rDNA, we found distinctive banding patterns for 14 genera and species. With our library of RFLP banding patterns and ITS and LSU sequences, we documented consistent phonological patterns among SBFS species in timing of colony appearance on apples, and identified several new reservoir host species. These tools have the potential to further clarify SBFS ecology, etiology, and taxonomy. In adapting a SBFS warning system from the Southeast U.S. for use in the Midwest, we found that cumulative hours of relative humidity greater than 97% was more accurate than cumulative hours of leaf wetness in predicting the initial appearance of SBFS colonies on apples.

*IPM, Sooty blotch and flyspeck, Genetic diversity, Biogeography, Disease-warning systems*

## **Fireblight research: Warming up to new ideas and solutions.**

Vincent Phillion

*Laboratoire de production fruitière intégrée de l'IRDA, Mont-Saint-Bruno, Québec*

Fire Blight (caused by *Erwinia amylovora*) remains a big concern in apple production regions around the world. Every three years, researchers meet for an international workshop dedicated to this disease. In 2007, the Portland (Oregon) meeting brought forward recent findings in pathogen biology, genomics, host-pathogen interactions and disease management. This talk will attempt to link the important findings reported at the meeting and see how novel detection techniques, reduction in host susceptibility, and new disease control methods can impact future disease management at the farm level.

*Fire Blight, Disease management*

## **Entomology Session 5a :**

### **Earwigs**

## **The complex life history of a predator: sibling species, variability of side-effects and enigmatic disappearances of the earwig**

Bruno Gobin<sup>1</sup>, Rob Moerkens<sup>2</sup>, Herman Helsen<sup>3</sup>, Kurt Jordaens<sup>2</sup>, Herwig Leirs<sup>2</sup>, Gertie Peusens<sup>1</sup>

*1pcfruit, Zoology Department, Fruittuinweg 1, B-3800 Sint-Truiden* *2University of Antwerp, Evolutionary Ecology Group, Groenenborgerlaan 171, B-2020 Antwerpen* *3Wageningen UR, PPO, Sector Fruit, Postbus 200, NL-6670 AE Zetten*

The common earwig (*Forficula auricularia*), plays an important role in reducing summer pest pressure. However, large inter-orchard and even inter-annual variation in earwig densities jeopardizes biocontrol reliability. To boost populations of univoltine earwigs we need a more detailed knowledge on presence, life history and interactions with orchard management. Detailed population monitoring and experimentation revealed some critical issues for biocontrol: (1) *F. auricularia* consists of two different phylogenetic species with different reproductive strategies (timing of egg-laying and number of broods). Which type inhabits an orchard determines population development and recovery potential after catastrophic events. (2) Earwig populations show high variability in responses to specific orchard management. Repetitive field trials aiming to determine side-effects of insecticide treatments and mechanical weeding showed wide ranges of effects. This is due to exposure level and rigidity of the earwigs rather than migration or mobility. To determine true side-effects, long-term (up to 1 month) monitoring is essential. (3) Earwig populations crash at two critical periods. Losses of nesting females during hibernation are very high, a factor most important in limiting population development. A second loss of substantial amounts of earwigs occurs at the moult from 4th instar nymphs to adults, a phenomenon that is perhaps linked to intraspecific competition. Breaking down the complexity of earwig populations in orchards into smaller components provides insights on how to increase populations and biocontrol efficacy of earwigs.

*Earwig, Forficula auricularia, Pests, Orchard, Populations*

## **Side effects of pesticides on the European earwig *Forficula auricularia* L. (Dermaptera:Forficulidae)**

Gertie Peusens<sup>1</sup>, Herman Helsen<sup>2</sup>, Bruno Gobin<sup>1</sup>

*1 pcfruit, Zoology Department, Fruittuinweg 1, B-3800 Sint-Truiden, 2 Wageningen UR, PPO, Sector Fruit, Postbus 200, NL-6670 AE Zetten*

The European earwig *Forficula auricularia* L. (Dermaptera: Forficulidae), a generalist predator in organic and integrated orchards, can contribute to the biological control of woolly apple aphid and pear sucker only when populations are numerous. As earwigs have a single generation per year, a potential side effect of crop protection is likely to influence population dynamics and size. Therefore we studied the effect of 31 plant protection products sprayed at

registered dose rates on larvae and adult earwigs using a standardised laboratory test. Earwigs were exposed to fresh dried residue on bean leaves for 5 days and then transferred to rearing units (with additional, untreated food and water) under controlled conditions for another 30 days. Lethal and sub lethal effects were assessed during the entire test period. As the earwigs were collected in Belgian and Dutch orchards populations of both countries were tested separately and exchanged between institutes for independent test validation. Results revealed that 20 compounds proved to be harmless and 5 slightly harmful. The remaining products were moderately harmful till toxic of which some induced abnormal behaviour. We selected 5 of these (abamectine, indoxacarb, spinosad, thiacloprid and flufenoxuron) for dose response testing and demonstrate that registered dose rates of some products hover between harmless and harmful.

*Forficula auricularia*, Insecticides, Beneficial

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### **First field test of the impact of four insecticides on European earwig, *Forficula auricularia*, in an apple orchard**

Heidrun Vogt<sup>1</sup>, Anderson Grutzmacher<sup>1, 2</sup>, Jürgen Just<sup>1</sup>

*1 Julius Kühn Institut (JKI), Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Fruit Crops and Viticulture, Dossenheim, Germany 2 Faculty of Agronomy 'Eliseu Maciel' (FAEM), Federal Research Centre for Cultivated Plant, Dossenheim, Germany*

The European earwig *Forficula auricularia* (Dermaptera: Forficulidae) is an important predator of psyllids and aphids, including the woolly apple aphid. Resurgence of the latter pests is often connected to the use of pesticides which harm earwigs. A field test was carried out in 2008 with four new-generation insecticides (thiacloprid, spinosad, indoxacarb and flonicamid) used in apple production, to study their effects on earwig populations. Earwigs are nocturnal and hide in shelters during the day. We installed bamboo tubes as artificial shelters at the end of May, for sampling purposes. Once the shelters were clearly occupied by earwigs, and when earwigs were in the 4th instar, the insecticides were applied (4 replicates of 7 trees per plot); control plots were left untreated. The numbers of earwigs in the shelters of 5 trees per plot were assessed for up to 10 weeks post-application, by knocking the earwigs out of the tubes, collecting them in a plastic bag and photographing them for later counts from the digital images. Immediately afterwards, the earwigs were released back to the appropriate tree. All of the insecticides caused significant (Henderson & Tilton method) reductions in the earwig numbers as compared with control populations. Within 2 weeks post-application, reductions were most pronounced for indoxacarb with a maximum of 76%, followed by thiacloprid with 60 %, spinosad with 59 % and flonicamid with 48 %. Six weeks post-application, the population effects were still about -50 % for indoxacarb and thiacloprid, and were reduced to about -30% for flonicamid and spinosad.

*Rhagoletis cingulata*, Cherry, Invasive species

### **Control of the woolly apple aphid (*Erisoma lanigerum* Hausm.) by releasing earwigs (*Forficula auricularia* L.) and support oil applications**

Ina Toups<sup>1</sup>, Juergen Zimmer<sup>1</sup>, Martin Trautmann<sup>2</sup>, Nicole Fieger-Metag<sup>3</sup>, Sascha Buchleither<sup>4</sup>, Horst Bathon<sup>5</sup>

*1 DLR Rheinpfalz, Kompetenzzentrum Gartenbau Ahrweiler, Walporzheimer Str. 48, D-53474 Bad Neuenahr-Ahrweiler, 2 Kompetenzzentrum Obstbau Bavendorf, Schuhmacherhof 6, D-88213 Ravensburg-Bavendorf, 3 Öko-Obstbau Norddeutschland Versuchs- und Beratungsring e.V., Moorende 53, D-21635 Jork, 4Beratungsdienst Ökologischer Obstbau e.V., Schuhmacherhof 6, D-88213 Ravensburg-Bavendorf, 5Julius-Kuehn-Institut, Institut für biologischen Pflanzenschutz, Heinrichstr. 243, D-64287 Darmstadt*

The woolly apple aphid (*Erisoma lanigerum* Hausm.) has been recognised for many years as a serious pest in organic fruit growing where it may cause severe economic damage due to a lack of control strategies. Based on preliminary results a research project funded by the Federal Office for Agriculture and Food (Bundesanstalt für Landwirtschaft und Ernährung, BLE) has been started in 2007 and runs until 2009 in cooperation with different research facilities in Germany. The aim is to develop an on-farm strategy to control the woolly apple aphid in organic fruit growing. It is known that earwigs (*Forficula auricularia*) as natural predators of woolly apple aphids climb the trees when they turn into L3-Larvae at the end of May/beginning of June. By then the population of woolly apple aphid can have increased to high infestation levels. To control the woolly apple aphid prior to the appearance of earwigs in the trees, oil applications were made in addition to the release of earwigs. We present preliminary results of the first and second year of the project's field trials. Applying oil preparations by brush in the first year showed good efficacy. The efficacy of releasing earwigs depended on the infestation intensity. In the second year the trials have been expanded by a comparison of conventional oil application and application of oil by brush in combination with releasing earwigs.

*Woolly apple aphid (*Erisoma lanigerum*), Earwig (*Forficula auricularia*), Oil application*

### **Population modelling of the European earwig as a decision tool for orchard management**

Rob Moerkens<sup>1</sup>, Bruno Gobin<sup>2</sup>, Gertie Peusens<sup>2</sup>, Laurent Crespin<sup>1</sup>, Herman Helsen<sup>3</sup>, Herwig Leirs<sup>1</sup>

*1 University of Antwerp, Evolutionary Biology Group, Groenenborgerlaan 171, BE-2020 Antwerp, Belgium 2 Zoology Department, pcfruit TWO, Fruittuinweg 1, Belgium*

Earwigs, *Forficula auricularia* (L.) (Dermaptera: Forficulidae) are beneficial predators in apple and pear orchards where they are capable of maintaining several pest species below economic thresholds. Earwigs thus play an important role in integrated fruit orchards and are essential in organic top fruit cultures. Numbers of earwigs show large interannual variations in densities in both organic and IPM orchards, this limits their practical use. All practical attempts for re-establishing earwig populations have failed. These problems indicated that a theoretical approach was necessary. In order to develop strategies for increasing earwig

populations we have built a population model. This enables the prediction of earwig phenology throughout the season while a sensitivity analysis allows us to identify key factors and critical periods in the earwigs' life cycle. The European earwig is a complex of two sibling species. The timing of oviposition, before and after winter respectively, is a big difference in life history characteristics between these species. A day-degree model was constructed and validated with existing field data from several European and non-European populations. Results show remarkable differences between regions regarding both oviposition strategies. Oviposition timing can cause either large variation in earwig phenology or not. First sensitivity analyses reveal that the numbers of nests during winter have a very big impact on the population in relation to spring or summer survival. However more knowledge about the interactions between species and limiting and regulating processes is required for developing specific and effective orchard management strategies. Such work is currently underway.

*Population dynamics, Day-degree model*

## **Entomology Session 5b :**

### **Pesticide resistance**

## **Codling moth insecticide resistance management in North Carolina apples**

James Walgenbach<sup>1</sup>, Leonardo Magalhaes<sup>2</sup>, Vonny Barlow<sup>1</sup>, Michael Roe<sup>2</sup>

*1 Department of Entomology, Mountain Horticultural Crops Research and Extension Center, NC State University, Mills River, NC. 28759 2 Department of Entomology, NC State University, Raleigh, NC. 27695*

In recent years the codling moth has become the major pest of apples in North Carolina. The emergence of this pest coincided with the widespread adoption of insect growth regulators and neonicotinoids as primary control tools. A resistance monitoring program was conducted in 2006 and 2007 that used a novel 16-well plasticware containing lyophilized codling moth diet that was rehydrated with insecticide solutions to assay neonates. Resistance was detected to the IGR's methoxyfenozide and novaluron, and the neonicotinoid acetamiprid. In 2008, codling moth resistance management programs were initiated that relied on the use of mating disruption and targeted applications of two new insecticides, spinetoram and rynaxypyr. Codling moth damage in commercial orchards declined to its lowest levels in recent years, and overall insecticide use was also reduced.

*Cydia pomonella, Insecticides, Mating disruption*

## **A new CpGV isolate overcoming *Cydia pomonella* resistance to Granulovirus: improvement of the virus efficiency by selection pressure on resistant hosts**

Marie Berling<sup>1</sup>, Christine Blachere-Lopez<sup>1</sup> Olivier Soubabère<sup>2</sup>, Yannis Tallot<sup>2</sup>, Miguel Lopez Ferber<sup>1</sup>, Benoît Sauphanor<sup>3</sup>, Antoine Bonhomme<sup>2</sup>

*1 EMA, centre LGEL, 6 avenue de Clavières 30100 ALES, France ; 2 NPP (Arysta LifeScience), 35 avenue Léon Blum 64 000 Pau, France ; 3 INRA, unité PSH, Agroparc, 84914 AVIGNON Cedex 9, France*

Since 2004, some codling moth (*Cydia pomonella*) populations resistant to the Mexican isolate of *Cydia pomonella* Granulovirus (CpGV-M), the active ingredient of the bio insecticide Carpovirusine that has been used for fifteen years in Europe, were detected in different organic orchards in Western Europe. The efficiency of CpGV isolates from various origins was investigated in order to overcome this resistance. A resistant laboratory colony of codling moth (RGV) was built by introgression of the resistance in a susceptible laboratory colony (Sv). The resistance of the RGV colony to CpGV-M exceeded 60,000-fold when compared to the susceptible laboratory colony (to Sv). Two viral isolates (I12 and NPP-R1) presented an increased activity on RGV larvae. I12 had already been identified as effective against a resistant *C. pomonella* colony in Germany. I12 reduced the resistance factors of RGV to 200- and 1,000-fold at the LC50 and LC90, respectively. The recently identified isolate NPP-R1 reduced the resistance factors of RGV to 7- and 46-fold at the LC50 and LC90, respectively. Genetic characterization showed that NPP-R1 is a mixture of at least two prevalent genotypes, one of them being similar to CpGV-M. The 2016-r8 isolate obtained from eight cycles of selection of NPPR1 on RGV larvae had a sharply reduced proportion in

the CpGV-M genotype and an increased efficiency on RGV. Carpovirusine samples were formulated with the different strains tested in the lab, for field experiments. Results from the field in Germany, Italy and France gave promising results, showing that the 2016-r8 isolate is a good candidate to control CpGV-M resistant Codling moth populations.

*Cydia pomonella, Granulovirus, Resistance, Virus isolate, Selection*

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## **Resistance Management: A Global Industry Response from the Insecticide Resistance Action Committee**

Andrea Bassi

*Insecticide Resistance Action Committee (IRAC)*

IRAC was formed in 1984 to provide a co-coordinated crop protection industry response to prevent or delay the development of resistance in insect and mite pests. The main aims of IRAC are firstly to facilitate communication and education on insecticide resistance and secondly to promote the development of resistance management strategies in crop protection and vector control so as to maintain efficacy and support sustainable agriculture and improved public health. It is IRAC's view that such activities are the best way to preserve or regain the susceptibility to insecticides that is so vital to effective pest management. In general, it is usually easier to proactively prevent resistance occurring than it is to reactively regain susceptibility. IRAC is an inter-company organisation that operates as a Specialist Technical Group under the umbrella of CropLife International. IRAC is also recognised by The Food and Agriculture Organization (FAO) and the World Health Organization (WHO) of the United Nations as an advisory body on matters pertaining to resistance to insecticides. The group's activities are coordinated by the IRAC Executive and Country or Regional Committees with the information disseminated through conferences, meetings, workshops, publications, educational materials and the IRAC website ([www.iraconline.org](http://www.iraconline.org)). The Executive Committee supports resistance management project teams and also provides a central coordination role to regional, country and technical groups around the world. Insecticide resistance remains one of the greatest challenges in modern agriculture and public health pest management, and it is crucial that it is tackled effectively. Indeed, resistance is everyone's problem and by working together, insecticide resistance can be successfully managed. IRAC is playing a major role in this effort.

*IRAC, Resistance management, IPM, IRM, Vectors, Public health*

## **Pathology Session 5 :**

**Fungicide resistance, disease resistance, and diseases of  
small fruits**

## **Molecular aspects of QoI and DMI fungicide resistance in NY populations of the apple scab pathogen *Venturia inaequalis***

K.D. Cox, S.A. Villani, W. Köller

*Cornell University, Department of plant pathology and plant-microbe biology, Geneva, NY, 14456*

Apple producers in the northeastern US are strongly reliant on sterol demethylation inhibitor (DMIs) and Quinone outside inhibitor (QoIs) fungicides to manage yearly epidemics of apple scab. DMI resistance in NY populations of *Venturia inaequalis* has been observed for several years, but the mechanisms of resistance are not completely understood. Similar to what was described previously, 32 NY *V. inaequalis* isolates representing a range of DMI sensitivities had anomalous insertions containing promoters upstream of the CYP51A1 gene. Unlike previous reports, several baseline sensitive isolates lacked inserts all together, while highly resistant isolates provided indications of larger previously uncharacterized insertions. At the range of DMI sensitivities tested, a clearer pattern for this mechanism of DMI resistance is beginning to emerge. In 2007, we detected five isolates in a western NY orchard displaying the qualitative resistance phenotype to QoI fungicides. On sequencing the target site region in the cytochrome b gene, we found that all five isolates had the G143A target site mutation associated with QoI qualitative resistance in Europe. The mitochondrial mutation appeared to be at a homoplastic state on QoI-amended media. However, after three successive transfers on non-QoI-amended media over the course of four months, two of the five isolates reverted to the wildtype genotype, raising questions as to mutation stability in the absence of selective pressure.

*Sterol demethylation inhibitor, Quinone outside inhibitor, Fungicide resistance, Apple scab, Venturia inaequalis*

## **Practical aspects of QoI and DMI fungicide resistance in Northeastern US populations of the apple scab pathogen *Venturia inaequalis***

K.D. Cox, S.A. Villani, W. Köller

*Department of plant pathology and plant-microbe biology, Cornell University, Geneva, NY, 14456 Address Correspondence to: Kerik Cox, kdc33@cornell.edu 1-315-787-2401*

Sterol demethylation inhibitor (DMIs) and quinone outside inhibitor (QoIs) fungicides are essential for managing apple scab and other early season apple diseases in the northeastern United States. Moreover, a second generation of DMI fungicide chemistries is on the verge of being released for apple disease management in the US. Shifts toward DMI and QoI resistance have been observed in Northeastern US populations of *Venturia inaequalis* over the past five seasons as use of these fungicide chemistries continues. In 2007 & 2008, we surveyed a minimum of 25 commercial, 4 research, and 3 baseline apple orchards for sensitivity to myclobutanil (DMI), trifloxystrobin (QoI), and dodine (guanidines). We found

that all of the commercial orchards were strongly shifted above baseline sensitivity to myclobutanil and trifloxystrobin. We also found that more than 75% of the orchards had a myclobutanil sensitivity level reduced beyond the point in which we achieved apple scab control in our research orchard with DMI-resistant *V. inaequalis* populations. Interestingly, several orchards have dodine sensitivities approaching that of *V. inaequalis* populations from baseline orchards. Field testing of DMI and QoI fungicides in DMI-resistant and QoI-shifted orchards suggests that the new chemistries could overcome practical resistance in varieties less susceptible to apple scab, but not in highly susceptible varieties that contribute to high levels of *V. inaequalis* inoculum. However, it remains to be seen if dodine resistance will quickly re-emerge during a season of renewed use.

*Sterol demethylation inhibitor, Quinone outside inhibitor, Fungicide resistance, Apple scab, Venturia inaequalis*

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### **Can *Venturia inaequalis* populations show a reduced sensitivity to a multisite fungicide? The case study of Captan in French orchards. Subtitle:**

L. Parisi<sup>1, 2</sup>, P. Expert<sup>1</sup>, I. Nock<sup>1</sup>, T. Louis-Etienne<sup>1</sup>, N. Bourdoiseau<sup>1</sup>, F. Didelot<sup>1</sup>

*1 INRA (National Institute for Agricultural Research), UMR INRA/INH/Université Pathologie Végétale, 42 rue G. Morel, 49071 Beaucozé Cedex, France; 2 Present address: Unité Expérimentale de Recherches intégrées INRA, Site Gotheron, 26320 St Marcel-les-Valence, France*

Since 2000, the control of apple scab, which in French orchards is mainly based on chemicals has in several cases failed. The high susceptibility of most cultivars, weather conditions and the emergence of resistance to strobilurin and anilinopyrimidine fungicides probably has contributed to this situation. However, another hypothesis, namely the emergence of a reduced sensitivity of *V. inaequalis* to multisite fungicides, could explain some of the cases of failure. As multisite fungicides are not known to induce resistance in fungal pathogens, such a possibility had not been investigated. Between 2002 and 2006, different experiments demonstrated in vivo a reduced efficiency (27.6 to 48 % of the incidence and severity of the disease) with Captan for the control of a *V. inaequalis* population from an orchard in which this fungicide failed to control scab. This efficiency was lower than that achieved by Mancozeb (96.5 to 100 %) when used on the same population, and lower than the efficiency of Captan on other populations less exposed to the fungicide. The variability in sensitivity to Captan of *V. inaequalis* strains collected in 5 orchards differently exposed to Captan was assessed in vitro, and a significant difference of ED50 values, which ranged between 5.2 and 51.9 mg/l was displayed. These results bring consistent elements but, as it was not possible to collect a population which had never been exposed to Captan or other multisite fungicides, there is no clear evidence of a reduced sensitivity of *V. inaequalis* to multisite fungicides. Together with the persistence of control failure cases, they support the need of applied and basic research on this question.

*Apple scab, Chemical control, Fungicide resistance*

## **Validation of an apple scab fungicide spray action threshold to help reduce Captan residue levels on Fruits.**

Vincent Phillion<sup>1</sup>

*1 Laboratoire de production fruitière intégrée de l'IRDA, Mont-Saint-Bruno, Québec*

Although most fungicide applications targeting apple scab aim to control primary infections in spring, sprays are also routinely applied during the summer to avoid any potential fruit infection. The objective of this project was to validate an action threshold for summer sprays based on the incidence of summer foliar scab that could help refine the spray approach thus minimizing the presence of fungicide residues on harvested fruit. The experiment was carried from 2006 to 2008 in a McIntosh/M9 orchard with a planting distance of 3.65m x 1.25m. Replicated plots of 40 trees were set up with different scab levels, all within the range of that observed in well maintained orchards. This was done by skipping either one or two treatments in early spring or based on the inoculum level present from the previous year. There were 2 plots per inoculum level and per treatment and 6 or 7 blocks depending on year for a total of 36 to 42 plots. Treatments were: no summer fungicide application, current grower standard, sprays based on the proposed threshold of 5 scab-infested leaves per 100 shoots. Although fruit scab at harvest often remained low in plots with foliar scab levels below threshold, fruit scab observed after 12 weeks of storage was consistently at commercially unacceptable levels.

*Apple scab, Maturation Model, Spray timing*

## **Breeding high quality disease resistant apple varieties**

Markus Kellerhals, Andrea Patocchi, Brion Duffy, Jürg Frey

*Agroscope Changins-Wädenswil (ACW), P.O. Box 185, CH-8820 Wädenswil, Switzerland*

Introduction ACW develops high quality apples combined with excellent agronomic features. This includes durable genetic disease resistance against scab (*Venturia inaequalis*), powdery mildew (*Podosphaera leucotricha*) and fire blight (*Erwinia amylovora*). Marker-assisted selection (MAS) is common practice to reduce the number of plants and the time required for evaluation. Results: At ACW, MAS was applied with pre-selected seedling progenies in their second leaf. Phenotypic pre-selection was performed for scab resistance in the glasshouse and for mildew and growth habit in the second year in the nursery field. Marker analysis revealed seedlings that carry several markers and therefore several pyramided resistance genes. Glasshouse screening of advanced selections with a shoot inoculation test for fire blight resistance highlighted considerable differences among selections. MAS for fire blight resistance was successfully established with two SCAR-markers. Plants amplifying both markers AE 10-375 and GE-8019 flanking the QTL allele identified on linkage group 7 of 'Fiesta' conferring increased resistance to fire blight were selected. Conclusions Progress was achieved in breeding new apple varieties with durable disease resistance and high fruit quality. The strategy to pyramid resistance factors towards the same pathogen and to integrate scab, mildew and fire blight resistance in the same genotype is a promising approach.

## Recent advances in epidemiology of strawberry powdery mildew

D. M. Gadoury<sup>1</sup>, A. Stensvand<sup>2</sup>, R. C. Seem<sup>1</sup>, C. Heidenreich<sup>1</sup>, M. L. Herrero<sup>2</sup>, M. Welser<sup>1</sup>, A. Dobson<sup>2</sup>, H. Eikemo<sup>2</sup>, B. Asalf<sup>3</sup>.

*1 Department of Plant Pathology, Cornell University, New York State Agricultural Experiment Station, Geneva, New York, USA; 2 Norwegian Institute for Agricultural and Environmental Research, Plant Health and Plant Protection Division, 1432 Ås, Norway; 3 Norwegian University of Life Sciences, Department of Plant and Environmental Sciences, 1432 Ås, Norway*

Cleistothecia on leaves of deciduous perennials are often dispersed before leaf fall to other substrates. In contrast, strawberry leaves remain attached during winter, and cleistothecia of *Podosphaera macularis* remained attached to these leaves. Release of overwintered ascospores was coincident with renewed plant growth, and pathogenicity of ascospores was confirmed. Upper and lower surfaces of emergent leaves were similarly susceptible, but upper surfaces were obscured by folding in emergent leaves. Emergent leaves exposed to airborne inoculum developed severe infection of the lower surface, but not the obscured upper surface. Emergent leaves acquired ontogenic resistance during unfolding, and the upper leaf surface thereby escaped infection. We found no evidence that the pathogen survives winters in New York, USA or Norway within crown tissue. Plants stripped of infected leaves remained mildew-free when forced after overwintering, while mildew colonies commonly developed on emergent leaves of plants not stripped of mildewed leaves. Unsprayed plots established using mildew-free plants either remained asymptomatic or developed only traces of powdery mildew during one growing season, even when located within 100 to 150 meters of severely diseased plots. In summary, our results suggest the following: (i) sanitation, use of disease-free plants, and eradication treatments could contribute greatly to management of strawberry powdery mildew; (ii) cleistothecia represent a functional source of primary inoculum; and (iii) the common observation of higher mildew severity on lower leaf surfaces may reflect escape of the upper epidermis due to the combined effect of leaf folding and rapid acquisition of ontogenic resistance.

*Powdery mildew, Small fruit diseases, Strawberry diseases, Epidemiology, Ontogenic resistance, Cleistothecia*

## Integrated protection of table-grape from powdery mildew in Southern Italy

Agostino Santomauro, Dongiovanni Crescenza, Giampaolo Claudia, Di Carolo Michele

*Centro di Ricerca e Sperimentazione in Agricoltura "Basile Caramia" - Via Cisternino, 281 70010 Locorotondo (Bari - Italy) Email: enza dongiovanni@crsa.it Santomauro Agostino; Faretra France*

Powdery mildew (*Erysiphe necator* Schw.) is one of the most severe diseases of grapevine wherever the crop is grown, especially under hot and dry climate, like that occurring in the Mediterranean area. Two field trials were conducted on table-grape in Southern Italy in 2007 and 2008, to evaluate the effectiveness of different spray schedules based on the following fungicides: boscalid, tested either alone or in mixture with kresoxim-methyl; metrafenone; myclobutanil, used either alone or in mixture with sulphur or meptyldinocap; penconazole;

proquinazid; pyraclostrobin+metiram; quinoxyfen, either alone or in mixture with sulphur; sulphur; tebuconazole; and trifloxystrobin. The statistical scheme of randomised blocks, with 4 replicated plots of 12 vines, was adopted. Fungicides were applied with motorized knapsack sprayers delivering a water volume of 1,000 l/ha. Symptom severity was assessed by observing all bunches in each plot. An empirical scale with 8 classes of infection was used to calculate the percentage of infected bunches, disease severity and McKinney's index. Climatic conditions were particularly favourable to the pathogen so that first symptoms appeared quite early in the season, in both the trials. Thereafter, the infections markedly increased to reach, at the end of each trial, values of 97-100% of infected bunches in the untreated plots. Under such disease-inducive conditions, all the tested spray schedules always allowed a statistically significant reduction of the disease incidence, as compared to the untreated check. In particular, the best results were obtained when kresoxim-methyl + boscalid, pyraclostrobin + metiram, proquinazid or quinoxyfen had been applied during the periods of highest disease pressure.

*Powdery mildew, Table-grape, Integrated spray schedules*

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## **A multiphasic approach to evaluating the effects of biofumigation for management of wilt in strawberries**

David Yohalem, Tom Passey

*East Malling Research, East Malling, Kent, ME19 6BJ United Kingdom*

The use of isothiocyanate-releasing plant materials has been proposed as a method for replacing methyl bromide for reduction of inoculum densities of *Verticillium dahliae*, causal agent of wilt in strawberry. We have documented reductions in numbers of *V. dahliae* propagules in both microcosm tests and in the field. In addition to the benefits of reduced pathogen inoculum, we are evaluating non-target effects of the strategy in the field: plant health and yield; changes in functional and taxonomic community profiles in both bulk and rhizosphere soils; changes in culturable bacterial and fungal populations (both taxonomic and functional); and colonisation by arbuscular mycorrhizal fungi. Preliminary data will be presented for each of these indicators.

*Verticillium dahliae, Biofumigation, Brassicaceae, Cruciferae, Strawberry, Non-target effects*

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## **Armillaria root rot on highbush blueberry in Northern Italy**

Daniele Prodorutti<sup>1</sup>, Alberto Pellegrini<sup>1</sup>, Davide Gobbin<sup>2</sup>, Thalia Vanblaere<sup>2</sup>, Ilaria Pertot<sup>1</sup>

*1FEM-IASMA Research Centre, Plant Protection Department, S. Michele all'Adige TN 38010, Italy; 2SafeCrop Centre, S. Michele all'Adige TN 38010, Italy*

Highbush blueberry plants infected by *Armillaria spp.* were found in North-eastern Italy (Province of Trento). Disease symptoms on roots were white fan leaf of mycelium under the

bark and rhizomorphs inside and around the rotted wood. Highbush blueberry plants are mulched on rows with coniferous bark, usually collected by the growers in the forest. After inspection, 13 infected blueberry orchards were identified in Valsugana valley. *Armillaria sp.* samples were collected from bark spread on the blueberry rows, from old infected trees in the orchard surroundings and from some forest locations. The species determination was performed using a species-specific multiplex PCR approach and the discrimination between *Armillaria spp.* genotypes was performed by using SSR analysis. The average percentage of stunted plants in the infected fields was 11%, while the percentage of dead plants was generally very low (0.2-2.5%), reaching values higher than 5% only in two plots. The most frequent species infecting blueberry were *A. mellea* and *A. gallica*. There were no genotypes shared among blueberry fields. Some of the genotypes colonizing trees in the immediate vicinity of infected fields and the genotypes colonizing the bark spread on blueberry rows were also identified on blueberry plants. This result indicates that mulching bark and infected trees surrounding the orchards may represent important inoculum sources for highbush blueberry plants.

*Armillaria mellea, Armillaria gallica, Vaccinium corymbosum, Mulching barks*

**Plenary Session 2 :**  
**50<sup>th</sup> Anniversary lecture and IOBC business**

## **IOBC**

Lene Siggsgaard

### **The Working Group „Integrated Protection of Fruit Crops“is celebrating its 50th Anniversary. Historic Review by Ernst F. Boller**

Ernst F. Boller

*IOBC archives, c/o Swiss Federal Research Station of Horticulture, Agroscope ACW, CH-8820 Waedenswil, Switzerland*

The Working Group looks back to 50 years of successful history. The fruit entomologists can be considered the pioneers within WPRS with respect to the expansion of biological control via integrated control and integrated plant protection to the comprehensive concept of integrated production. The developments occurring during the early 1970s brought a change in the general concept reflected in the change of the name in 1974 from “Integrated control in orchards” to the broader term “Integrated plant protection in orchards”. A further milestone was the step from “integrated protection” to “integrated production” as described in the “Message of Ovronnaz” providing a historic landmark for the entire organisation. The expansion of the group’s activities in the 1970s and the establishment of subgroups to address specific topics led to the decision, to have the subgroups their meetings individually organised and to organise symposia at 4-years-intervals as plenary meeting of the entire group. The first meeting and colloquium of the WG took place in 1961 with 36 participants from 9 countries (NL 15, Germany 5, France 5, Switzerland 4, Belgium 3, Denmark, Egypt, Italy and UK 1 each).

### **Election of new WG Convenor and Scientific Secretary Arthropods Sub-Group; future meetings**

Jerry Cross

*East Malling Research, New Road, East Malling Kent ME19 6BJ UK, Jerry.Cross@emr.ac.uk*

**Entomology Session 6 :**  
**Integrated Fruit Production**

## **Peach orchard management strategies: aphid communities as a case study**

Servane Penvern<sup>1</sup>, Stéphane Bellon<sup>1</sup>, Joël Fauriel<sup>1</sup>, Benoît Sauphanor<sup>2</sup>

*1 Ecodéveloppement, INRA, Site Agroparc Cedex 9, 84914 Avignon, France, 2 Plantes et Systèmes de culture Horticoles, INRA, Site Agroparc Cedex 9, 84914 Avignon, France*

Because of the various negative side effects of intensive chemical pest control practices, there is a shift in horticulture towards the adoption of alternative approaches for crop protection. In order to characterise and evaluate management strategies being used, we carried out comprehensive interviews to obtain details of the peach orchard protection schedules of 20 organic and conventional fruit farms in south-eastern France. It appeared that besides the regular use of direct control, farmers also used cultural and/or alternative methods and indicators to optimize their orchard management. Combining the latter methods with IOBC's technical guidelines for plant protection, four strategies have been identified. Their efficacy on aphid communities was then evaluated through visual monitoring of aphids and of beneficial populations at plot level. *Brachycaudus persicae* and *Myzus varians* were the most frequent species. The two most efficient strategies were dominated by chemical treatments, whereas the two others, less detrimental to aphid antagonists, were predominantly used by organic farmers and in agreement with IOBC's guidelines. Variations in aphid communities could be explained by: (i) the use of efficient and therefore toxic products, correlated with low infestations and low abundance and diversity of antagonists; (ii) the link between pre-blooming treatments, cultural and alternative methods (as weed strips management and manual pruning of infested branches) and high populations of aphid communities. Against all expectations, such communities were neither related with kaolin applications, nor with management of vigour and nearby environment. According to the literature, the strategies identified can be interpreted as steps towards a redesign of orchards' protection.

*Aphid, community, Antagonist, Peach orchard, Integrated pest management, Crop protection, Organic production*

## **Adapting to new control strategies and area-wide management for cherry fruit flies in British Columbia, Canada**

Howard Thistlewood<sup>1</sup>, Noubar Bostanian<sup>2</sup>, Sue Senger<sup>3</sup>

*1 Pacific Agri-Food Research Centre, Agriculture & Agri-Food Canada, PO Box 5000, Summerland, B.C., V0H 1Z0, Canada ; 2 Horticulture Research and Development Centre Agriculture and Agri-Food Canada, 430 Gouin Blvd., St. Jean-sur-Richelieu, Quebec, J3B 3E6, Canada ; 3 Landscape Consulting Corp., PO Box 198, Lillooet, B.C., V0K 1V0 Canada*

The western and black cherry fruit flies (CFF), *Rhagoletis indifferens* and *R. fausta*, are serious risks to production of sweet cherries *Prunus avium* in British Columbia and across Canada, particularly to late-season or high-value export crops with zero tolerance for pest infestation. The availability of new reduced risk chemicals and of "soft" formulations, such as GF-120® NF Naturalyte® Fruit Fly Bait, has led to adaptations and changes in several aspects of crop protection. At the same time, there is interest in the development of an area-

wide program using “soft” techniques, similar to that existing for codling moth in the interior of B.C. Diverse information is being gathered from commercial and organic orchards, private gardens, and abandoned sites within the mixed urban-rural landscapes that are common in Canada. A summary of results will be presented from experiments or from practical experiences of fruit-growers. These include aspects of the use of Fruit Fly Bait, increased importance of knowledge of alternate hosts of CFF and of CFF flight and movement, and the compatibility of reduced risk pesticides with the key predatory mites of fruit-growing in western and eastern Canada.

*IPM, Cherry fruit fly, Insecticide, Control strategy, Bait, Phytotoxicity, Movement, Non-target*

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## **Plant protection in organic apple production of two North-East Spanish regions**

Mariano Vilajeliu<sup>1</sup>, Adriana Escudero<sup>1</sup>, Pere Vilardell<sup>1</sup>, Lluís Batllori<sup>2</sup>, Simó Alegre<sup>3</sup>, Georgina Alins<sup>3</sup>, M<sup>a</sup> Dolores Blázquez<sup>4</sup>, Marcos Miñarro<sup>4</sup>, Enrique Dapena<sup>4</sup>

*1 IRTA - Estació Experimental Agrícola Mas Badia. Canet de la Tallada, 17134 La Tallada d'Empordà. Girona. mariano.vilajeliu@irta.cat; adriana.escudero@irta.cat; pere.vilardell@irta.cat ; 2 Servei de Sanitat Vegetal. DARP. Aiguamolls de l'Empordà, 17486 Castelló d'Empúries. Girona. lluis.batllori@irta.es ; 3 IRTA-Estació Experimental de Lleida. Avda. Alcalde Rovira Roure, 191. 25198 Lleida. simo.alegre@irta.es; georgina.alins@irta.es ; 4 Servicio Regional de Investigación y Desarrollo Agroalimentario (SERIDA), Apdo. 13, 33300 Villaviciosa, Asturias. mdblazquez@serida.org; mmiñarro@serida.org*

Researchers at two experimental centres in two regions of Spain, IRTA in Catalonia (East part with Mediterranean climate) and SERIDA in Asturias (North part with Atlantic climate), have been working together in some organic apple production projects, since 2002, with the aim of finding the best use of the production methods and to make technical proposals available to growers. Trials have been devoted to evaluate both resistant and standard apple cultivars under local conditions, to find the best methods for fruit thinning and groundcover management, and to control pests and diseases of this crop. The most important pests and diseases of organic apple orchards and also some trials results on the control of common harmful agents in these two areas with different soil and climate are presented. Apple scab (*Venturia inaequalis* (Cke.) Wint.) has been successfully controlled by spraying with copper salts and lime sulphur just after the infective weather conditions according predictive models. The most common pest problems are rosy apple aphid (*Dysaphis plantaginea* Pass.) (Homoptera: Aphididae), codling moth (*Cydia pomonella* L.) (Lepidoptera: Tortricidae) and, in the Catalonia area, Mediterranean fruit fly (*Ceratitis capitata* W.) (Diptera: Tephritidae). Azadiractin (NeemAzal-T/S) has successfully controlled rosy apple aphid with one or two sprayings at the beginning of the season while alternative methods to chemicals have been used to prevent damage by other insect pests: mating disruption and CpGV (*Cydia pomonella* granulosis virus) for codling moth, and, in some orchards, mating disruption for wood leopard moth (*Zeuzera pyrina* L.) (Lepidoptera: Cossidae) and mass trapping for medfly and apple clearwing (*Synanthedon myopaeformis* Borkhausen) (Lepidoptera: Sesiidae). Secondary pests like rodents (pine voles) and pear lace bug (*Stephanitis pyri* F.) (Hemiptera: Tingidae) were observed in the organic apple orchards. Most of the common parasite agents were successfully controlled by products and methods permitted by the European organic rules (EEC 2092/91).

*Organic fruit production, Organic apple, Plant protection, Apple scab, Rosy apple aphid, Codling moth, Medfly*

## **Pathology Session 6 :**

### ***Nectria* Canker**

## **Field efficacy of slaked lime against European fruit tree canker and introduction into practice**

Bart Heijne<sup>1</sup>, Peter Frans de Jong<sup>1</sup>, Pieter Jans Jansonius<sup>2</sup>

*1 Wageningen UR/Applied Plant Research (PPO), P.O. Box 200, 6670 AE Zetten, The Netherlands; 2 Louis Bolk Institute, Hoofdstraat 24, 3972 LA Driebergen, The Netherlands*

Fruit tree canker, caused by *Nectria galligena*, is an increasing problem in fruit growing areas with wet periods during the leaf fall period. Several effective fungicides against the disease, such as benzimidazoles, will be banned in future in Europe. There is an urgent need for environmentally friendly solutions for this disease. Several field experiments were done to determine the efficacy of slaked lime (calcium hydroxide) against European fruit tree canker. Pieces of wood with sporulating canker were suspended in the top of trees during leaf fall to secure a high inoculum pressure. Infection was through natural wounds like leaf scars and no artificial wounds were made. Newly formed cankers were counted in the following spring. Three spray applications of 100 kg/ha slaked lime at 10, 50 and 90 % leaf fall reduced the number of newly formed cankers by 57 % compared to untreated plots. The number of newly formed cankers was reduced by 60 % when 50 kg/ha of slaked lime was applied in a comparable experiment in the following year. A comparison between 25, 50 and 100 kg/ha of slaked lime resulted in a reduction of 34, 53, 37 % of newly formed cankers. Slaked lime was applied through the overhead sprinkler system in experiments at commercial growers' sites. The average efficacy was 60 and 62 % in two years respectively. Further demonstrations resulted in the regular use of slaked lime by commercial growers.

*Calcium hydroxide, Fruit tree canker, Nectria galligena, Slaked lime*

## **Relation of duration of wet period and number of *Nectria* cankers for leaf scars and pruning wounds during the summer**

Peter Frans de Jong<sup>1</sup>, Adrie Boshuizen<sup>2</sup>, Marcel Wenneker<sup>1</sup>

*1 Wageningen-UR, Applied Plant Research, Lingewal 1, 6668 LA Randwijk, P.O. Box 200, 6670 AE Zetten, the Netherlands; 2 Bodata, AgroBusinesspark 42, P.O. Box 592, 6700 AN, Wageningen, the Netherlands*

Fruit Tree Canker (*Nectria galligena* Bres.) is an important fungal disease in apple (*Malus X domestica* Borkh) in the Netherlands. The fungus causes cankers on the shoots, main branches and trunks of apple trees. It takes a lot of effort to control the disease and when infection takes place whole trees can be lost especially when they are young. This makes the pathogen a problem not only for fruit growers but also for fruit tree nurseries. Some of the most effective fungicides no longer permitted in the Netherlands. Therefore, interest from fruit tree growers is increasing for a warning system to optimize the use of the remaining less effective fungicides. This model should be used during the whole year because on several occasions wounds are made. To build this model data about the infection conditions are needed.

Detailed information of these conditions during the summer is lacking. Therefore an experiment was done with potted trees in the summer. To investigate a possible difference in susceptibility, two types of wounds were made, a pruning wound and a leaf scar. Trees received different length of wet periods at 20°C after inoculation with *N. galligena* spores. It was found that no wet period was needed to get a successful infection in the summer. Also no relation between the duration of the wet period and the amount of canker formation was found. Finally, it was found that pruning wounds were more susceptible than leaf scars in summer.

*Warning system, Nectria galligena, Apple, Fruit*

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### **Detection of latent infections of fruit tree canker (*Nectria galligena*) in planting material of apple**

Marcel Wenneker, Nina Joosten

*Applied Plant Research, Wageningen University & Research Centre, P.O. Box 200, 6670 AE Zetten, the Netherlands*

Fruit tree canker (*Nectria galligena*) is a serious problem in (organic) apple production. Infections cause direct loss of yield by damage to productive shoots and branches, often leading to tree death. Control measures are applied to protect infection sites, notably leaf scars from external inocula. Young apple trees can be infected symptomlessly during propagation (latent infections). A test was developed for screening young apple trees from tree nurseries for latent infection by fruit tree canker caused by *Nectria galligena*, prior to planting in the orchard. Under specific conditions (high temperature and relative humidity) it was possible to induce symptoms in infected planting material within 8 weeks. Tests were performed with artificial inoculations to determine the sensitivity of the test. Screening of commercial planting lots with the newly developed method revealed infection incidences that were higher than recorded after planting in the orchard. The developed method is suitable for screening apple planting material for fruit tree canker infections before planting. The method also detects infections that initially stay latent under field conditions. The method seems valid to screen organically and conventional apple trees. However, the method is destructive; therefore an adequate sampling strategy needs to be developed.

*Apple canker, Propagation material, Disease control, Screening method*

## **Plenary Session 3**

## **From chemical ecology to IPM in raspberry**

Nick Birch

*SCRI, Invergowrie, Dundee, DD2 5DA, Scotland, United Kingdom*

At SCRI in Dundee Scotland, a multi-disciplinary team of plant breeders, entomologists, phytochemists and biostatisticians have been developing strategies for *Rubus* IPDM from basic ecological studies on plant-insect interactions in the raspberry agro-ecosystem. An overview will be given of how we develop practical IPDM measures for key raspberry pests and diseases in Scotland (e.g. raspberry aphids and associated viruses, raspberry beetle, raspberry cane midge) from our fundamental chemical ecology studies. These studies cover mechanisms of host plant resistance, durability of plant resistance genes to pest biotypes, semiochemicals modifying insect behaviour and effects of climate on tritrophic interactions. We work closely with other experts in Scotland, England, Wales, Norway, France and Switzerland to validate our ideas on commercial farms, via Hortlink and other applied projects. The aim is to develop durable and sustainable crop protection strategies for protected and field grown raspberries in the EU and Scandinavia.

*Chemical ecology, IPDM, Rubus, Breeding for resistance, Semiochemicals*

## **Prospect for crop protection in Europe: vision from the ENDURE Network**

Pierre Ricci<sup>1</sup>, Marco Barzman<sup>2</sup>

*1 INRA, Institut Sophia Agrobiotech, BP 167, 06903 Sophia Antipolis, France ; 2 Coordinator and Assistant coordinator of the Network of Excellence ENDURE*

The IOBC has been a pioneer in defining and promoting the Integrated Pest Management and Integrated Production concepts. Despite a wide theoretical recognition of these concepts, the extent to which they are translated into practice at the field level is quite variable, so that European agriculture is still largely relying on pesticide use. Under increasing pressure from public concern on the consequences on human health and on the environment, a more stringent policy is being elaborated at the EU level that will reduce the range of available pesticides and impose a rapid shift towards IPM. In this context, research and extension have to engage even more than before in elaborating and implementing innovative solutions. As practical solutions are generally devised at national or local levels, there is an immediate benefit in comparing them, considering their transferability between countries, identifying their performance and shortcomings, exploring their potential for combination and detecting the gaps and needs for additional knowledge. ENDURE ([www.endure-network.eu](http://www.endure-network.eu)) - a Network of Excellence gathering 18 institutions from 10 European countries – takes advantage of its multinational point of view to perform such analyses. It also explores new technologies such as precision spraying and early detection of pests and pathogens which have not been much developed yet to assess their potential for reducing pesticide use. In the

mid-term, however, introducing technologies for mitigating pesticide impacts and some alternative methods may not suffice to meet the expectation of a sustained crop protection reconciling low impacts and high productivity. With the objective of reducing the vulnerability of crops to pests, pathogens and weeds altogether, changes in the farming system must be considered, as well as the role of the whole food chain from input providers to retailers and consumers. Thanks to the large range of disciplines gathered in this Network, ENDURE is in a unique position to adopt this holistic approach and to take into account the interactions between crop protection, agronomy, ecological and landscape factors as well as the socio-economic framework in which innovative crop protection strategies need to be implemented. Work is in progress on some agricultural systems most representative of European agriculture. As a typical perennial cropping system subject to multiple pest and disease constraints, pomefruit orchards are one of them. Current results on this system will be emphasised.

*IPM*

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**Convenor past & present : Farewell ans thanks**

# **Abstracts - Poster Session 1**

## Poster Session 1 : Arthropod Pests

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### State of the Art of Control Strategies of Codling Moth, Apple Scab and Brown Spot in Europe

Daniel Casado<sup>1</sup>, Jesús Avilla<sup>1</sup>, Andrea Patocchi<sup>2</sup>, Jörg Samietz<sup>2</sup>, Klaus Paaske<sup>3</sup>, Claire Lavigne<sup>4</sup>, Benoît Sauphanor<sup>4</sup>, Luciana Parisi<sup>5</sup>, Bart Heijne<sup>6</sup>

<sup>1</sup> *Departament de Producció Vegetal I Ciència Forestal, Universitat de Lleida, Av. Rovira Roure 191, 25198 Lleida, Spain.* <sup>2</sup> *Agroscope Wädenswil, P.O. Box 185, 8820 Wädenswil, Switzerland.* <sup>3</sup> *Danish Institute of Agricultural Sciences, Department of Horticulture, Research Centre Aarslev, Kirstinebjergvej 10, P.O. Box 102, 5792 Aarslev, Denmark.* <sup>4</sup> *Plantes et Systèmes de culture Horticoles, INRA, Site Agroparc Cedex 9, 84914 Avignon, France.* <sup>5</sup> *INRA, Site Gotheron, 26320 St Marcel-les-Valence, France.* <sup>6</sup> *Applied Plant Research, P.O. Box 200, 6670 AE Zetten, the Netherlands*

ENDURE ([www.endure-network.eu](http://www.endure-network.eu)) is a European Network of Excellence which aims to the reduction of insecticide use in European agriculture, and the identification of gaps of knowledge in pest control science. Among the diverse actions of this network, a survey of the state of the art of control strategies of codling moth, apple scab and brown spot in Europe was conducted. These are 3 key pests of pome fruit production all over Europe, and they are responsible for most of the phytosanitary treatments applied in these crops. The survey was conducted at least in 5 European regions, Rhône Valley (France), The Netherlands, Emilia Romagna (Italy), Lake Constance (Switzerland and Germany), and Lleida (Spain); and in some cases additional regions were surveyed. The survey was carried out by means of a questionnaire for each pest that was filled in by regional experts with close relationship with growers. Questionnaires requested information on monitoring, decision support systems, sanitation practices, use of environmentally friendly products, pesticide resistance management, cultural methods, emerging secondary pests, functional biodiversity, and bottlenecks; all considered basic elements to define a pest control strategy. The results of the survey are shown and discussed regarding specially durability of the strategy, major actual control tools, important bottlenecks, and discrepancy and heterogeneity among regions, for the control of the different pests.

*IPM, codling moth, apple scab, brown spot, pomefruit, control strategy*

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### Investigations on the bark beetle species (Coleoptera: Scolytidae) found in cherry and peach orchards in the east Mediterranean region of Turkey

Hazir Adalet, Naim Öztürk

This two-year long study was carried out in cherry and peach orchards in Adana, Mersin, Osmaniye and Kahramanmara provinces in the east Mediterranean region of Turkey in 2004-2005. In this study the species of bark beetles -Scolytid spp. were identified and the distribution and the infection rates of this pest were determined. As a result of this study, five species of the family *Scolytidae*, which are major pests of cherry and peach in the region, were found. These species were *Scolytus rugulosus* Müller, *Scolytus amygdali* Guerin, *Xyloborus dispar* Fabricius, *Taphrorynchus villifrons* Dufour and *Scolytus pygmaeus* Fabricius. *S. rugulosus* was found to be the most common species followed by *S. amygdali*. It was determined that the first adults appeared at the beginning of May (3th-5th of May) and survived until mid-September. All provinces in the study area were infected by the pest at different rates. The infection rates of bark beetle species in Mersin, Adana, Osmaniye and Kahramanmara were determined to be 4.3, 5.6, 7.0 and 7.4 % respectively. In the area where the survey was conducted orchards were found to be infected at an average of 5.8%.

*Cherry, Peach, Pest, Bark beetle species*

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### **The incidence and control of cranberry tipworm, *Dasineura vaccinii* S., in cranberry plantations in Latvia**

Ilze Apenite

*Latvian Plant Protection Research Centre, State Ltd, Lielvārdes iela 36/38, Rīga LV-1006, Latvia*

The commercial cultivation of American large-fruited cranberry (*Oxycoccus macrocarpus* (Ait.) Pers.) began in Latvia in the last decade of 20th century, because the area of natural cranberry (*O. palustris* Pers. and *O. microcarpus* Pers.) had decreased. The spread, development and progress of the most harmful pests were regularly monitored in a field trial located in the Aluksne region in the north-eastern part of Latvia. Mainly the cranberry variety 'Stevens' was observed. One of the most important reasons for cranberry yield loss is insect damage. After three years (2004-2006) it was concluded that the most widespread and harmful pest of this crop in Latvia is cranberry tipworm *D. vaccinii*. At the beginning of the experiment it was established in north-eastern part of Latvia (2004, 2005) but in 2006 the cranberry tipworm appeared also in other regions. In North America cranberry, tipworm is controlled with flooding, sanding and chemical control (insecticide treatments). In Latvia in many cranberry plantations it is difficult to perform flooding and sanding treatments (intensive growth of weeds- neutral soil). Therefore it was necessary to carry out experiments to test the effects of insecticide treatments. Currently no insecticide is registered for cranberry in Latvia. One of the tasks was to test the efficacy of the insecticide Fastac, 10% EC (a.i. - cypermethrin) for control of cranberry tipworm at different dosages and treatment times and to compare the efficacy with an untreated control. The experiment was carried out from 2005 to 2006. Higher efficacy was obtained with two treatment times with the highest dosage of Fastac applied.

*Insects, Development, Weeds, Insecticide, Treatments*

## **Preliminary trials for developing a continuous rearing system for *Bactrocera oleae* (Rossi) on its natural host *Olea europaea* L. in the laboratory and future prospects**

Antonio Franco Spanedda, Valentina Baratella

*Dipartimento di Protezione delle Piante DiProP, Facoltà di Agraria, Università della Tuscia, 01100 Viterbo, Italy*

Setting up a simple and affordable small-scale rearing technique to supply olive fly instars continuously throughout the year, even when fresh fruits are not available naturally for oviposition, is essential to optimize biological studies. Olive fruits were obtained from a typical olive grove in northern Lazio (Cura di Vetralla, VT, Central Italy), which was organically managed. Cages, feeders and instruments were specially designed for the project. The fruits were kept fresh for more than 1 year in special “muffs” of straw and tulle, assembled directly on fruiting branches. Rearing started in 2005, as soon as emergence occurred, by collecting adults from the field and moving them to the rearing cages with a bunch of sound and fresh fruits, to allow egg laying. Thereafter, every time a new lab generation started emerging, a bundle of fresh fruits was moved from the field into the cages to let new ovipositions to occur. Temperature and RH were maintained in standard lab conditions,  $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ,  $60\% \pm 5\%$  RH, and natural photoperiod. From 11 October 2005 to 22 January 2007, the fly produced 13 continual reproductive cycles in the lab, with 1 generation every 40 days on average. As an exception, the 9th generation (27 August -27 September) lasted 31 days because of accidental high temperatures ( $26\text{-}27^{\circ}\text{C}$ ). Having verified the effectiveness of our method, we are going to improve it, then test the responses of the fly to different temperature, RH and photoperiod. This is the first method that has succeeded in obtaining olive fly generations continuously, which can be used for other studies (i.e. parasitoid rearing and release).

*Olive fly, Olive tree, Development cycles, Maintaining, Biocontrol*

## **The current issue of codling moth control in Croatian apple orchards**

Božena Baric, Ivana Pajac, Dinka Grubišić

*Faculty of Agriculture, Department of Agricultural Zoology, 10 000 Zagreb, Svetošimunska cesta 25. Croatia*

In recent times, high populations of codling moth (*Cydia pomonella*) have been observed in Croatian apple orchards. The appearance of large populations of this pest is in accordance with data from other parts of Europe and the world. In the last ten years in orchards in which monitoring of codling moth by pheromone traps is conducted increasing daily moth catches and earlier appearance of the pest have been observed. More than ten years ago codling moth was caught to the end of July. Today adult flight lasts until the end of September. The number of treatments against codling moth has increased seven times. Reasons for the increased number of treatment are complex; global warming, resistant strains of codling moth, a third generation of the pests. Monitoring the appearance of the first generation of adults and

efficient temperature sums in field conditions indicate the emergence of pests with a lower temperature requirement. The extended flight of adults to September and the dynamics of adult catches on pheromone traps indicate the presence of a third generation of the pest. Integrated protection measures against codling moth are encountering a series of problems. Environmentally more favourable measures of protection against codling moth, like the mating disruption technique, which is applied in Western Europe has not shown satisfactory results in Croatia because of the small size of orchards. Biological products such as those based on the virus are not available on the Croatian market. The number of insecticides registered for codling moth control is small, with only a few active substances, which will lead to a greater number of applications per year and increase the rate of development of resistant strains of the pest.

*IPM, Codling moth, Apple, Resistant types*

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### **Loquat and pomegranate thrips in the eastern Mediterranean region of Turkey**

Refik Bozbuga, Naime Z. Elekçio?lu

*Plant Protection Research Institute, Zirai Mucadele Arastirma Enstitusu, P.O Box:21 Kisla Caddesi Koprulu mah.01321, Yuregir- Adana-TURKEY*

A Thrips survey was conducted during 2006-2007 in pomegranate and loquat trees in the eastern Mediterranean region of Turkey which includes Adana, Mersin, Hatay and Osmaniye provinces. For the extraction of thrips in the laboratory, new shoots with terminal buds and flowers were collected and 400 pomegranate and 1000 loquat fruits were randomly checked visually for any damage. A total of 511 adult thrips were collected. Seven species of thrips were identified: *Frankliniella occidentalis* Pergande (loquat, pomegranate), *Thrips tabaci* Lindeman (loquat, pomegranate), *Thrips major* Uzel (loquat, pomegranate), *Pezothrips kellyanus* Bagnall (pomegranate), *Frankliniella intonsa* Trybom (pomegranate), *Thrips meridionalis* Priesner (loquat), *Melanthrips fuscus* Sulzer (loquat). Among these species, *T. major* was the most widely distributed species (90, 6%), occurring throughout all loquat - growing districts in the Eastern Mediterranean Region followed by *T. meridionalis* (3.5%) in both years. However, *F. occidentalis* was the most widely distributed species (94%), occurring throughout all pomegranate -growing districts in the Eastern Mediterranean Region followed by *T. tabaci* (3%) in both years. Thrips are presently of little economic importance as pests of pomegranate (little damage) and loquat (damage rate 17%) in the region.

*Loquat, Pomegranate, Thrips, Pests*

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### **Two Spotted Mite, *Tetranychus urticae*, a new pest in persimmon orchards; approaches to reduce its density**

Bu-Keun Chung<sup>1</sup>, Mitsuhiro Kawashima<sup>2</sup>, Chuleui Jung<sup>2</sup>

Oriental persimmon, *Diospyros kaki* Thunb., endemic to East Asia, is one of the major fruit crops in Korea. After several decades two spotted mite (TSM) finally emerged recently as one of the key pest in the orchards. To solve the mite problem we have undertaken faunal surveys and defined the dominant species. We are identifying and conserving predators, assessing the status of the mite as a pest in orchards, developing effective miticides against TSM, and attempting to analyze the fluctuations of populations. The faunal survey of mites in 2006 in Korea showed that most of the collected tetranychid mites belonged to the genus *Tetranychus*, and additional collections of tetranychids made in 2007 were identified as *Tetranychus urticae* Koch. Among phytoseiid species collected, *Amblyseius eharai* was the most abundant. Most *A. eharai* were found on the branches in pedicels. In early spring, *A. eharai* was abundant before the extension of persimmon leaves, so was considered to be overwintering on the trees. Seventeen populations of TSM from farmer's orchards were monitored. Among these orchards, only 2 were properly managed, 5 farms should have applied control measures but the farmers had little information on the mite and its damage, and 10 orchards were not in danger of mite damage. For control of TSM in fields, applications of spiromesifen 20SC and acequinocyl 15SC showed more than 90% control activity. Fluctuations of TSM populations may have been caused by pesticide activity and spray, density of predacious mites, rainfall, and weeds in the persimmon orchards.

*Persimmon, Fauna, Tetranychus urticae, Amblyseius eharai, Miticides, Control strategy*

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## **Autumn control of aphid pests of tree and bush fruit crops**

Jerry Cross<sup>a</sup>, Michelle Fountain<sup>a</sup>, Adrian Harris<sup>a</sup>, Richard Harrington<sup>b</sup>

*a East Malling Research, New Road, East Malling, Kent ME19 6BJ, UK; b Rothamsted Research, Harpenden, Herts AL5 2JQ, UK*

The aphid species that are significant pests of tree and bush fruit crops in Europe are almost all host-alternating. They spend the autumn, spring and early summer on their winter woody tree/bush fruit host but migrate to a herbaceous host in summer. In the autumn, there is a return migration to the winter woody host by males and pre-sexual females (gynoparae), the latter producing sexual females (oviparae) which mate with the males and lay overwintering eggs on the bark. The normal strategy to control aphid pests is to apply an aphicide in spring shortly after the eggs have hatched to avoid the subsequent development of damaging colonies, which cause severe curling of leaves on shoots and stunting. Work on apple, raspberry and blackcurrant is reported, which has shown that good control of all the important aphid pests of these crops can be achieved by autumn application of an aphicide timed to kill the returning winged forms before egg-laying occurs. The advantages of autumn application are that the aphids are vulnerable to direct interception by sprays and that pesticide residues on fruit due to aphicide application do not occur. Possible methods for gauging the size and timing of the autumn migrations to rationalise the use of autumn aphicide sprays, including suction and sex pheromone trapping and surveying the incidence of gynoparae and oviparae on trees in the autumn, are discussed.

### **New infestation outbreaks of *Panonychus ulmi* Koch (Acari: Tetranychidae) in apple orchards of North-West Italy**

Daniele Demaria, Graziano Vittone, Fabio Molinari

*CReSO, Consorzio di Ricerca e Sperimentazione per l'Ortofrutticoltura piemontese, Cuneo, Italy; Università Cattolica del Sacro Cuore di Piacenza, Istituto di Entomologia e Patologia Vegetale, Piacenza, Italy*

The fruit tree red spider mite, *Panonychus ulmi*, has been a major pest in almost all fruit growing regions of the world, due to the negative effects of chemical sprays on natural enemies, until integrated pest management became widespread. Indeed, the reduction of insecticide applications allowed the biocoenosis of antagonists, (mainly the coccinellid *Stethorus punctillum*, anthocorid *Orius* sp., mite *Amblyseius andersonii*; the main predators of tetranychids in North-West Italy) to control the red spider mite. Because of the use of certain insecticides this mite became a local problem once more. In 2003 and 2005, in North-West Italy, inexplicably the spread of infestations of the mite, both on apple and peach, was recorded. Our studies, conducted in 2006, 2007 and 2008, aimed to understand the cause of these new outbreaks.

*Panonychus ulmi, Apple, Peach, Insecticides*

### ***Ostrinia nubilalis* Hübner (Lepidoptera, Pyralidae) as a threat to apple**

Daniele Demaria, Graziano Vittone, Fabio Molinari

*CReSO, Consorzio di Ricerca e Sperimentazione per l'Ortofrutticoltura piemontese, Cuneo, Italy; Università Cattolica del Sacro Cuore di Piacenza, Istituto di Entomologia e Patologia Vegetale, Piacenza, Italy*

For the last few years, damage to fruits due to the European Corn Borer (ECB), *Ostrinia nubilalis* Hübner, has been recorded in apple orchards of Piedmont (North-West Italy). Investigations carried out in 2006 and 2007 aimed to understand the phenomenon, evaluate the better way to monitor the insect, and modify the pests management strategy for control. Field surveys confirmed that the main damage occurred in orchards close to corn field or, in few cases, in orchards with the grass *Echinochloa crus-galli*. Research demonstrated that pheromone-baited mesh cone traps were more efficient than delta sticky traps for monitoring the flight of European corn borer and that, in the Piedmont area, E-strain is prevalent. Field surveys confirmed that ECB generally lives and reproduces on corn, and migrates onto apple trees when the main host plant is harvested. In Piedmont this occurs at the beginning of September, even if damage sometimes appears earlier, in August, when high populations of ECB are present. Information collected allowed the extension services to monitor the pest and modify the pests management strategy.

*European Corn Borer, Ostrinia nubilalis, Apple*

## **Investigations on the occurrence of the quarantine fruit fly species *Rhagoletis cingulata* and *Rhagoletis indifferens* on *Prunus avium* and *Prunus cerasus* in Austria**

Alois Egartner, Norbert Zeisner, Hermann Hausdorf, Christa Lethmayer, Sylvia Blümel

AGES, Austrian Agency for Health and Food Safety, Institute of Plant Health, Spargelfeldstraße 191, A-1226 Vienna, Austria

During the growing seasons 2007 and 2008 the occurrence of the two quarantine fruit flies *Rhagoletis cingulata* (Loew) and *R. indifferens* (Curran) was monitored in cherry production and home garden sites for the first time in Austria. *R. cingulata* originates from the eastern and *R. indifferens* from the western part of North America. Whereas *R. cingulata* mainly infests various *Prunus* species causing severe quality problems, *R. indifferens* also occurs on *Crataegus sp.* and on *Rhamnus sp.* After the first findings of the North American cherry fruit flies in Europe in 1983 in the South of Switzerland, *R. cingulata* was also detected during monitoring in other European countries, such as the Netherlands, Germany, Hungary and recently in 2007 in Slovenia. The survey in Austria was carried out in the main cherry production areas and in those areas where high invasion potential was most probable along the south-eastern border of Austria. Catches of the fruit flies were carried out with Pherocon® AM yellow sticky traps, which were placed in orchards and cherry fruit production sites with different cultivation systems. In 2007, two traps were installed and replaced weekly at each of the seven cherry production sites until 2 weeks after the last seasonal occurrence of the fruit flies. In 2008, the survey was carried out on 6 cherry production sites in fortnight intervals, including 4 new monitoring sites compared to 2007. Identification of the caught individuals was carried out morphologically. A high number of European cherry fruit flies (*R. cerasi* Linné), which is considered an important cherry pest in Austria, was caught in both years in most of the traps. In 2007, at each of two of the collection sites one individual of *R. cingulata* was found. The results for 2008 still have to be confirmed. The implications of the findings are discussed.

*Quarantine pest, Rhagoletis cingulata, R. indifferens, Cherry, Distribution, Austria*

## **Population evolution of *Ceratitis capitata* (Wied.) in the NE of Spain and its implications for the establishment of control methods.**

L. Adriana Escudero-Colomar<sup>1</sup>, Mariano Vilajeliu<sup>1</sup>, Esther Peñarrubia-María<sup>1</sup>, Lluís Batllori<sup>2</sup>

1 IRTA - Estació Experimental Agrícola Mas Badia. Canet de la Tallada, 17134 La Tallada d'Empordà. Girona. [adriana.escudero@irta.cat](mailto:adriana.escudero@irta.cat); [mariano.vilajeliu@irta.cat](mailto:mariano.vilajeliu@irta.cat); [esther.penarrubia@irta.cat](mailto:esther.penarrubia@irta.cat) ; 2 Servei de Sanitat Vegetal. DARP. Aiguamolls de l'Empordà, 17486 Castelló d'Empúries. Girona. [lluís.batllori@irta.cat](mailto:lluís.batllori@irta.cat)

The Mediterranean fruit fly *Ceratitis capitata* (Wied.) is a worldwide pest that has increased its populations in the last 10 years in Girona province (NE of Spain, 42° North latitude). The adult population has been carefully monitored, using dry food based attractants containing three components, in peaches (2005-2007) and apples (2007) in the two main fruit growing areas of Girona. One trap per orchard was installed and the captures were registered using

SIG technology; interactive distribution maps were drawn on a weekly basis using two software programs jointly, Hesperides® and Google map®. An area-wide control project was applied using mass trapping in both areas hanging 50 traps/ha in each fruit orchard, baited with dry food based attractant of three components. The project acreage started on 300 ha in 2005 and grew to 774 ha in 2007. Damage level and chemical treatments were recorded and sanitation methods were applied as a compulsory requirement. Results showed a seasonal population evolution, with maximum catches at the end of September or early October in both fruit species studied. The highest population was found in the Northern part of the two Girona fruit growing areas. SIG technology has enabled us to determine the zones with the highest population in each area and to choose the control strategy in each orchard. Mass trapping as a control method on an area-wide basis gave good protection of fruits and in only a few cases it was necessary to apply reinforcement with chemical spraying. Sanitation measures have proved to be necessary to complete mass trapping as a control method of the Mediterranean fruit fly. All these results will be discussed in order to improve the control of Medfly in the Girona fruit area.

Medfly, *Ceratitis capitata*, Population evolution, Monitoring, Mass trapping, Area-wide control, SIG

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### **Preliminary studies about the effect of ‘*Candidatus Phytoplasma mali*’ on the psyllid *Cacopsylla melanoneura* (Homoptera: Psyllidae)**

Valeria Malagnini<sup>1</sup> Federico Pedrazzoli<sup>1</sup>, Valeria Gualandri<sup>1</sup>, Flavia Forno<sup>1</sup>, Alberto Pozzebon<sup>2</sup>, Claudio Ioriatti<sup>1</sup>

*1 FEM-IASMA Research Centre, Plant Protection Department, via E. Mach, 1, 38010 San Michele all’Adige (TN,) Italy; 2 University of Padua, Department of Environmental Agronomy and Crop Science, viale dell’Università, 16, 35020 Legnaro, Padova, Italy*

*Cacopsylla melanoneura* Föster (Homoptera: Psyllidae), an univoltine psyllid, is a vector of ‘*Candidatus Phytoplasma mali*’, the etiological agent of apple proliferation disease (AP), which is a severe problem in Italian apple orchards. Preliminary studies were conducted about the influence of ‘*Ca. Phytoplasma mali*’ on the fitness of *C. melanoneura*. Couples of overwintering adults of the psyllid collected in the field were exposed to the phytoplasma by feeding on infected and non-infected apple (*Malus domestica* L.) (Rosaceae) shoots. The effect of the exposure to the phytoplasma with the diet was determined by measuring some of the life history traits correlated to the fitness of the individuals such as longevity of the females, number of eggs laid, egg hatching and development of larval instars. The longevity of AP-exposed adult females was not significantly different to that of psyllids fed on healthy apple shoots. However, the AP-exposed females laid significantly less eggs than unexposed ones, and the eggs produced by AP-exposed females were significantly delayed in hatching. Moreover, the progeny of AP-exposed females (number of nymphs emerging from eggs laid on apple shoots) was significantly less numerous than the progeny of unexposed females, while there were no significant differences in their development to adulthood. Further studies are necessary to establish whether such differences are due to the presence of AP phytoplasma in the body of the psyllid or in the plant.

*Apple proliferation, Psyllid, Apple, Phytoplasma*

## **New insights into management of the white grub, *Polyphylla olivieri* in fruit orchards of Iran**

Aziz Kharazi-Pakdel, Javad Karimi

*Dept. plant protection Campus of Agriculture and Natural Resources University of Tehran Karaj Iran  
Department of Plant protection Ferdowsi University of Mashhad, Mashhad Iran*

*Polyphylla olivieri* (Col., Melolonthidae) is the most destructive white grub in the Iran. This Scarabaeid has a wide host range including different fruit trees in most part of Iran. Chemical pesticides is the common for controlling this pest. Considering side effects of this method, application of biocontrol agent has been considered in management programmes. Among the natural pathogens, several isolates of entomopathogenic nematodes from both genus of *Steinernema* and *Heterorhabditis* were isolated from third and second larval stages of this pest in Iran. This isolates belonged to *Heterorhabditis bacteriophora*, *Steinernema carpocapsae* and *Steinernema glaseri*. Laboratory assay showed that the last species, *S. glaseri* had the highest mortality potential. The prevalent pathogen of this melolonthid in Tehran province was *Metarhizium anisopliae* and after this *Beauveria bassiana*. Compatibility studies on application of entomopathogenic nematodes and fungi indicated that application of entomopathogenic nematodes and *M. anisopliae* can reduce population of this white grub considerably. In addition to natural pathogens as natural biocontrol agents, some isolates of nematodes were isolated from soil habitats of this pest. Among this, *Steinernema feltiae* and *Heterorhabditis megidis* had the highest virulence compared with other species. A survey for characterization and introduction of isolates with high virulence can provide a good alternative in integrated management of *Polyphylla olivieri* in future.

*White grub Polyphylla olivieri Natural Pathogens Iran*

## **First evidence of the walnut husk fly (*Rhagoletis completa*) in Austria**

Christa Lethmayer

*AGES, Austrian Agency for Health and Food Safety, Institute of Plant Health, Spargelfeldstraße 191, A-1226 Vienna, Austria, christa.letmayer@ages.at*

The walnut husk fly *Rhagoletis completa* (Tephritidae, Diptera), originating from North-America, is listed as a quarantine pest in Annex I/AI (directive 2000/29/EC). As the main host plants of *R. completa* are various species of *Juglans* spp., infestations could become a problem for walnut production because larval feeding in the mesocarp (nutshell) could also damage the pericarp and the nut itself. Under certain conditions, peaches (*Prunus persica*) may also be attacked. In international trade, the major means of dispersal is the transport of infected fruits

containing live larvae. In Europe (Switzerland) some specimens were collected in the late 1980s for the first time. During the last years *R. completa* also occurred in Slovenia, Italy and Germany, recently in France (2007). Due to the fact that there are still no individuals of the walnut husk fly documented for Austria a monitoring program was started by the Institute of Plant Health (AGES) in 2008. The monitoring took place in Tyrol, near Innsbruck in private gardens following up information provided by the Tyrolean Plant Protection Service. Sticky yellow traps were used to catch the fruitflies and were set up and recorded from the end of June at 14-day intervals. In the first half of July first individuals were caught and the first presence of *R. completa* was demonstrated for Austria. Monitoring in other parts of Austria will be continued in 2009.

*Quarantine pest, Rhagoletis completa, Walnut, Distribution, Austria*

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## **The occurrence of leaf rollers in Polish apple orchards and possibilities of their integrated control**

Zofia Pluciennik, Remigiusz W. Olszak

*Institute of Pomology and Floriculture, Dept of Plant Protection, Pomologiczna 18, 96 – 100 Skierniewice, Poland*

Leaf rollers constitute the major pests of fruit crops - particularly apple and pear in many regions with temperate climate. Among a dozen or so species occurring in fruit orchards in Poland only four are important or even (depending on year) very important. They are: dark fruit-tree tortrix (*Pandemis heparana*), summer fruit tortricid (*Adoxophyes orana*), apple bud moth (*Spilonota ocellana*) and european leaf roller (*Archips rosanus*). The harmfulness of these pests during warm seasons is particularly serious. Since 2002 an increasing significance of *Adoxophyes orana* has been observed which is probably connected with warming of the climate. This complicates the control of the above leaf roller species as its larvae are present at a different time to those of the others, and especially the summer generation of larvae of *Adoxophyes orana*. Several monitoring techniques can be used to evaluate the occurrence and abundance of *Adoxophyes orana*, tree inspections used along with the use of sex-pheromone traps seem to be the most effective ones. Despite of wide host range *Adoxophyes orana* prefers to feed on apples, so together with other tortrix species (see above) it is able to cause serious problems in many orchards. Several pesticides are registered in Poland for chemical control of these pests in orchards along with IFP programs. These are thiacloprid (Calypso 480 SC), acetamiprid (Mospilan 20 SP), indoxacarb (Steward 30 WG), metoxyfenozid (Runner 240 SC) and spinosad (Spintor 480 or 240 SC). The insecticide indoxacarb, metoxyfenozid and spinosad are used mainly in the summer because they reduce the codling moth population as well. In the case when other pests (e.g. aphids) occur along with tortrix species, neonicotinoids (thiacloprid and acetamiprid) are recommended. Since 2006 a few experiments with the new active ingredient rynaxypyr have been conducted and very promising results for leaf roller control were obtained.

*IPM, Leaf rollers, Pomefruit, Control Strategy*

## **Control of *Cacopsylla pyri* L. (Sternorrhyncha, Psyllidae) in pear orchards in the Czech Republic**

Jana Ourednickova

*Research and Breeding Institute of Pomology, Czech Republic*

The aim of this trial was to assess the efficacy of a range of treatments; pre-spring spray treatments of kaolin, spring treatments of oil and treatments of three types of insecticides used during the growing season. The trial was conducted in 2008 in the Czech Republic in a pear orchards which had a high initial level of pest infestation. There efficacy of kaolin was tested against over-wintered adults of *Cacopsylla pyri* to prevent the females laying their eggs. Ekol (90% coleseed oil) was tested in order to suffocate adults and eggs. Insecticides were applied to reduced nymphs especially: Sanmite 20 WP (pyridaben), Insegar 25 WP (fenoxycarb) and Calypso 480 SC (thiacloprid). These insecticide treatments were used on the the first and second generation. Their efficacy was compared with an untreated control. Beating tray samples were taken in both control and treatment plots 6 or 7 days after application to monitor the density of adults. One sample comprised 1 beating on 25 branches. Eggs-laying and nymph's infestation were visually monitored on 20 randomly chosen blossom's clusters or young shoots. For all plots the population of *Cacopsylla pyri* remained at a damaging level. This observation might be explained by the high initial infestation level and the migration of pear suckers from untreated control to treated plots. However during the growing season lower number of adults, nymphs and eggs were observed on treated trees compared to the untreated control. The population density of this pest was significantly decreased, crop yield wasn't decreased and no honeydew or smooty moulds were observed on the fruits.

*Integrated pest management, Cacopsylla pyri, Pears, Kaolin, Oil, Insecticides*

## **Geographical distribution and population dynamics of the European cherry fruit fly, *Rhagoletis cerasi* (Diptera: Tephritidae) in Greece**

N.T. Papadopoulos<sup>1</sup>, M. Kleopatra<sup>1</sup>, S. Papanastasiou<sup>1</sup>, A. Diamantidis<sup>1</sup>, I. Kounatidis<sup>2</sup>, P. Mavragani<sup>2</sup>, K. Bourtzis<sup>3</sup>, B. I. Katsoyannos<sup>4</sup>

*1 Laboratory of Entomology and Agricultural Zoology, University of Thessaly Greece, Phytokou st. N. Ionia (Volos), 58446 Magnisia, Greece ; 2 Department of Genetics, Development and Molecular Biology, School of Biology, Aristotle University of Thessaloniki, 54 124 Thessaloniki Greece ; 3 Laboratory of Applied Zoology and Parasitology, School of Agriculture, Aristotle University of Thessaloniki, 54 124 Thessaloniki Greece ; 4 Department of Environmental and Natural Resources, University of Ioannina, 30100 Agrinio, Greece*

Although the European cherry fruit fly *Rhagoletis cerasi* L (Diptera: Tephritidae) poses a major threat to cherry production in Greece, there are only a few studies on its bioecology. Following extensive fruit sampling (during 2004 – 2008) we studied the geographical distribution of *R. cerasi* in several areas all over Greece. Infested fruit samples were collected in the areas of Macedonia (Thessaloniki, Katerini, Kozani, Halkidiki, Kavala), Thessaly (Trikala, Magnisia, Larissa, Karditsa), Peloponnesus (Ilea, Achaia), Thrace (Komotini), Crete island (Chania), North Aegean sea (Lesvos island). In addition to sweet cherries, *R. cerasi* pupae have been recovered from sour cherries (Thessaloniki), wild growing cherries (*Prunus spp.*) (Kozani, Trikala, Magnisia) and *Prunus mahaleb* (Trikala). Infestation levels varied greatly among sampling years, areas, and fruit species. Adults obtained from pupae collected from samples, from all the above areas except Crete, were examined for infections by the intracellular bacterium Wolbachia, which is known to exist in many European populations of *R. cerasi*. All populations were found to be singly infected by the same Wolbachia strain (wCer1). Pupal diapause termination and adult flight have been studied in a lowland – coastal (Kala Nera Magnisias) and a highland area (Dafni Kozanis). Considerable differences exist both in diapause intensity and adult flying period between the two populations. The above data together with earlier data, collected in our laboratory, were used to construct population models for both areas.

*Geographical distribution, Infestation levels, Wolbachia, Diapause termination, Adult flight*

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## **Population dynamics and damage analysis of *Cetonia aurata* / *Potosia cuprea* in Croatian peach orchards**

Josip Razov<sup>1</sup>, Baric Bozena<sup>2</sup>, Miklós Tóth<sup>3</sup>

<sup>1</sup> University of Zadar, Department of Mediterranean Agriculture and Aquaculture, Mihovila Pavlinovica bb, 23000 Zadar, Croatia <sup>2</sup> Faculty of Agriculture, University of Zagreb, Svetosimunska 25, 10000 Zagreb, Croatia <sup>3</sup> Plant Protection Institute, Hungarian Academy of Science, Budapest, Pf 102, Hungary, H-1525

During the last fifteen years in the coastal part of Croatia it has been beetles from the subfamily Cetoniinae have been observed causing damage to ripening peaches. With further analysis it was shown that these species are *Cetonia aurata* and *Potosia cuprea*. In 2007 we have been monitored the presence of and population dynamics of these species, and estimated the damage they caused. This work was carried out at two locations in the Zadar, Ravni kotari region. The Csalomon® traps with the baits consisting of 100 µl phenethyl alcohol + 100 µl methyl eugenol + 100 µl trans anethol + 100 µl lavandulol were used. The total number of trapped beetles on two locations is 569 pcs. of *Cetonia aurata* and 200 pcs of *Potosia cuprea*. The damage percentage was from 0 % up to 7 %.

*Cetonia aurata, Potosia cuprea, Peaches, Damages, Population dynamics, Attractant traps*

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## Spatial patterns and Sampling of predatory mites (Acari: Phytoseiidae) on apple orchards

J. Raul Rodrigues<sup>1</sup>, Laura M. Torres<sup>2</sup>

*1 Instituto Politécnico de Viana do Castelo, Escola Superior Agrária de Ponte de Lima, Dep. Ciências da Planta e do Ambiente, Refóios do Lima, 4990-706 Ponte de Lima, Portugal; 2 Universidade de Trás-os-Montes e Alto Douro, Dep. Protecção de Plantas, Quinta de Prados, 5000-911 Vila Real, Portugal.*

The spatial distribution of the predatory mites (*Acari phytoseiidae*), was studied by applying Taylor's power law and Iwao's regression models. Studies were carried out during two consecutive growing seasons (2003 and 2004) in a two apple orchards (Cvs: Royal Gala and Golden Smoothie) of Northwest Portugal. The species present, there was a complex dominated by the generalist predators *Euseius stipulatus* (Athias-Henriot) and *Kampimodromus aberrans* (Oudemans) in Ponte de Lima and by *Amblyseius andersoni* (Chant) and *E. stipulatus* in Braga. The relationship between mean and variance was studied by Taylor's power law and Iwao's regression models. Both models showed good fit to the data (Taylor  $R^2=97.3\%$ , Iwao  $R^2 = 90.3\%$ ,  $p<0.001$ ), concluding that the phytoseiid species has an aggregated distribution on vineyard fields. The spatial distribution of phytoseiids was aggregated, according the Taylor ( $b = 1.195 \pm 0.021$ ;  $t_{1,987} = 8.921$ ; d.f. = 88;  $p < 0.001$ ) and Iwao ( $b = 1.652 \pm 0.058$ ;  $t_{1,987} = 11.292$ ; d.f. = 88;  $p < 0.001$ ) coefficients. The Taylor's regression coefficients were commons for both places and cultivars, which justifies a common sampling program for the complex species presents. The optimal sample size (leaves) for phytoseiids populations with fixed precision levels of 0.15, 0.20 and 0.25 where estimated with Taylor's regression coefficients. The results showed that a smaller number of leaves are required for the detection of high phytoseiids densities and the required sample sizes, increased considerably with increased levels of precision. A binomial sampling procedure has been developed through the relationship between the proportion of leaves occupied and the mean number of phytoseiids per leaf. The strong significant relationship between the estimated and observed proportion of occupied leaves ( $R^2 = 87.5\%$ ; d.f. = 89;  $F = 614.48$ ;  $p < 0,001$ ), makes it possible to use a binomial or presence-absence sampling approach. Presence-absence sampling is an efficient method for crop management purposes because less time is needed to process the samples compared with a method where all phytoseiids are counted.

*Phytoseiidae, Biocontrol, Sampling methods, Taylor power law, Integrated pest management*

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## An inventory of tortricids (Lepidoptera, Tortricidae) in Swedish apple orchards as a basis for future management strategies

Patrick Sjöberg<sup>1</sup>, Christer Tornéus<sup>2</sup>, Birgitta Rämert<sup>1</sup>, Ylva Hillbur<sup>1</sup>

*1 Department of Plant Protection Biology, SLU Swedish University of Agricultural Sciences, P.O. Box 102, SE-230 53 Alnarp, Sweden, e-mail: patrick.sjoberg@ltj.slu.se 2 Swedish Board of*

Over the last couple of years, growers, researchers, advisors and plant protection companies have noticed increasing problems with tortricids in Swedish apple orchards. Since the insecticide Gusathion (azinphosmethyl) will be banned by the end of 2008 a further increase of tortricids can be expected. In 2007, an inventory was made in three orchards in Sweden on

seven species of tortricids, *Adoxophyes orana*, *Archips podana*, *Archips rosana*, *Cydia pomonella*, *Hedya nubiferana*, *Pandemis heparana* and *Spilonota ocellana*. The objective was to get a better understanding of the species' flight period and abundance. The inventory was made with pheromone traps (Pherobank, The Netherlands) and the results indicated that population densities of all the studied species was high. As a consequence, a more extensive inventory was initiated in 2008. The inventory includes the same set of species, but is conducted at 11 sites (10 conventional and one organic). The methods used are pheromone trapping, visual observations and bud sampling. Bud samples were taken in early spring to look for newly hatched and over-wintering larvae. Pheromone traps were then deployed in May and monitored during the season. Existing forecasting models were tested where applicable to try to determine application dates. Crop damage will be estimated before harvest and compared with trap catches and bud samples. The future goal for the project is to develop management strategies for Swedish apple orchards. Results from the inventory will be presented at the conference.

*Tortricids, Pheromone traps, Apple orchard, Inventory*

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### **Spread of European stone fruit yellows in Piedmont (northwestern Italy) and presence of *Cacopsylla pruni* Scopoli in plum and apricot orchards**

Rosemarie Tedeschi, Daniele Demaria, Alessandro Cesano

*CReSO, Consorzio di Ricerca e Sperimentazione per l'Ortofrutticoltura piemontese, Cuneo, Italy. Università degli Studi di Torino, Di.Va.P.R.A. - Entomologia e Zoologia applicate all'Ambiente "Carlo Vidano", Gruglias, Italy*

In recent years, high percentages of declining plants showing symptoms ascribable to the European stone fruit yellows (ESFY) disease have been recorded in plum and apricot orchards in Piedmont, northwestern Italy. Since 2006, visual inspections were carried out in tens of orchards in order to assess the incidence of symptomatic plants in early spring (premature budbreaking) and at the end of the summer (yellowing and leafroll). Surveys with yellow sticky traps and using the beating tray method were carried out from the beginning of March until the beginning of June to monitor the presence of *Cacopsylla pruni* Scopoli and other possible vectors in the orchards and in the surroundings on wild *Prunus* species. The presence of "*Candidatus Phytoplasma prunorum*" in plum and apricot trees as well as in the insects was ascertained by PCR and RFLP analyses. The very low *C. pruni* population density recorded and the presence of "*Ca. Phytoplasma prunorum*" in recently planted orchards (1 year old) suggest that early infection can possibly occur in nurseries.

*European stone fruit yellows, Cacopsylla pruni, Plum, Apricot.*

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### **Observations of *Rhagoletis cingulata*, an invasive species from North America, on cherry in Germany**

Heidrun Vogt, Kirsten Köppler

*Julius Kühn Institut (JKI), Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Fruit Crops and Viticulture, Dossenheim, Germany Dahlbender, Werner & Hensel, Günter Dienstzentrum Ländlicher Raum (DLR)*

Since 2003, the Eastern cherry fruit fly, *Rhagoletis cingulata* (Loew), an introduced Tephritid fly from North America, has been observed in Germany in increasing abundance. We present an overview of the increase in distribution and discuss the consequences for management programs for sour cherry (*Prunus cerasus*). Following the identification of a single female in a malaise trap in Rhineland-Palatinate (central Rhine region) in 1999, a trapping program was conducted near the original host site and in several cherry growing regions from 2002 onwards. In 2003, a few specimens of *R. cingulata* were reported on yellow traps in cherry orchards in the Rhineland-Palatinate area. From 2004 onwards, the number of individuals found in Rhineland-Palatinate cherry growing regions increased considerably and the species was also found in other Federal states. At the present time, the species has been collected from nearly all cherry-growing regions of Germany, with high abundance in Rhineland-Palatinate, Thuringia, Saxony and Brandenburg. In Germany, this species is emerging 3-4 weeks later than the European cherry fruit fly, *R. cerasi*, and mainly attacks sour cherries. In some years and locations, the Eastern cherry fruit fly has caused more than 20% damage in sour cherries, whereas infestation due to *R. cerasi* in sour cherries usually is of low importance. The species status has been confirmed by Dr. Allen Norrbom, Systematic Entomology Laboratory, Agricultural Research Service, US Department of Agriculture, USA.

*Forficula auricularia, Insecticides, Integrated plant protection*

## Poster Session 1 : Biocontrol Agents

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### **Impact of insecticides utilized in citrus crops in Brazil on *Chrysoperla externa* (Hagen, 1861) (Neuroptera: Chrysopidae)**

Maurício Sekiguchi Godoy, Geraldo Andrade Carvalho, César Freire Carvalho

*Universidade Federal de Lavras, Departamento de Entomologia, 37200-000 Lavras, Brazil*

The control of pest arthropods in citrus crops is conducted mainly by means of insecticides, which are employed on a large scale, acting also on the beneficial insects. Among those organisms are the green lacewings, considered important predators of pests on citrus. Thus, the effect of the chemicals thiametoxam (0.05 g a.i. L<sup>-1</sup>), imidacloprid (0.07 g a.i. L<sup>-1</sup>), milbemectin (0.008 g a.i. L<sup>-1</sup>), pyriproxifen (0.075 g a.i. L<sup>-1</sup>) and spiroticlofen (0.06 g a.i. L<sup>-1</sup>) on the eggs of *Chrysoperla externa* and their effects upon the subsequent stages of their development were investigated. Eggs had received the chemicals by means of Potter's tower set at 15 lb/po12, with a volume of application of 1.5±0.5 µL/cm<sup>2</sup>. After drying, they were placed individually into glass tubes and kept at 25±2 °C, 70±10% RH and 12h of photophase. After hatching, the larvae were fed with eggs of *Anagasta kuehniella*. The design was completely randomized with six treatments and six replicates, each consisting of five eggs. The embryonic period and the survival rate of the eggs, as well as the duration and survival of larvae, pupae and adults were evaluated. For the adults, fecundity was also evaluated. The compounds according to their total effect were put into toxicity classes according to the IOBC classifications. It was found that thiametoxam, imidacloprid, milbemectin and spiroticlofen were harmless (class 1) to *C. externa*, thus being compatible with Integrated Pest Management Programs on citrus, whilst espiroticlofeno was regarded as slightly harmful (class 2).

*Citrus growing, Green lacewing, Phytosanitary chemical, Biologic control*

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### **First record of the parasitoid *Copidosoma varicornis* (Nees) (Hymenoptera: Encyrtidae) in Greece** Author : Petros Damos

Petros Damos, Matilda Savopoulou-Soultani

*Aristotle University of Thessaloniki, Faculty of Agriculture, Laboratory of Applied Zoology and Parasitology, 54 124, Thessaloniki, Greece*  
*matilda@agro.auth.gr, damos@agro.auth.gr*

Biological control has been a fundamental element of the IPM concept since its initial definition more than 30 years ago. Region specific and naturally occurring biological control agents play a significant role in agro-ecosystems. This is the first record of the natural

endoparasitoid *Copidosoma varicornis* (Encyrtidae) in Northern Greece (40.32oN). A significant number of *C. varicornis* individuals were reared on *Anarsia lineatella* larvae originating from organic and IPM peach orchards. Species that appear as well established indigenous predators or parasitoids in the fruit growing areas of northern Greece should be conserved and brought in as potential biocontrol agents. Additionally, modification of pest control and production practices to enhance the suppression of insect pests by naturally occurring beneficial organisms are of special interest in IPM.

*Copidosoma varicornis, Anarsia lineatella, Biological control, IPM*

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### **Natural regulation of the rosy apple aphid (*Dysaphis plantaginea*) in organic apple orchards**

H. Dib<sup>1</sup>, Y. Capowiez<sup>1</sup>, S. Simon<sup>2</sup>, B. Sauphanor<sup>1</sup>

*1 INRA-PSH, Equipe EPI, Domaine St Paul, Site Agroparc, 84914 Avignon Cédex 9, France. 2 INRA-UERI Gotheron, F-26320 Saint-Marcel-lès-Valence, France*

Rosy apple aphid, *Dysaphis plantaginea* Passerini (Hemiptera: Aphididae), is the most destructive aphid species in European organic apple orchards. This study aimed to evaluate the biological control of *D. plantaginea* and the effect of installing flat anti-hail nets on its control. The study was carried out in 2008 in one experimental apple orchard without pesticide, as well as, four organic apple orchards, located at the south of France. The density and the diversity of natural enemies observed in the experimental orchard were higher than those in the studied organic orchards. The colonies of *D. plantaginea* were exploited by a diverse guild of natural enemies. However, hoverflies, lady beetles and earwigs were the most abundant. Hoverflies tended to arrive first, followed by lady beetles and earwigs. In some orchards, a high level of infestation was observed, presumably due to the low level of natural enemies and the high level of ants in these orchards. In terms of the effect of flat anti-hail nets, this study showed the positive influence of nets on the control of the rosy apple aphid and the negative influence on the presence of natural enemies, especially lady beetles. In conclusion, this field study showed that the natural control of rosy apple aphid in natural conditions is possible but remains generally limited. New means of management that would make this regulation possible are important.

*Rosy apple aphid, Dysaphis plantaginea, Natural regulation, Natural enemies, Organic apple orchards*

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### **Behaviour and biological control of two-spotted spider mite (*Tetranychus urticae*) in floriculture red raspberry plantations**

Alberto Grassi, Romano Maines

*IASMA-FEM Research Centre, Via Edmondo Mach n° 1 – 38010 S.Michele all'Adige, Trento (Italy)*

Tetranychid mites (*Neotetranychus rubi* and particularly *Tetranychus urticae*, TSSM) represent key pests on floriculture red raspberry cultivated in Trentino, northern Italy. Their natural control relies on many indigenous predators, among which, the phytoseiid mite, *Amblyseius andersoni*, is the most important and effective. Our poster deals with biology and behaviour of these mites, and their reciprocal relationships from surveys carried out from 2005 to 2007 in a plantation in Mocheni's Valley and from previous investigations. In the experimental site we evaluated the efficiency against TSSM of a *Amblyseius andersoni* local strain and two commercially available predators, *Amblyseius californicus* and *Phytoseiulus persimilis*, comparing two introduction rates (26 and 52 individuals/m of row, equivalent to 10.4 and 20.8 individuals/m<sup>2</sup>) at different times of release. *A. californicus* releases, applied before the middle of June, were more effective than late releases, every year, in comparison with the control plots (no release). The best control was recorded where the highest dose was introduced. However, *A. californicus* did not perform as well as *A. andersoni* in the reintroduction plot. The early, season-long and reactive control, in addition to a highest rusticity and tolerance to the chemical sprayed, are probably the main reasons of the better performances of the indigenous phytoseiid compared to *A. californicus*. In our trials, *P. persimilis* established in the crop with very small populations, showing probably important requirements (prey density, release rate, climate under tunnels, etc.) that limit a lot the possibilities of its application on floriculture raspberry in our region. The information we collected was used to produce a scheme for TSSM management.

*Tetranychus urticae*, *Neotetranychus rubi*, Floriculture fruiting red raspberry, Behaviour, Biological control

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## **Pest management practices and environmental factors affect natural regulation of the codling moth**

L.B. Monteiro<sup>1</sup>, C. Dor<sup>2</sup>, P. Franck<sup>2</sup>, C. Lavigne<sup>2</sup>, B. Sauphanor<sup>2</sup>

<sup>1</sup> UFPR, Parana Federal University, DFF, CEP 81831-990, Curitiba, Brazil <sup>2</sup> INRA, UMR 1115 Plantes et Systèmes de culture Horticoles, Agroparc, F-84914 Avignon Cédex 9, France

Numerous arthropod predators and parasitoids species attack codling moth eggs and larvae, but these antagonists do not efficiently control the pest in commercial orchards. Parasitism of diapausing larvae was assessed in 79 apple and pear orchards from South-eastern France (2007-2008). The predation and parasitism of egg masses was investigated on a sub-sample of 13 orchards in 2008. Parasitism of diapausing larvae was recorded in 21.0% and 16.4% of orchards with codling moth larvae in 2007 and 2008, respectively. The mean parasitism rate over the two years was 3.7 %, 2.3% and 0.8% in the organic and conventional with or without mating disruption orchards, respectively. It was higher in apple than in pear orchards, for high densities of windbreak hedgerows and low densities of orchards surrounding the analysed fields. Six parasitoid species were identified, among which *Ascogaster quadridentata*, *Pristomerus vulnerator* and *Perilampus tristis* were the most frequent whatever the management practices. The composition of the parasitoid community was explained by both local (27%) and landscape factors (16%). On average 12.5% and 54.1% of egg masses exposed to natural antagonists were consumed by predators in July and August 2008, respectively. The highest predation rates were also recorded in the organic orchards and close

to hedgerows. Egg parasitism was negligible (0.1%). It appears from this analysis that parasitism of eggs and larvae, more frequently described in the literature, has lower impact on codling moth populations than the predation of eggs. Comparing with previous analyses in the same area, it appeared that larval or egg parasitism was much more affected by the crop protection practices than egg predation.

*Cydia pomonella, Predation, Parasitism, Apple orchard*

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### **A geostatistical approach to evaluate the side effects on non target species using a non repeated plot.**

E. Pasqualini<sup>1</sup>, M. Melandri<sup>2</sup>., G. Pradolesi <sup>2</sup>., S. Civolani<sup>1</sup>, V. De Luigi<sup>1</sup>., G. Burgio<sup>1</sup>

*IDiSTA, (Department of Environmental Science and Technologies), University of Bologna (I) 2 Agronomica R&D - Coop. Terremerse (RA, Italy)*

A geostatistical approach to evaluate the side effects of insecticides on non target species using a non replicated treatments. Field research was carried out, in pear orchards in the Emilia-Romagna region (I), to study the side effects on populations of *Anthocoris nemoralis* F. of three different strategies to control the first generation of *Cydia pomonella* L. The strategies were: i) soft = application of CpGV, ii) OP = application of phosmet and chlorpyrifos and iii) reduced risk = thiacloprid and methoxyfenozide. These strategies were applied on large single block plots and the responses on *Cacopsylla pyri* L. and *A. nemoralis* F. populations were analysed by means of geostatistical approach. The *A. nemoralis* data was collected by means of a grid sampling plan based on referenced points while *C. pyri* were sampled as average of mobile instars per each plot. The population density of *C. pyri* and *A. nemoralis* were higher in OP and soft strategies than in the reduced risk strategy, but the prey/predator population ratio was similar for the three strategies. The geostatistical monitoring method could be adapted to measure the effects of different products on some target and non target species populations, also on non replicated large plots or wide areas.

*Anthocoris nemoralis, Cacopsylla pyri, Side effects, Geostatistical monitoring*

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### **Rosy apple aphid and beneficial insect dynamics: effect of the situation within the orchard**

K. Morel, H. Defrance, A. Garnier, E. Durand, M. Lecorre, S. Simon

*INRA (National Institute for Agricultural Research), UERI Gotheron, F-26320 Saint-Marcel-lès-Valence, France*

The natural control of the rosy apple aphid *Dysaphis plantaginea*, a major pest in European apple orchards, was studied from 2006 to 2008 in two organic apple orchards planted with the cultivars Ariane and Melrose. The development of *D. plantaginea* and the beneficial complex associated with aphid colonies were visually assessed in spring, and the effect of the situation

within the orchard (edge, inner and, in 2008 only, intermediate areas) was studied. Infestation of edge trees was higher. Beneficial numbers and the predator/prey ratio were also higher in edge trees in 2007, and similar in 2008. Predatory arthropods that were assessed within infested shoots mainly comprised *Syrphidae*, *Cecidomyiidae*, ladybirds and earwigs, but their proportion differed between cultivars. It also differed between areas of the orchard: *Cecidomyiidae* were assessed earlier and also prevailed in edge areas, whereas *Syrphidae* prevailed in the inner parts of the orchards. However, even the most favourable situations did not permit the natural control of *D. plantaginea*. These results suggest that the cultivar affects both *D. plantaginea* and associated predatory arthropods, and that the management of edge effects through orchard redesign and/or cultural practices deserves to be considered for the management of the rosy apple aphid in IPM orchards.

*Aphid, Dysaphis plantaginea, Predatory arthropod, Edge effect, Apple orchard*

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### **Susceptibility of codling moth populations originated from Czech Republic to *Cydia pomonella* granulovirus (CpGV)**

Stará Jitka

*Crop Research Institute, Department of Entomology, Drnovská 507, Prague 6, 161 06, Czech Republic*

Baculoviruses are very important agents of organic and integrated crop production due to their favorable ecotoxicological qualities, high selectivity and efficacy. Whereas many European countries and the USA have been using *Cydia pomonella* granulovirus (CpGV) products to control the codling moth for many years, registration of CpGV in the Czech Republic is still in progress. However, in the last five years, resistant populations of the codling moth to CpGV-M isolate were locally found in some European countries. With regard to this experience, the object of the research is to evaluate susceptibility of various codling moth populations in the Czech Republic to CpGV-M and also to propose suitable anti-resistance strategy for the Czech Republic. This year, the first monitoring of natural codling moth populations' susceptibility to CpGV-M has been evaluated by laboratory bioassays. Three natural populations (Praha Ruzyně, Bulhary and Velke Bílovice) and a reference (sensitive) population have been monitored. LC50 in the 7th and 14th day after the infection of the first larval instar was determined by probit analysis. No decreased sensitivity to the CpGV-M was demonstrated. This work was supported by the Ministry of Agriculture, the Czech Republic, project no. 0002700603.

*Codling moth, Cydia pomonella granulovirus, CpGV-M, resistance, LC50.*

## Poster Session 1 : Biodiversity

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### Indicators to assess the environmental impact of protection practices in apple orchards

Benoît Sauphanor<sup>1</sup>, Camille Picard<sup>1</sup>, Daniel Plenet<sup>1</sup>, Sylvaine Simon<sup>2</sup>

*1 INRA, UMR 1115 Plantes et Systèmes de culture Horticoles, Agroparc, F-84914 Avignon Cédex 9, France 2 INRA (National Institute for Agricultural Research), UERI Gothenon, F-26320 Saint Marcel les Valences, France*

Apple fruit production requires the application of numerous pesticides, mostly targeted against scab, codling moth and aphids. A Principal Component Analysis of the protection practices in 54 randomized apple orchards of a small production area near Avignon, in South-eastern France, involved 4 groups of growers, which were relying on the following protection strategies against *Cydia pomonella* : organic production, exclusive use of mating disruption (MD) against *C. pomonella*, exclusive use of chemical insecticides, and a fourth group with both MD and chemicals. The environmental impacts of these management strategies were assessed using two different indicators i) the environmental impact quotient (EIQ) cumulating the impacts on farmers, consumers and non human biota ii) I-PHYARBO, a fuzzy expert system focusing on the environmental impact of pesticides. The outputs of these two indicators strongly differed from each other, the highest environmental impact being attributed to the organic orchards by EIQ while according to I-PHYARBO organic farming had the safer protection program. The three other protection systems did not differ strongly from each other whatever the indicator. This range discrepancy, which is conserved when considering only the beneficial organisms, is mainly due to the structure of the models. Conversely to I-PHYARBO, EIQ assumes dose proportionality and a strict additivity of the effects of successive treatments, thus attributing high adverse effects to the organic programs that involve frequent applications of mineral fungicides. Attention has to be paid to the significance of these indicators, which may become useful tools to establish the consistency of pest-control strategies and recommendations.

*Pest management, Agri-environmental indicator, EIQ, I-PHY, Mating disruption, Organic orchard*

## Poster Session 1 : Pathology

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### Potential new storage rot problems in UK Cox apples

A.M. Berrie, B.E. Ellerker, J.D. Robinson

*East Malling Research, East Malling, Kent, ME19 6BJ, UK*

Recent surveys of rotting in Cox apples in the UK have identified new fungal rots due to *Botryosphaeria obtusa*, *Basidiomycete fungi* and *Phomopsis mali* causing losses in the orchard and in store. Only studies on *B. obtusa* are reported here. *B. obtusa* causes a brown rot of fruit in the orchard and in store a purple rot, usually at the stalk end, and with a distinct medicinal smell. The fungus can invade fruit directly or via wounds. All apple varieties tested were susceptible to *B. obtusa*, but Cox was most susceptible. The rot also occurs on pears but at a much lower incidence. Studies on *B. obtusa* invasion of wood showed that the fungus did not form cankers on trees or invade wounds, but rapidly colonised dead 1-3 year-old branches on the tree. Similarly prunings on the ground were also rapidly colonised by the fungus. Dead apple twigs in orchards are therefore the main source of inoculum. *Botryosphaeria* infected apple twigs were present in all orchards examined. *B. obtusa* was rarely found on alder or *Chamaecyparis* twigs and windbreaks do therefore not appear to be a source of the fungus for apple trees. Monitoring fungal activity on infected twigs showed that conidia were produced all year round. Studies on *B. obtusa* rot in store on Cox, Gala and Fiesta showed that rot development was very slow and secondary spread to healthy fruit unlikely to be significant. Losses in store will therefore depend on the level of fruit infection in the orchard. Changes in orchard management practices relating to pulverisation of prunings in the orchard rather than removal and burning have probably contributed to the increase in incidence of *Botryosphaeria*.

*Botryosphaeria obtusa, Phomopsis mali, Inoculum,*

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### Is it possible to predict the aerial concentrations of *Venturia inaequalis* ascospores in apple orchards?

L. Brun<sup>1</sup>, F. Didelot<sup>2</sup>, F. Combe<sup>1</sup>, G. Orain<sup>3</sup>, C. Payen<sup>4</sup>, A. Lemarquand<sup>3</sup>, L. Parisi<sup>1</sup>

*1 INRA (National Institute of Agricultural Research), UERI, Domaine de Gotheron, 26320 Saint-Marcel-lès-Valence, France; 2 INRA, UMR INRA/INH/Université Pathologie Végétale, 42 rue G. Morel, 49071 Beaucozézé Cedex, France; 3 INRA, UE Bois l'Abbé – La Rétuzière, BP 60057, 49071 Beaucozézé Cedex, France; 4 DRAF-SRPV, Antenne de Valence, 33 avenue de Romans, BP 2145, 26021 Valence Cedex, France*

Daily aerial concentrations of ascospores of *Venturia inaequalis*, the infectious agent responsible for apple scab, were observed over four years in apple orchards in the Drôme and

Maine-et-Loire departments in France. These concentrations were recorded throughout the entire primary ejection period with Burkard 7-day volumetric spore traps, placed directly on the ground at the inter-row level of the orchard. During days with particularly high ejections, i.e., greater than 5% of the total quantity of ascospores trapped for the year, concentrations of more than 400 ascospores/m<sup>3</sup> of sampled air were recorded in the two regions. Using meteorological data recorded by the weather stations located near the orchards studied, it was possible to model daily ascospore ejections with two types of decision support software used on a regular basis in France for agricultural warning systems. However, these models did not correctly estimate a significant number of large ejections for some of the years. It would therefore be unrealistic to recommend the use of these modelled values of daily ascospore ejections for pest control strategies requiring precise details about these quantities, without taking excessive risks. On the other hand, it seems possible to use these two models to determine the period (from 1 to 2 months, depending on the year) during which the aerial concentrations of ascospores are the highest.

*Apple scab, Venturia inaequalis, Ascospores, Aerial concentrations, Modelling*

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## **Efficiency of association of scab control methods on resistance durability of apple**

Valérie Caffier, F. Didelot<sup>1</sup>, L. Parisi<sup>2</sup>

*1 INRA, UMR PaVé, 42 rue Georges Morel, 49071 Beaucozéz, France 2 INRA, UERI, Domaine de Gotheron, 26320 Saint-Marcel-Les-Valence, France*

The major scab resistance gene Vf has been deployed in several commercial cultivars, and is overcome in Europe by virulent isolates of *Venturia inaequalis*. In France, Vf has been used in the north-west region, which resulted in its breakdown in 1995. Since 2002, the Vf cultivar Ariane has been planted in France on large acreages. To increase the durability of its resistance, it was recommended to destroy leaf litter in winter and to cover the highest scab risks by fungicides. These recommendations, however, had not previously been evaluated experimentally. In 2004, we initiated a project to test these recommendations. Our objective was to evaluate the efficiency of association of scab control methods to delay the breakdown of Vf. In an experimental orchard planted with Ariane, we compared scab development in 3 untreated and 3 treated plots, situated near another plot where virulent isolates were present. In untreated plots, scab increased with up to 98% of scabbed trees and 12% of scabbed fruits in 2008. In treated plots, destruction of leaf litter was performed each year, and 5 to 9 fungicides were sprayed each spring to cover medium and high risks of scab development following Mill's curves. In 2008, 4% of the trees presented a very low severity of disease, and up to now, no scabbed fruit has been observed. This study shows the efficiency of prophylactic measures and reduced fungicide spraying to complete Vf resistance and delay its breakdown. This experiment will continue next year. This work was supported by ANR (project ADD-Cedre).

*Scab, Apple, Durable resistance, Reduced spraying, Prophylaxis*

## **Control of oriental fruit moth, *Cydia molesta* Busck., by isomate ofm-rosso dispensers in peach orchards of Bulgaria.**

H. Kutinkova<sup>1</sup>, V. Dzhuvinov<sup>1</sup>, J. Samietz<sup>2</sup>, V. Veronelli<sup>3</sup>, A. Iodice<sup>3</sup>

*1 Fruit Growing Institute, Ostromila 12, 4004 Plovdiv, Bulgaria; e-mail kutinkova@abv.bg 2 Swiss Federal Research Station Agroscope Changins- Wädenswil ACW, Switzerland 3 CBC (EU)*

Peach is the major fruit produced in the southeast of Bulgaria. Its main pest is oriental fruit moth (OFM), *Cydia molesta* Busck. For a long time pest management in stone fruit production in Bulgaria has relied on organophosphate and pyrethroid insecticides. Although originally quite effective, they caused environmental problems and increasing consumer concerns. Recently, their effectiveness decreased, apparently due to the resistance developed in many pests. Hence, alternative means of control are urgently needed. The most frequently applied environment friendly methods are those related to sex pheromones. Until recently, their use has been limited mainly to monitoring, aimed at reduction of chemical treatments. Mating disruption (MD) presents a more perspective solution. From 2007 a programme to manage OFM without pesticides began. It relied on mating disruption with Isomate OFM-rosso dispensers (ShinEtsu, Japan). Trials were carried out in an isolated 10 ha peach orchard in 2007 and 2008. Pheromone trap catches were completely inhibited in the MD block, whereas, there were numerous moths in the control traps, in a conventionally treated orchard during both years. Isomate OFM rosso dispensers, installed before the first flight of OFM males, efficiently reduced fruit damage – down to 0.1-0.2% at harvest. In the control orchard, with 5-6 treatments against OFM, damage reached 5-6% before harvest. The results indicate that mating disruption for control of OFM may be effective in Bulgaria. Its use will be helpful in meeting the requirements of the EU for residues free fruit production.

*IPM, Peach, Oriental fruit moth, Mating disruption, Isomate OFM rosso, Cydia molesta*

## **An integrated approach for reducing fungicide sprays against scab in organic apple orchards**

Imre J. Holb

*University of Debrecen, Centre for Agricultural Sciences and Engineering P.O. Box 36, H-4015 Debrecen, Hungary and Plant Protection Institute, Hungarian Academy of Sciences, P. O. Box 102, H-1525 Budapest, Hungary*

The aim of this study was to evaluate scab control efficacy in integrated approaches of i) three sanitation treatments (fallen leaf removal combined with winter pruning and non-sanitized control), ii) three onsets of first fungicide sprays (dormant bud, early tight cluster and pink bud stage), and iii) three final dates for finishing fungicide programs (mid-July, mid-August and mid-September) in an organic apple orchard on two cultivars. Results on scab resistant cultivar Prima indicated that sprays against scab could be omitted before pink bud stage and after mid-July by holding the threshold of 1 % fruit scab incidence. On moderately scab susceptible cultivar Jonathan, a delay in the onset of first spray until pink bud stage resulted in

higher scab incidences on both leaves (16-21 %) and fruits (13-15 %) compared with the non-delayed spray treatments (5-8 % and 6-9 %, respectively). Final leaf and fruit scab incidence increased significantly when sprays were omitted after mid-July compared to spray treatments finished at mid-August or mid-September. A combination of leaf removal with pruning resulted in lower scab incidence (5-12 %) compared with the non-sanitized plots (7-15 %) when spray treatments were finished at mid-August or mid-September. Results on cultivar Jonathan suggested that sprays against scab could only be omitted before early tight cluster stage and after mid-August if leaf removal was combined with pruning.

*Organic production, Apple scab, Apple, Sanitation, Pruning, Spray omission, Management strategy*

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### **Searching inoculum sources of brown spot of pear**

Jürgen Köhl, Lia Groenenboom-de Haas, Helen Goossen-van de Geijn, Richard van Hoof, Pieter Kastelein, Cees Waalwijk

*Plant Research International, Droevendaalsesteeg 1, 6700 AA Wageningen, The Netherlands*

*Stemphylium vesicarium* causes brown spot disease on pear and leaf blights in asparagus and onion. Multiple fungicide applications for disease control are common in infested pear orchards. The fungus is also able to colonise plant debris saprophytically. The objectives of our study were (1) to determine the pathogenicity on pear of *S. vesicarium* isolates from different origins, (2) to develop a molecular tool for discrimination between isolates pathogenic or non-pathogenic on pear and (3) to quantify pear-pathogenic populations of *S. vesicarium*. *S. vesicarium* was isolated from infected pear fruits and necrotic leaves of pear, orchard lawn grasses, onion and asparagus. The pathogenicity of 116 *S. vesicarium* isolates was assessed on detached pear fruits and on leaves. Disease incidence was similar for isolates from fruits or leaves of pear or from necrotic orchards lawn grasses. Isolates from asparagus or onion caused no symptoms on pear. AFLP patterns of isolates showed clustering of isolates originating from pear orchards (either from diseased fruits or from orchard lawns), whereas onion and asparagus isolates clusters into separate groups. AFLP bands unique for pear-pathogenic *S. vesicarium* isolates were sequenced and a quantitative detection was developed based on one of these unique AFLP bands. The specific quantification of pear-pathogenic populations of *S. vesicarium* by TaqMan-PCR is currently used in studies on population dynamics in orchards. Results will be used for the development of efficient sanitation measures which will reduce the risks of brown spot epidemics.

*Stemphylium vesicarium, Pathogenicity, Detection*

## **The project: Monitoring of *Venturia inaequalis* virulences**

Andrea Patocchi

*Agroscope Changins-Wädenswil ACW, Schloss, P.O. Box 185, 8820 Wädenswil, Switzerland,*

Since the breakdown of the Vf gene in the central-north part of Europe breeders are looking for new resistance sources to introduce in their breeding programs. Alternative major genes to Vf are available (e.g. Va, Vb, Vbj, Vm, Vr Vh2, Vh4, Vd, Vg, Vr2), but, with few exceptions (e.g. Vm, Vh4), they are not exploited as source of resistance. For nearly all these R-genes molecular markers suitable for marker assisted selection (MAS) are available. One of the strategies that can be used to develop apple cultivars with durable apple scab resistance is the pyramiding of major genes. But which genes are the best suited to produce such new cultivars? The most interesting genes are surely those which have not been overcome. However, also overcome genes, but with a limited spread of the virulence, may be used in breeding. To know if an R-gene is overcome and the dimension of the spread of the virulence is difficult and time consuming. Moreover most of the time the reports found are not up-dated, the correctness of the data are difficult to verify and to compare. To solve these problems the monitoring project has been proposed. The project foresees: 1) the establishment of a large network of orchards of selected differential hosts; 2) the yearly scoring of apple scab incidence by the partners participating to the network; 3) the submission of the data to the curator of the project; and 4) the regular publication of the collected data through the homepage of the project. Persons interested in participating to the network are invited to contact the curator of this project.

*Apple scab, Apple breeding, Marker assisted selection, Pyramiding of major genes*

## **Late winter climatic conditions influence ascospore production and release in *Venturia inaequalis*.**

Vincent Phillion<sup>1</sup>, Arne Stensvand<sup>2</sup>, Håvard Eikemo<sup>2</sup>, David M. Gadoury<sup>3</sup>

*1 Laboratoire de production fruitière intégrée de l'IRDA, Mont-Saint-Bruno, Québec ; 2 Bioforsk Norwegian Inst of Agric & Env Res, Aas 1432, Norway*

Most fungicide applications targeting apple scab aim to control primary infections caused by ascospores and spraying is thereby linked to ascospore availability. We investigated the effect of pre bud break climatic conditions on seasonal patterns of ascospore release. Apple leaves bearing pseudothecia of *Venturia inaequalis* were overwintered at orchard sites in 8 countries for up to 3 years. Leaf samples were collected 2 to 5 weeks before bud break and again at bud break, air dried, and sent via airmail to Norway. The samples were stored at -18 °C upon arrival until tested. Disks cut from each replicate leaf sample were incubated moist at 20 °C to allow ascospore maturation but prevent discharge. Matured ascospores were induced to discharge twice a week and enumerated until the supply was exhausted. The proportion of ascospores ejected was fitted against degree-day accumulation using logistic regression. The regression intercept (onset maturation), slope (maturation rate), as well as the absolute

number of spores counted differed significantly ( $P < 0.001$ ,  $P = 0.05$ ,  $P < 0.001$  respectively) among sites and sampling dates. There was a significant interaction between site and sampling date, indicating that climatic conditions prior to bud break differentially impacted the subsequent ascospore availability. Observed differences could perhaps be used to further refine previously described models of ascospore maturity.

*Apple scab, Maturation model, Spray timing*

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## **Efficacy of fungicides mixtures to avoid apple scab fungus resistance in integrated apple orchards**

Regina Rancane, Maija Eihe

*Latvian Plant Protection Research Centre, Lielvārdes iela 36/38, Riga, Latvia*

IOBC guidelines for integrated fruit production prescribe use of forecasting systems in direct plant protection. In Latvia, LPPRC, model RIMpro for apple scab *Venturia inaequalis* control was tested from 2003. Following to FRAC guidelines to reduce the risk of fungus resistance developing, from 2007 efficacy of fungicides mixtures (Chorus, a.i. cyprodinil + Dithane NT, a.i. mancozeb; Effector, a.i. dithianon + Candit, a.i. kresoxim-methyl) and alternately curative or strobilurine – protective fungicides use was tested. In all cases the first protective application before scab ascospores discharge was carried out with Cu product Champion 50. In case of emergency Effector was used during the secondary scab infection period. Fungicides registered in Latvia for apple scab control were effective with a mixture of protective/curative or strobilurine products being alternately used, the exception being the strobilurine Candit (Qo inhibitor) which was used separately, until fungal resistance appeared in the 3rd season of Candit use. The efficacy of Candit/Effector mixture was on a level with other treatments and that of the curative product Chorus wasn't lost after 6 seasons of use when applied no more than 3 times per season. Nevertheless, further strategy of resistance preclusion has to be considered and what request minimal at-risk products to use separately. In all cases fungicides applications, even Chorus/Dithane mixture, were more effective if used before infection and as weather forecasting was not always the number of necessary applications had to increase. Under Latvia conditions frequently there are three severe scab infection periods during the total primary infection period, subsequently 3 or 4 fungicides applications being necessary in addition to the first Champion treatment.

*Apple scab, Resistance, Fungicides mixtures, Alternately use*

### Use of the A-scab model for rational control of apple scab.

Simona Giosuè<sup>1</sup>, Riccardo Bugiani<sup>2</sup>, Tito Caffi<sup>3</sup>, Gian Franco Pradolesi<sup>4</sup>, Massimiliano Melandri<sup>4</sup>, Tullio Bevilacqua<sup>5</sup>, Vittorio Rossi<sup>3</sup>

*1 Horta Srl, Spin off company of Università Cattolica del Sacro Cuore, Via E. Parmense 84, 29100 Piacenza, Italy; 2 Servizio Fitosanitario, Regione Emilia-Romagna, Via di Saliceto 81, 40128 Bologna, Italy; 3 Istituto di Entomologia e Patologia vegetale, Università Cattolica del Sacro Cuore, Via E. Parmense 84, 29100 Piacenza, Italy; 4 Agronomica R&S, Terremerse Soc. Coop., P.O. Box 69, 48012 Bagnacavallo, Ravenna, Italy; 5 CAACAF-UIMEC, Via Costa 87, 40062 Molinella, Bologna, Italy*

A-scab is a dynamic model for *Venturia inaequalis* primary infections. It simulates ascospore maturation, ejection, deposition and infection during the season based on hourly data of air temperature, rainfall, relative humidity and wetness duration. A-scab produces a risk index for each infection period and predicts the time of disease onset. The ability of the model to predict infection events has been validated under different epidemiological conditions (years x locations). Since the model produced accurate and robust predictions, a 3-year (2006 to 2008) experiment was carried out in order to determine the possibility of using A-scab for scheduling fungicide sprays. Trials were performed in northern Italy (at Ravenna and Bologna) by comparing: i) untreated control, ii) farming practice, iii) A-scab recommendations. Disease incidence and severity were assessed on both leaves and fruits. Data were subjected to ANOVA and averages were compared using Tukey's test (P=0.05). The disease on both leaves and fruits in the plots sprayed according to A-scab predictions did not change significantly relative to the farm practice. The use of A-scab led to a general reduction in the number of fungicide applications. For instance, at Bologna 2007 the weather conditions were not favourable for scab, and the disease did not develop: the model suggested one spray while the farmer sprayed eight times. At Bologna 2008, 58% of fruits were affected on the untreated control: ten fungicide applications were made according to the farm practice (which resulted in 1% of affected fruits), and five following A-scab (with 2% of scabbed fruits).

*Disease modelling, Venturia inaequalis, Field trials, Apple scab control, Fungicide reduction*

### Monitoring of *Venturia inaequalis* strains sensitive to strobilurin fungicides and occurrence of apple scab on resistant cultivars in the Czech Republic

R. Vavra, J. Kloutvorova, S. Bocek, A. Svoboda

*RBIP Holovousy, Czech Republic*

The occurrence of apple scab (*Venturia inaequalis*) on resistant cultivars was investigated in the Czech Republic. However symptoms were never observed up to the year 2006. Apple scab is currently recorded in six isolated plantings of resistant cultivars in the territory of the Czech Republic. Apple scab was founded only on Vf resistant cultivars (Rubinola, Topaz, Rajka, Otava, Melodie etc.) in all cases indicating that those isolates can be classified as race 6 or 7. Monosporic isolates of *V. inaequalis* were prepared for next testing using plant

indicators and distinction using PCR methods. At the same time, sensitivity of *V. inaequalis* strains to strobilurine fungicides was tested in orchards, where chemical control against apple scab was ineffective. Leaf samples were collected from 22 commercial orchards and one sample was taken in nature from solitary standing apple tree. The germination of spores in fungicide solutions was assessed. A decreasing in sensitivity of *V. inaequalis* to strobilurine was observed in several localities.

*VF gene, Apple scab, Races, Strains, Venturia inaequalis, Sensitivity, Strobilurin*

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### **Apple Proliferation phytoplasma in South Tyrol – an Integrated Approach**

Markus Prantl<sup>1</sup>, Robert Wiedmer<sup>1</sup>, Josef Österreicher<sup>1</sup>, Michael Unterthurner<sup>1</sup>

*1 South Tyrolean Extension Service for Fruit and Wine Growing, I 39011 Lana, A. Hoferstraße 9/1, Italy; info@beratungsring.org*

In 2000 and 2001 a severe occurrence of apple proliferation phytoplasma was noticed for the first time in apple orchards in South Tyrol (Italy). Simultaneously, in 2000 an increased occurrence of *Cacopsylla melanoneura* and in 2004 for the first time also a second vector, *Cacopsylla picta*, were detected in the orchards. The rather heavy economic losses caused by these attacks in some cases induced all appropriate institutions to look for solutions together with the producers. The phytoplasma had to be controlled in compliance with the principles of integrated fruit production. The complete elimination of all infected trees including the roots and chemical control of the two vectors proved successful and resulted in a considerable reduction in infections in the past two years.

*Apple Proliferation, Cacopsylla melanoneura, Cacopsylla picta*

## Poster Session 1 : Pesticides and resistance

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### **Development and validation of a rapid method testing of CpGV susceptibility in codling moth populations**

Johannes A. Jehle, Stefanie Schulze

*Biotechnological Crop Protection, Department of Phytopathology and Plant Protection, Agricultural Service Center Palatinate (DLR Rheinpfalz), Breitenweg 71, 67435 Neustadt a. d. Weinstrasse*

In the last five years the phenomenon of emerging resistances of codling moth (*Cydia pomonella*) against *Cydia pomonella* granulovirus (CpGV) has been observed in about 30 orchards in different European countries. So far, bioassays with the F1 generation of the diapausing CM larvae have been used for testing CpGV susceptibility. This is labour-intensive and time consuming; results are only available about 9 months after collection of larvae. Therefore, we were seeking for an alternative method by performing a direct test on the younger instars during the season. We developed and validated a more rapid test by optimizing the virus concentration in the bioassay, duration of bioassay and improvement of diet in order to be able to directly test the susceptibility on second to fourth instar larvae extracted from apples. By testing more than 3700 larvae extracted from 12000 infested apples from 20 orchards in Germany, Switzerland, The Netherlands, Austria and Italy we could prove that direct testing is feasible and provide results within 3 weeks after sampling. This new method allows us to make precise predictions about the status quo in resistance of an examined population, even if the orchard was treated with CpGV products, pheromones or chemical insecticides, which, as a matter of course, complicates the identification and determination of a potential resistance.

*Codling moth, Cydia pomonella Granulovirus, CpGV, Resistance testing*

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### **Effect of a rape seed oil based growth enhancer on mites and natural mite enemies in apple**

Tuomo Tuovinen

*Plant Production Research, MTT Agrifood Research Finland, 31600 Jokioinen, Finland*

The importance of mite pests is increasing in Finnish apple production i.e. due to lack of efficient pesticides, introduction of new cultivars and effect of climate change. Integrated pest management has been successful to allow natural control of mites by indigenous OP-resistant phytoseiid mites but banning of OP-insecticides may cause increasing problems. Plant derived substances have been successful to restrain spider mite populations in greenhouses. Tests with a growth enhancer ‘Carbon Kick Booster’® containing rape seed oil, emulsifiers and

triacontanol were conducted in the laboratory and field to evaluate its effect on apple rust mite (*Aculus schlechtendali*) and fruit tree red spider mite (*Panonychus ulmi*). In the laboratory a 1-2 % solution killed the majority of the pest mites in 3-4 days, whereas in field tests the results were inconsistent but comparable to sulphur treatments. Mites of the families Tarsonemidae, Tydeidae and Winterschmidtidae were also affected whereas in field tests phytoseiid mites survived the enhancer sprayings better than the sulphur sprayings. Natural enemies limited both red spider mite and eriophyid mite population increase in unsprayed trees.

*Eriophyidae, Tetranychidae, Phytoseiidae, Apple rust mite, Fruit tree red spider mite, Aculus schlechtendali, Panonychus ulmi, Euseius finlandicus*

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### **Biological efficacy of botanical insecticides in the control of green apple aphid (*Aphis pomi* De Geer)**

Slobodan Milenkovic<sup>1</sup>, Snežana Tanaskovic<sup>2</sup>

*1*Megatrend University, Belgrade, Faculty of Biofarming, Balka Topola, Maršala Tita 39; *2*Faculty of Agronomy, Cara Dušana 34

The effect of application of botanical insecticides pyrethrin (Pyros®), rotenone (Rotenone®) and pyrethrin + rotenone (ShowTop) was monitored in two apple plantings planted with cvs Granny Smith and Kožara. The trial was set up in accordance with the EPPO PP1/21(2) protocol. The insecticides were applied in five rows each. Four leaves of each tree were designated as samples for monitoring of the population pressure of *Aphis pomi* De Geer. The insecticides were applied on June 6th, 2008, around 7 pm by a spray drift. The temperature was 23°C, relative air humidity 63%. The pest population pressure was checked immediately before the treatment as well as on the 1st, 2nd, 3rd and 7th days after the treatment (day after treatment- abbr. DAT). The obtained results of biological efficacy of the stated insecticides have inferred highest efficacy of Pyros® (83.2%) on 1 DAT, ShowTop displayed somewhat lower efficacy (82.8%), whereas Rotenone® was the least efficient (67.1%). The application of Rotenone® showed its highest efficacy on 2 DAT (72.1%) whereupon subsequent inspection showed decrease in the efficacy (67.3% and 44.7%). As for Pyros®, further inspection on 2 and 3 DAT registered a fall in the efficacy to 72 – 73%, whereas on DAT 7 it was lowered to 55.7%. The inspection on 2 DAT reported highest efficacy of ShowTop (84%) and further fall to 76.4% and 69.5% on 3 DAT and 7 DAT respectively.

*Apple, pests, Aphis pomi, Botanical insecticides*

**Evolution of apple surface metabolites throughout the season and codling moth (*Cydia pomonella* L.) egg-laying behaviour.**

Nadia Lombarkia

*INRA Unité de Phytopharmacie et Médiateurs Chimiques. Route de Saint-Cyr 78026 Versailles Cedex France, e-mail: nlombarkia@yahoo.fr, derridj@versailles.inra.fr. fax: + (33) 01.30.83.31.19*

*Cydia pomonella* behaviour is related to plant surface metabolites. Among them soluble carbohydrates (glucose, fructose and sucrose) and sugar alcohols (sorbitol, quebrachitol and myo-inositol) influence plant site acceptance and stimulate egg-laying. It is generally observed in orchards that throughout the season the females shift their egg-laying site whenever a majority of eggs remaining on the leaf surface. On the variety Granny Smith they first lay eggs in majority on the twigs and upper side of corymb leaves and then progressively they lay more eggs on the lower side of corymb leaves and fruits. Our aim is to study the relationship between the chemicals throughout the season and the behaviour shifts. For both varieties Golden Delicious and Granny Smith, we considered different plant organs: twigs, leaves, leaf sides, fruit at several growth stages. Within the six metabolite pattern the concentrations and ratios (ng/cm<sup>2</sup>) of metabolites vary with the plant organ, leaf side and the season period. Although quantities are different between the varieties, differences remain according to the sites and are rather similar: the upper side of corymb leaves is the richest site throughout the periods. On the twigs, fructose, sorbitol and mannitol increase throughout the periods but quebrachitol decreases dramatically. Apple surface enriches in sorbitol and grow poorer in fructose. On the base of our knowledge on the influence of metabolite blend on egg-laying behaviour we verified a good correlation between them in orchards throughout the season. This study could open new ways of apple tree protection based on the recognition of the host by the insect.

*Surface metabolites, Sugars, Sugar alcohols, Cydia pomonella, Egg-laying*

## Poster Session 1 : Population Modelling

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### **Evaluation of integrated management scenarios of the peach tree - *Myzus persicae* system using a crop-pest model.**

Isabelle Grechi<sup>1</sup>, Benoît Sauphanor<sup>1</sup>, Nadine Hilgert<sup>2</sup>, Michel Génard<sup>1</sup>, Rachid Senoussi<sup>3</sup>, Marie-Hélène Sauge<sup>1</sup>, Arnaud Chapelet<sup>4</sup>, Jean-Philippe Lacroze<sup>1</sup>, Françoise Lescourret<sup>1</sup>

*Institut National de la Recherche Agronomique, 1Plantes et systèmes de culture*

Integrated Fruit Production (IFP) calls for an adaptation of production processes to improve crop quality and environmental safety. It includes reducing the use of pesticides by increasingly relying on alternative methods of pest control. This study aims at investigating the potential, with respect to IFP objectives, of management strategies integrating chemical, biological (inondative release of *Harmonia axyridis*) and cultural (nitrogen fertilization and winter pruning) pest control methods, for the peach potato -aphid (*Myzus persicae*) system. A modeling approach was used to address this question. Based on existing models, we developed a global model that considers the peach-aphid interactions and the effects of the chosen practices on the whole system behavior. Then, we defined (i) management scenarios that were based on four theoretical pest control strategies (no treatment, conventional, organic farming, integrated) and characterized by control variables, and (ii) variables referring to agronomical, economical, environmental and sustainability performances of the system. Finally, we performed model simulations of these management scenarios, and studied the relationships between system performances and control variables, mainly by using principal component analysis with instrumental variables (PCAIV). The model predicts only a weak effect of aphid infestation on peach growth and fruit production. When no chemical treatment was applied, cultural practices influenced pest numbers. Finally, results indicated that agronomical performances were largely controlled by agronomical practices, while 'pest performances' were largely controlled by pest control practices.

*Biological control, Harmonia axyridis, Cultural control, Winter pruning, Nitrogen fertilisation, Green peach aphid, Population dynamics, Foliage growth, Fruit quality*

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### **Modelling codling moth damage as a function of adult monitoring and crop protection**

Benoit Ricci<sup>1</sup>, Olivier Martin<sup>2</sup>, Pierre Franck<sup>1</sup>, Jean-François Toubon<sup>1</sup>, Rachid Senoussi<sup>2</sup>, Claire Lavigne<sup>1</sup>

*1 Plantes et Systèmes de culture Horticoles, INRA, Site Agroparc Cedex 9, 84914 Avignon, France 2 Biostatistique et Processus Spatiaux, INRA, Site Agroparc Cedex 9, 84914 Avignon, France*

The codling moth (*Cydia pomonella*) is the major insect pest in European pomefruit orchards where it is responsible for most insecticide treatments. Damage is caused by young larvae that burrow into fruits. In a context of reduction in pesticide use, we aim at a better understanding of the factors that affect damage intensity in orchards. We modelled the link between the proportion of damaged fruits in an orchard at the end of the codling moth first flight and both constant covariables (plant species in the orchard [pear or apple], the use or not of mating disruption and if the orchard is organic or not) and time-varying covariables (weekly counts of adult moths in the orchard and the insecticide treatment calendar). This model combines survival analysis methods and generalized linear mixed techniques. Corresponding observations were collected in 2006 and in 2007 from 40 orchards in south-eastern France. By using model selection procedures and parameter estimations, we found that damage intensity increased with the number of adults codling moths trapped and that, everything else being equal, it was higher in apple than pear orchards. An analysis of the random orchard effect further indicated (i) a certain temporal stability in the risk probability of orchards and (ii) that risk probability was lower in orchards surrounded by numerous pomefruit orchards and windbreak hedgerows. The framework developed here could be used for investigating general questions that involve the counting of specific time events at fixed dates and the simultaneous observation of some constant and time-varying covariables.

*Codling moth, Damage, Trap, Mixed model, Survival analysis*

## Poster Session 1 : Semiochemicals

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### **A comparative study on auto-confusion by Exosex2 Gvm-Lb and mating disruption by Isonet-L against European Grapevine Moth, *Lobesia botrana* Den.-Schiff. (Lep.: Tortricidae) in Turkey**

F.O. Altindisli<sup>1</sup>, F. Ozsemerci<sup>1</sup>, Pervin H?ncal<sup>2</sup>, Asiye Derin<sup>2</sup>, Ibrahim Ç?narl?<sup>2</sup>, Garry Pease<sup>3</sup>, Tony Ray<sup>3</sup>

*1 Plant Protection Research Institute, Genclik Caddesi No:6, 35040 Bornova, Izmir, Turkey, 2 Elit Tarimsal Muhendislik, Besicilik, Sanayi ve Tic. Ltd. Sti. Tibas Vakif Han, No.19/114, Konak Izmir, Turkey, 3 Exosect Limited, Leylands Business Park Colden Common Winchester SO21 1TH United Kingdom*

In this study, the auto-confusion (AC) technique was applied in vineyards at two different locations against European grapevine moth, *Lobesia botrana* Den.-Schiff. by Exosex2 dispensers each containing 10 mg pheromone. Total application area was 16.9 ha and 26 ha in 2007 and 2008 in Manisa and 12 ha in Çanakkale in both of two years. Isonet L dispensers registered in Turkey, each containing 172 mg pheromone were compared in Manisa. At the beginning of the flight period, 180 Exosex2 dispensers/ha and 600 Isonet L dispensers/ha were installed. Exosex installation was repeated at sixty day intervals. Additionally, chemically treated vineyards were used to compare infestation levels both in Manisa and Canakkale. Pheromone traps were used to monitor adults and check the efficacy of the technique. Release rates of two different dispensers were determined. At the end of the 1st installation, Exosex2 dispensers were analysed by the GC method. In 2007, 10 ha-AC vineyards were sprayed against *L. botrana* once, whereas 4.9 ha were treated two times because the infestation rate was higher than the threshold of 5% in Manisa. The infestation rates were lower than 5% in the entire AC area (8.6 ha) during harvest. It can be assumed that Exosex2 dispensers reduced the number of insecticide applications from 5 to 1-2 in Manisa, when compared to chemically treated vineyards. In Canakkale, the average infestation rate was 2.2% in the Exosex2 treated vineyard in 2007 and chemical application was not required. The assessment has been continuing in both of two locations in 2008.

*Lobesia botrana, Auto confusion, Mating disruption, Grape, Aegean Region, Turkey*

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### **Identification of the female sex pheromone of the pear midge, *Contarinia pyrivora***

Lakmali Amarawardana<sup>1</sup>, David Hall<sup>1</sup>, Jerry Cross<sup>2</sup>, Michelle Fountain<sup>2</sup>, Gunnhild Jåstad<sup>2</sup>

*1 Natural Resources Institute, University of Greenwich, Chatham Maritime, Kent, ME4 4TB, U.K 2 East Malling Research, New Road, East Malling Kent ME19 6BJ UK*

Pear midge, *Contarinia pyrivora* (Riley) is a pest of pear fruitlets. Larval feeding causes abnormal swelling of fruitlets, and damaged fruitlets blacken and die. *C. pyrivora* is normally controlled by application of insecticide either at the beginning of the pupal emergence stage or at the green bud stage of pear blossoms. Therefore the timing of the insecticide application is crucial and if the pest is not carefully monitored, the spraying of insecticide becomes ineffective. This study was carried out to identify the female sex pheromone of *C. pyrivora* to provide a basis for development of improved monitoring and control strategies. Mature larvae emerging from damaged fruitlets were collected individually in plastic tubes. Volatiles were collected from newly-emerged males and females separately and volatile collections were analysed for the presence of pheromone components using gas chromatography (GC) linked to electroantennographic (EAG) recording and GC coupled to mass spectrometry (MS). GC-EAG analysis of volatile collections from females on male EAG preparations elicited two responses from males on polar and non-polar GC columns. The compounds responsible were identified as 7-acetoxyundecane-2-one and 2,7-diacetoxyundecane from their mass spectra and comparison of their GC retention times with those of synthetic standards. The two compounds were synthesised and the stereoisomers of both components were separated by high performance liquid chromatography (HPLC) on a chiral phase. The racemates of the two compounds and their separate stereoisomers were tested in traps in the field. Significant numbers of *C. pyrivora* males were caught by some of the lures, but results were complicated by the attraction of another midge species of similar appearance by some of the lures. A second field test is planned for 2009.

*Contarinia pyrivora*, Pear midge, Pheromones, Electroantennography, Chiral HPLC

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### **Raspberry beetle *Byturus tomentosus*: flight monitoring with semiochemical traps**

Catherine A. Baroffio

*Agroscope Changins-Wädenswil ACW, Centre de Recherche Conthey, 1964 Conthey, Switzerland*

The raspberry beetle, *Byturus tomentosus* is a major pest of Swiss raspberries. In 2008, in the frame of an international cooperation with UK, Norway and France the flight of the raspberry beetle has been monitored for the first time in the Swiss Alps with the semiochemical trap (floral attractant) developed in Scotland by SCRI. Early results show an irregular attractiveness of the trap. The traps were installed before flowering at the beginning of June and were immediately attractive for 2 weeks. Then the catch decreased until the end of July. A second important flight was observed at the end of July and at the beginning of August. Fruit analysis showed that at the end of August 14% of the fruits were damaged. Neighbouring woods with wild *Rubus* sp. near the plot could explain the high beetle populations recorded. This monitoring will continue for three years.

*Soft fruits, Raspberry, Monitoring, Byturus tomentosus*

### **Control of the Plum Fruit Moth, *Cydia funebrana* (Treitsch.) (Lepidoptera, Tortricidae), by false-trail following**

Paola Riolo<sup>1</sup>, Roberto Bruni<sup>2</sup>, Cappella Luigi<sup>1</sup>, Rama Franco<sup>3</sup>, Nunzio Isidoro<sup>1</sup>

*1* Dipartimento di Scienze Ambientali e Produzioni Vegetali, Università Politecnica delle Marche, Via Brecce Bianche, 60131 Ancona, Italy. *2* Istituto Tecnico Agrario "Celso Ulpiani," Viale della Repubblica 30, 63100 Ascoli Piceno, Italy. *3* Isagro Ricerca s.r.l., Via Fauser 4, 28100 Novara, Italy. MAIL: p.riolo@univpm.it

*Cydia funebrana* (plum fruit moth) is a serious pest in many plum orchards in Italy. Control of the plum fruit moth using the false-trail following technique or 'sexual disorientation' was evaluated in two commercial plum orchards for baby-food production, based on a zero pesticide residue management system. The effectiveness of the false-trail following technique was demonstrated through experimental trials over two seasons (2005-2006) in two orchards (of the cultivar Stanley ) located in the Ascoli Piceno Province of the Marche Region (central-eastern Italy). Each experimental orchard was of about 1 hectare. Specific, biodegradable, pheromone dispensers, known as Ecodian CF<sup>TM</sup>, were used for each application, with about 2,000/ha. During 2005, three dispenser applications were carried out (23-25 March, 16 May, 8-15 July), with two in 2006 (20-24 April, 27 June). The evaluation of this technique was carried out by monitoring adult males by specific synthetic sex pheromone traps and visual inspections for fruit damage. *Anarsia lineatella* (peach twig borer), secondary pest in plum orchards, was also monitored by pheromone traps in the experimental orchards. The efficacy of Ecodian CF<sup>TM</sup> dispensers was compared with that achieved in commercial plum orchards sprayed with chemical insecticides (ca. 0.80 ha) or managed with mating disruption technique (ca. 1.50 ha). Over the two seasons, the control of the plum fruit moth in the experimental orchards was as good as or better than that in the control plots.

*Cydia funebrana*, Plum fruit, Sex pheromone, False-trail following

### **Eight years of practical experience with mating disruption to control grape berry moth, *Lobesia botrana*, in Porto Wine Region**

Cristina Carlos<sup>1</sup>, Fernando Alves<sup>1</sup>, Laura Torres<sup>2</sup>

*1* Associação para o Desenvolvimento da Viticultura Duriense. Qta de Sta Maria • Godim • P.O. Box 137 • 5050-106 Peso da Régua. Portugal. (cristina.carlos@advid.pt); *2* CITAB – Centre for the Resea

Since 2000 the mating disruption technique has been applied to control the grape berry moth, *Lobesia botrana* (Den. and Schiff.) (Tortricidae) in Porto Wine Region. In most of the trials, ISONET-L dispensers have been used, in plots whose surface area ranged from 3 to 25 ha. The results obtained demonstrated that moth captures in pheromone-baited traps were significantly reduced in the treated plots compared to the untreated ones. The average percentage of male disorientation for the 8-year experimental period ranged from 70.4 to 100%, being 100% in 49.4% of the 87 sampling periods studied. However, the technique did not successfully reduce larval infestation below the tolerance threshold, mainly in the case of the third generation, and insecticides had to be applied. Some constraints to the technique

have been identified, such as the high biotic potential of the species, the high summer temperatures and the local orography (height and steepness). However, the effectiveness of mating disruption in other European countries along with the need for environmentally safe management strategies for this key pest, are stimulating its use. In this paper results from the several years of use of mating disruption are critically discussed and weak spots are analyzed, as a basis for identifying the real possibilities of the technique in Porto Wine Region.

*Lobesia botrana, Viticulture, Mating disruption, Constrains*

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## **Use of sprayable pheromone formulations in Europe**

Enzo Casagrande

*AgriSense BCS, United Kingdom*

Sprayable formulations of pheromones for the mating disruption control of different moth species offers an innovative alternative to the use of the current dispenser based technologies. While still ensuring the same efficacy as the dispenser systems, the sprayables offer greater flexibility and ease of use. Applied using standard spray equipment, the sprayables can be combined with other treatments. This paper will review the technology, efficacy and use strategies of the Checkmate sprayable technology in Europe.

*Pheromone, Checkmate Flow, Mating disruption, AgriSense, Suterra*

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## **Cells responding to pheromone components and plant volatiles could affect semiochemical based control strategies of insect pests in agricultural ecosystems**

Antonio De Cristofaro<sup>1</sup>, Gianfranco Anfora<sup>2</sup>, Giacinto Salvatore Germinara<sup>1</sup>, Claudio Ioriatti<sup>2</sup>, Valerio Mazzoni<sup>2</sup>, Giuseppe Rotundo<sup>1</sup>

*1 Dept. of Animal, Plant and Environmental Sciences, University of Molise, Via De Sanctis, I-86100 Campobasso, Italy; 2 Plant Protection Department, IASMA Research Centre, Via E. Mach 1, I-38010 S. Michele a/A (TN), Italy*

Electrophysiological and behavioural responses by several insect pests have been recently recorded in order to identify plant volatile compounds, and particularly kairomones, involved in the host-finding process and oviposition site selection. Such compounds have been addressed as candidates to be used in semiochemical based control strategies since they are potentially able either to enhance the sex pheromone activity or to monitor female emergence or to interfere on their behaviour. During similar studies, olfactory cells sensitive both to pheromone components and plant volatiles in *Cydia pomonella* antennae were described. In the present paper we analysed single cell recordings (SCR, surface contact technique) from olfactory neurons of different tortricid moths (*C. pomonella*, *C. splendana*, *C. fagiglandana*, *Pammene fasciana*, *Lobesia botrana*) stimulated by the two categories of compounds. Cellular types varying from the specific (relatively to the tested compounds) to the highly

generalist ones were identified. The finding of these cells partly supports the observations reported by various authors about the ability of plant compounds to modulate the biological activity of a pheromone component. It seems not inappropriate to hypothesize that these “peripheral interferences” in odour perception could culminate in changeable behavioural responses that should also be of practical importance when pheromone based control strategies are applied in different agricultural environments, where they frequently show a variable efficiency.

*Kairomones, Olfactory neurons, SCR, Fruit crops, IPM*

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### **Integrating pear ester into direct management programs for codling moth**

Alan Knight

*Agricultural Research Service, United States Department of Agriculture, Wapato, WA, USA*

Pear ester has proven to be a useful tool that has improved both monitoring and management of codling moth in pome fruits. Recent studies have explored the use of pear ester in combination with sex pheromone for improved mating disruption using both hand-applied and sprayable formulations and in combination with insecticides to improve larval control. Results from studies conducted during 2008 that combined pear ester with both sex pheromone and seasonal applications of insecticides to optimize the use of all three tactics will be presented. The potential and difficulties encountered in optimizing the use of pear ester during the growing season will be discussed.

*Pear, Codling Moth, Ester, Pome fruits, Mating Disruption*

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### **Control of oriental fruit moth, *Cydia molesta* Busck., by Isomate OFM-Rosso dispensers in peach orchards of Bulgaria – preliminary results**

Hristina Kutinkova<sup>1</sup>, Vasiliy Dzhuvinov<sup>1</sup>, Jörg Samietz<sup>2</sup>; Vittorio Veronelli<sup>3</sup>, Andrea Iodice<sup>3</sup>

*1 Fruit Growing Institute, Ostromila 12, 4004 Plovdiv, Bulgaria 2 Swiss Federal Research Station Agroscope Changins- Wädenswil ACW, Switzerland 3 CBC(EUROPE) Ltd. Via E. Majorana, 2, I-20054 Nova Milanese Milano, Italy*

Peach is the major fruit in the southeast of Bulgaria. Its main pest is oriental fruit moth (OFM), *Cydia molesta* Busck. For a long time pest management in stone fruit production in Bulgaria relied on organophosphate and pyrethroid insecticides. Although originally quite effective, they caused environmental problems and increasing consumer concerns. Recently their effectiveness decreased, apparently due to the resistance developed in many pests. Hence, alternative means of control are urgently needed. The most frequently applied environment friendly methods are those related to sex pheromones. Until recently, their use has been limited mainly to monitoring, aimed at reduction of chemical treatments. Mating disruption (MD) presents a more perspective solution, however. From 2007 a programme to manage OFM without pesticides started. It relied on mating disruption with Isomate OFM-

rosso dispensers (ShinEtsu, Japan). Trials were carried out in an isolated 10-ha peach orchard in 2007 and 2008. Pheromone trap catches were completely inhibited in the MD block, whereas they were numerous in a reference, conventionally treated orchard during both years. Isomate OFM rosso dispensers, installed before the first flight of OFM males, efficiently reduced fruit damage – down to 0.1-0.2% at harvest. In the reference orchard, with 5-6 treatments against OFM, damage reached 5-6% before harvest. The results indicate that mating disruption for control of oriental fruit moth may be effective in Bulgaria. Its use will be helpful in meeting the requirements of EU for residues free fruit production.

*IPM, Peach, Oriental fruit moth, Mating disruption, Isomate OFM – rosso*

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### **Using Insect behavior to facilitate precision agriculture: odor-baited trap trees for management of the plum curculio, *Conotrachelus nenuphar* (Herbst) (Coleoptera: Curculionidae)**

Tracy C. Leskey<sup>1</sup>, Starker E. Wright<sup>1</sup>, Jaime C. Piñero<sup>2</sup>, Ronald J. Prokopy<sup>3</sup>, †

*1USDA-ARS, Appalachian Fruit Research Station, 2217 Wiltshire Road, Kearneysville, WV 25430-2771 USA  
2University of Hawaii at Manoa, College of Trop Agric & Human Resources. 3050 Maile Way, Honolulu, HI 96822  
3Department of Plant, Soil, and Insect Science, The University of Massachusetts at Amherst, Amherst, 01003, †Posthumously, d. 14 May 2004*

Management programs for tree fruit have been developed based on an intensively managed perennial monoculture with standardized management practices. This design has had unforeseen consequences for pest management in that horticultural uniformity leads to a homogenous resource distribution requiring protection on a whole-orchard basis. The ecological foundation of insect behavior offers a clear opportunity to replace indiscriminate whole-orchard insecticide treatments with targeted management zones, bringing together the sustainability of IPM and behavioral control with the efficiency of precision agriculture. Behaviorally active stimuli are presented to attract and retain pests within a particular location in the orchard to allow for implementation of precise control strategies, thereby reducing insecticide inputs and increasing sustainability of the cropping system. The plum curculio, *Conotrachelus nenuphar* (Herbst), is one of the most destructive direct tree fruit pests in eastern North America. A novel approach termed the ‘odor-baited trap tree strategy’ (based on the tenets precision agriculture and insect behavior) has been developed to replace standard whole-orchard insecticide treatments. Select apple trees in the perimeter row are baited with a synergistic two-component lure to aggregate adult activity in specific perimeter row trees. Then by applying insecticides to these baited trap trees rather than the entire perimeter row or whole orchard after petal fall, substantial reductions in the amount of insecticide applied can be achieved without compromising plum curculio control. We currently are working to improve this strategy based on deploying even more powerful attractants within tree canopies to increase aggregation and reduce the number of required trap trees.

*IPM, Plum curculio, Pheromone, Trap crop, Weevil*

### **Cage test to assess the mating disruptant activity for different pheromone blends and formulations on Peach Twig Borer (*Anarsia lineatella* Zeller) in the orchards**

Fabio Molinari, Manuela Cigolini, Andrea Iodice, Vittorio Veronelli

*Università Cattolica del Sacro Cuore di Piacenza, Istituto di Entomologia e Patologia Vegetale, Piacenza, Italy.  
( )CBC Europe Ltd, Nova Milanese, Italy*

Mesh cages were used as a method for assessing the disruption of Peach Twig Borer (*Anarsia lineatella* Zeller) and Oriental Fruit Moth (*Grapholita molesta* (Busck)) mating in peach orchards where different blends of synthetic pheromones and different dispenser formulations had been applied. The trials carried out in seasons 2006-2008 showed that this method is easy to apply for evaluating the effectiveness of MD in the field and give a reliable feedback allowing fine-tuning of formulations.

*Peach Twig Borer, Anarsia lineatella, Oriental Fruit Moth, Grapholita molesta, Cage test, Pheromone, Peach*

### **Comparison of different pheromone lures to monitor the flight of *Cydia pomonella***

Denis Pasquier, Patrik Kehrlı

*Agroscope Changins-Wädenswil, Protection de végétaux-Entomologie, Route de Duillier, CP 1012, 1260 Nyon, Suisse*

The control of the codling moth, *Cydia pomonella*, relies on an accurate understanding of its biology and phenology. Pheromone trapping is an effective and timesaving technique to follow the phenology of adults and to estimate the appearance of the different larval instars. In this study we tested three different pheromone lures for monitoring the flight of *C. pomonella*. The Tripheron capsule attracted most males followed by a capsule developed at the University of Neuchâtel and the unattractive PheroNet capsule. In the future, we recommend the use of the Tripheron capsule for monitoring the flight of *C. pomonella*, in particular, in regions with low population density.

*Pomiculture, Insect monitoring, Delta traps*

### **Effectiveness of mating disruption and granulovirus against codling moths in central Bulgaria**

Penka Peeva<sup>1</sup>, Nyonka Velcheva<sup>1</sup>, Olıa Karadjova<sup>2</sup>, Vittorio Veronelli<sup>3</sup>, Denis Pasquier<sup>4</sup>, Radoslav Andreev<sup>5</sup>, Katia Radeva<sup>6</sup>

*1 Department of Biological and Integrated pest control, Plant Protection Institute, 35 Panayot Volov str., 2230 Kostinbrod, Bulgaria; 2 Department of Entomology, Plant Protection Institute, 35 Panayot Volov str., 2230*

Kostinbrod, Bulgaria; 3 CBC (EUROPE) Ltd., Milan Branch, Via E. Majorana, 2, 20054 Nova Milanese (MI), Italy; 4 Agroscope Changins-Wädenswil, CP 1012, 1260 Nyon, Switzerland; 5 Department of Plant Protection and Agricultural Ecology, 12 Mendeleev str., 4000 Plovdiv, Bulgaria; 6 Agrobiocconsult Ltd., 4 Gen. Asen Nikolov, 1336 Sofia, Bulgaria

Due to economical changes, problems of resistance and the parcelling of agricultural area, mating disruption (MD) was studied on its own or in combination with granuloviruses (CpGV) against the codling moth (CM), *Cydia pomonella* L. (Lepidoptera: Tortricidae), in the region of Plovdiv (Bulgaria). The effectiveness of MD and CpGV was tested in small orchards with high pest density. Until the 5th of July 2005, the percentage of CM-damaged fruits was at acceptable level 5.1% in the 0.5 ha apple orchard treated with Isomate C LR® dispensers. The number of trapped CM males was 11 times lower than in a conventionally treated orchard, which served as a reference. Except for *Rhynchites spp.* and *Stephanitis pyri*, fruit damage by other pests was around the economical threshold. In 2007, Isomate C plus® dispensers together with the CpGV as Madex® were applied in a 19 year old orchard of 1.3 ha. Once again, fruit damage by CM were below the economical threshold until the beginning of July. Thereafter, five treatments with chlorpyrifos-ethyl and chlorpyrifos-methyl were used to avoid higher levels of infestation. Just prior to harvest, only 1.9% of apples were found to have developed CM larvae, compared to 17.0% in the reference orchard, which was treated 11 times with conventional insecticides. The combination of MD and CpGV showed the best results in an 8-year old apple orchard. In this orchard, pre-harvest only 1.5% of apples were found to be infested with live or developed larvae or 1.5 diapausing CM larvae per tree. In the accompanying reference orchard, the density of hibernating CM larvae was 23 times higher. Overall, the development of alternative IPM strategies incorporating mating disruption and granuloviruses seems to be promising.

*Codling moth, Mating disruption, Granulovirus, Apple orchards, Bulgaria*

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## **Control of codling moth (*Cydia pomonella*) under the aspects of active mating disruption, different application systems and varieties**

B. Schildberger<sup>1</sup>, L. Wurm<sup>1</sup>, E. Vogl<sup>1</sup>, M. Kickenweiz<sup>1</sup>

Federal College and Institute for Viticulture and Pomology Klosterneuburg, Wiener Straße 74, 3400 Klosterneuburg

Email: [barbara.schildberger@hblawo.bmlfuw.gv.at](mailto:barbara.schildberger@hblawo.bmlfuw.gv.at)

Beside standard systems of mating disruption the activity of the product Exosex CM and Ecodian under the aspect of different application systems and several varieties were tested in the years 2007 and 2008 at the research station of the Federal College and Institute for Viticulture and Pomology Klosterneuburg. Standard mating disruption techniques usually rely on the introduction of amounts of pheromone emitted by natural populations of pest species into the atmosphere. Exosex CM significantly reduces deployment time and labour costs in the orchards, additionally the flexibility to fit in with IPM programmes was tested. Ecodian® dispensers were placed at a rate of 2000 dispensers/ha. The tube dispensers of pheromone (Exosex CM) were observed in a three hectare orchard which was split into three trial fields, one left untreated, one where the first generation was treated and one, in which all generations of codling moth (*Cydia pomonella*) were treated. Ecodian was tested on one hectare and with no components against codling moth (*Cydia pomonella*) treated.

The assessments were done visually on windfall fruits, fruits on the tree and on all fruits at harvest followed by statistical evaluation. In 2007, among the fruits sprayed with the IPM system there was an infestation rate of the first (*Cydia pomonella*) generation with the variety Idared of 0,8%, the second generation treated with Exosex showed an infestation of 13%. In the organic trial, however, the infestation by the first generation was about 4% and the infestation by the second generation about 31%. 2008 the results were comparable to 2007.

*mating disruption, pheromone, codling moth, IPM, varieties*

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## **Mating disruption across the peach/apple interface**

Peter Shearer, Kris Tollerup, Ann Rucker Rutgers

*University, Agricultural Research & Extension Center, Bridgeton, NJ*

Our hypothesis is that deploying mating disruption against the oriental fruit moth, *Grapholita molesta* (Busck), across adjacent peach and apple blocks provides better control than if applied to only one of the two crops. CheckMate OFM dispensers were applied in mating disrupted peach blocks and CheckMate CM/OFM Duel dispensers were used in mating disrupted apple blocks. Where used, mating disruption was in addition to insecticide programs. Results confirm that it is easier to disrupt oriental fruit moth in peach than codling moth in apple.

*Grapholita molesta, Pheromone disruption*

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## **Exploring the potential for using peripheral treatments with pheromone dispensers for controlling the grape berry moth (Lepidoptera: Tortricidae) by mating disruption**

Mitch Trimble

*Southern Crop Protection and Food Research Centre, Agriculture and Agri-Food Canada, Vineland Station, Ontario L0 2E0*

The potential for using peripheral treatments with hand-applied pheromone dispensers for controlling *Paralobesia viteana* (Clemens) by mating disruption was examined in commercial vineyards in the Niagara peninsula, Ontario, Canada during 2007. Four 1 ha (100 x 100 m) experimental plots, each separated by 100 m, were established within each of three vineyards. Twenty-five synthetic sex pheromone-baited traps were deployed in each plot on a 20 x 20 m grid to indirectly measure the effect of pheromone treatments on the mate locating ability of male moths. The application of 500 dispensers/ha reduced the mean total number of moths

trapped by 96% compared to the untreated control, indicating a high level of mating disruption. Trap catch was reduced by 87% when 80 or 160 dispensers were applied at intervals of 5 or 2.5 m, respectively, along the periphery of the 1 ha plots. The results provide impetus for additional research to determine if peripheral treatments with pheromone dispensers can be used to control *P. viteana*.

*Grape berry moth, Paralobesia viteana, Pheromone, Mating disruption*

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### **Control of codling moth, *Cydia pomonella* (L.) (Lepidoptera Tortricidae), with EcoTape pheromone dispensers**

Federica Trona<sup>1</sup>, Mario Baldessari<sup>1</sup>, Gianfranco Anfora<sup>1</sup>, Valerio Mazzoni<sup>1</sup>, Enzo Casagrande<sup>1</sup>, Claudio Ioriatti<sup>2</sup>, Gino Angeli<sup>1</sup>

*1*Plant Protection Department, FEM Research Center, via E. Mach 1, 38010 San Michele all'Adige (TN), Italy; *2* FEM-IASMA Research Centre, Plant Protection Department, via E. Mach, 1, 38010 San Michele all'Adige (TN,) Italy

A mating disruption approach using high densities of pheromone point sources has been developed for codling moth, *Cydia pomonella* (L.) (Lepidoptera Tortricidae), control. The EcoTape® device comprises a continuous adhesive tape integrated with 3-cm length dispensers at a separation of 0.6 m, loaded with 2.5 mg codlemone. Thus, in comparison with standard mating disruption, the content of dispensers is strongly reduced, whereas the density of point sources is increased (2,000 or 4,000 points/ha), with the purpose of increasing the competition between natural and syntetic sources. The release rate of new and field aged dispensers, measured directly by solid-phase micro-extraction (SPME), decreased over time but at the end of the season was still more potent than a calling codling moth female. Dispensers elicited close-range approaches in a wind tunnel irrespective of their field age. Traps lured with aged EcoTape dispensers were also able to catch a number of males in the field throughout the season comparable to that of traps loaded with reference dispensers. The results of field trials (2004-2007) showed that codling moth control can be obtained applying EcoTape dispensers. Our experiments demonstrated that EcoTape dispensers are a useful tool for efficient CM control throughout the season under the climatic conditions of the Trento Province (North Italy) and may satisfy some of the prerequisites for producing false-trail following effects.

*E8,E10-dodecadien-1-ol, Mating disruption, SPME, Wind tunnel, Field trial*

## **Abstracts - Poster Session 2**

## Poster Session 2 : Arthropod Pests

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### **Two Spotted Mite, *Tetranychus urticae* Koch, Emerged as a New Pest in Persimmon Orchards and Approaches to Their Control**

Chung Bu-Keun, Mitsuhiro Kawashima<sup>2</sup>, Chuleui Jung<sup>2</sup>

*School of Bioresource Sciences, Andong National University, Andong 760-749, Korea*

Oriental persimmon, *Diospyros kaki* Thunb., endemic to East Asia is one of the major fruit crops in Korea. We conducted a faunal survey of mites on persimmon trees in Korea from June to September 2006, focusing on herbivorous and predacious mites. Mites of Tetranychidae and Tenuipalpidae were dominantly collected as herbivores, while those of Phytoseiidae and Stigmaeidae were predominant as predators. All identified tenuipalpid mites were *Tenuipalpus zhizhilashviliae* Reck. Most of the collected tetranychid mites were found to belong to the genus *Tetranychus*. To clarify the species identity, additional collections of tetranychid mites during summer 2007 on sweet persimmon were made. The mites were identified as *Tetranychus urticae* Koch. Four phytoseiid species, *Neoseiulus womersleyi* (Schicha), *Amblyseius eharai* Amitai and Swirski, *Phytoseius (Dubininellus) rubii* Xin, Liang and Ke and *Typhlodromus (Anthoseius) vulgaris* Ehara were collected. Among them, *A. eharai* was the most dominant species. Seventeen populations of two spotted mites (TSM) were observed 3 times per month from May to October to decipher their fluctuations at the site of individual farmer's orchard from Sacheon, Sancheong, and Jinju in Gyeongsangnam-do and Gwangyang, Gurye, and Suncheon in Jeollanam-do. Among them, only 2 sites were properly managed, 5 sites were required to control but the farmers had little information on the mite and its damage, though 10 orchards were not at risk of infestation. Numbers of TSM on 100 leaves reached more than 400 at orchards from Sacheon, Okgok, and Muncheok, showing remarkably discolored leaves.

*Persimmon, Tetranychus urticae, Overwintering, Control*

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### **Observations on the relation between the induction and termination of diapause in codling moth in Dutch and Belgian populations.**

Marc Trapman<sup>1</sup>, Matty Polfliet<sup>2</sup>, Herman Helsen<sup>3</sup>

*1 Bio Fruit Advies, Dorpsstraat 31, Zoelmond, the Netherlands, 2 Fruit Consult, Zetten, the Netherlands,; 3 Applied Plant Research, Wageningen UR, Zetten, the Netherland*

Effective codling moth (CM) management requires accurate information on the phenological stage and development of the local CM population to be controlled. Several advisors and scientists in Europe explain local differences in pheromone trap catches from the hypotheses

of “recalled diapause day length”. According to this hypothesis, individuals in the population remember the day length at which their diapause was induced, and terminate their diapause the following spring at the same day length. This would mean that events that have a quantitative impact on parts of the population shape the phenological development next year. This has the practical consequence that codling moth phenology is determined at a local scale and regional warning systems cannot provide the information necessary for local control. The aim of our work was to test if this hypothesis holds for CM populations in the Netherlands and Belgium. CM collected from orchards in the Netherlands and Belgium in 2007 consisted for 98% of univoltine individuals. For these individuals we found no relation between the date we collected them as fully grown larva during summer 2007, and their date of pupation in 2008. These results mean that the hypothesis of “recalled diapause day length” does not hold for the almost completely univoltine CM populations in the Netherlands and Belgium. Therefore, the phenology of our local populations can not be influenced by events in the previous year. Temperature relations and a normal distribution can be used to describe the spring pupation of a codling moth population.

*Cydia pomonella, Diapause*

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## **Practical results of a stacked control strategy for codling moth (*Cydia pomonella* L ) management**

Marc Trapman<sup>1</sup>, Herman Helsen<sup>2</sup>, Matty Polfliet<sup>3</sup>

*1 Bio Fruit Advies, Dorpsstraat 31, Zoelmond, the Netherlands; 2 Applied Plant Research, Wageningen UR, Zetten, the Netherlands; 3 Fruit Consult, Zetten, the Netherlands*

Codling moth (CM) is an important pest in both organic and integrated apple production in the Netherlands and Belgium. Control of the pest became more difficult during the past ten years. A series of biological and chemical plant protection products (PPP's) is available for the regulation of CM, but field trials throughout Europe have shown that season long application of the same PPP provides only 50 to 70% control. Random alternation of products is not likely to improve efficacy. However, the available PPP's have different modes of action, and act at different life stages in the CM biology. When applied with respect to their individual mode of action, and scheduled according to the local biology of the CM population, the efficacy of PPP's could be stacked, yielding a technically, economically and ecologically improved control. This approach was tested in commercial apple orchards in an extension project in 2007 and 2008. The phenology of the CM populations was calculated with the RIMpro-Cydia model using weather data from on-farm weather stations. Combinations of pheromone confusion to reduce the total number of eggs deposited, fenoxycarb at 30% rate as an ovicide at the predicted peaks in egg deposition, and granulosis virus at a 50% rate in periods of predicted peaks in egg-hatching were used on the farms following the Stacked Control Strategy. Randomly chosen orchards in the same geographic region that did not take part in the extension project served as control group. In both years CM control in the Stacked Control Strategy orchards was more effective, and had a lower insecticide input and a lower environmental impact compared to the control group.

*Codling moth, Cydia pomonella, Control strategy, RIMpro-Cydia*

## Poster Session 2 : Biocontrol Agents

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### **Predatory capacity and biological aspects of *Chrysoperla externa* (Hagen, 1861) (Neuroptera: Chrysopidae) fed on *Planococcus citri* (Risso, 1813) (Hemiptera: Pseudococcidae).**

César Carvalho

*Universidade Federal de Lavras, Departamento de Entomologia, 37200-000 Lavras, Brazil*

In the mealybug complex which occurs on citrus, *Planococcus citri* is one of the most important species and its control is done by application of insecticides. Considering that the green lacewing *Chrysoperla externa* is an insect found often in citrus orchards and it is a natural predator of *P. citri*, an investigation was undertaken to study the predatory capacity and some biological aspects of larvae of *C. externa* fed on nymphs in the three instars and on adult female of *P. citri*. The experiments were conducted at  $25 \pm 1$  °C,  $70 \pm 10\%$  of RH and 12-hour photophase in a completely randomized design with four treatments represented by the developmental stages of the pest and with 30 replicates. It was found that the total predatory capacity of lacewing larvae was 231.2; 77.8; 32.6 and 21.5 nymphs of the three instars and adult females, respectively. The duration of the second and third instars of green lacewing was lengthened when the larvae consumed adult female mealybugs. The duration of the pupal stage was longer for those developing from larvae fed nymphs of second and third instar and adult female mealybugs. The duration of the immature stage ranged from 19.8 to 22.9 days, and the survival for this period ranged from 78.0 to 91.0%. Independently of the lacewing's instar, a trend in reduction of the number of consumed mealybugs in each stage was found. However, both nymphs and adult female mealybugs were adequate prey for larval development of *C. externa*.

*Citrus, Lacewing, Biology, Predation*

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### **Effect of floral strips on the abundance of hymenopteran parasitoids in apple and olive organic orchards**

Hazem Dib<sup>1</sup>, Gilles Libourel<sup>2</sup>, François Warlop<sup>2</sup>

*1 INRA "Institut National de la Recherche Agronomique", Unité PSH "Plantes et Systèmes de culture Horticoles", Equipe EPI "Ecologie de la Production Intégrée", Domaine St Paul, Site Agroparc, 84914 Avignon Cedex 9, France ; 2 GRAB "Groupe de Recherche en Agriculture Biologique", Site Agroparc-BP 1222, 84911 Avignon Cedex 9, France*

Habitat manipulation techniques improve the availability of resources required by natural enemies to increase their effectiveness. This study focused on the effects of sown floral strips on Hymenopteran parasitoid abundance. The experiments were conducted during spring 2007 in one experimental apple orchard and five organic olive orchards located in southern France. The density and the diversity of parasitic wasps collected from sown floral strips were higher than those from naturally occurring flora or mowed plants. The family of parasitic wasps of Braconidae was strongly dominant, followed by Mymaridae, Eulophidae and Pteromalidae. In the apple orchard and between the 26 studied flowering species, the greatest diversity and density of parasitic wasps were collected from *Potentilla reptans*, *Achillea millefolium*, *Trifolium repens* and *Torilis arvensis*. In terms of the early flowering plants, the most important results were *Euphorbia helioscopia*, *Senecio vulgaris* and *Veronica persica*. To give an idea of the functional role of these plants, we studied the parasitic wasps of the diapausing larvae (cocoon) of codling moth *Cydia pomonella*. We recorded three emerged species; *Ascogaster quadridentata*, *Pristomerus vulnerator* and the hyperparasite *Perilampus fulvicornis*. However, we did not remark on any of these species on the 26 studied plants. Hence, this result may be suggesting that the studied plants do not have a functional role concerning these parasitoids. These studies may be advantageous for biological control programs for the selection of flowering plant species to attract species of parasitic wasps specific to fruit pests.

*Conservation biological control, Habitat manipulation, Floral strips, Hymenopteran parasitoid, Organic orchard, Olive, Apple, Codling moth, Cydia pomonella, Cocoon*

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### **Side effect of selected insecticides on *Aphidius colemani*, *Amblyseius cucumeris* and *Neoseiulus cucumeris* as model species of natural enemies**

Stará Jitka

*Crop Research Institute, Department of Entomology, Drnovská 507, Prague 6, 161 06, Czech Republic*

Side-effect of selected insecticides on model species of natural enemies, *Aphidius colemani*, *Aphidoletes aphidimyza* and *Neoseiulus cucumeris* was tested in laboratory conditions. Methoxyfenozide (Integro), indoxacarb (Steward 30 WG), pyridaben (Sanmite 20 WP), acetamiprid (Mospilan 20 SP), azadirachtin A (NeemAzal T/S) and spinosad (Spintor 480 SC) were tested against adults of *A. colemani* and larvae of *A. aphidimyza* in rates registered for use in orchards. Against adults of *N. cucumeris*, propargite (Omite 570 EW) was also tested. Mortality of tested species after 24 or 48 hours of exposition to dry or fresh residues of pesticides was evaluated. In case of low toxic effect on mortality, the effect on fecundity of *A. colemani* was tested. Methoxyfenozide had low toxic effect on all three insect species, causing mortality after 24h from 4.6% to 29.8%. Similarly, indoxacarb caused mortality of tested species after 24h from 11.1% to 25%. However, higher mortality of *A. colemani* was found after 48h of exposition to methoxyfenozide and indoxacarb. Acetamiprid was highly toxic against *A. colemani* (100% mortality), medium toxic against *A. aphidimyza* (48.1%) and no effect was found against *N. cucumeris* (2.3%). Similar results were obtained with NeemAzal T/S. However, low toxicity against *A. colemani* was found, were pure azadirachtin A was tested instead of formulated product NeemAzal T/S. In general, *N. cucumeris* exhibited the lowest sensitivity to all the insecticides. In contrast to this, *A. colemani* was highly

sensitive to most of the insecticides. This work was supported by the Ministry of Agriculture, the Czech Republic, project no. 1G58081.

*Insecticides, Natural enemies, Side-effect*

## Poster Session 2 : Biodiversity

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### **Avian biodiversity: impacts of phytosanitary practices and landscape in south-eastern French apple orchards**

Jean-Charles Bouvier<sup>1</sup>, Julia Agerberg<sup>1</sup>, Benoît Ricci<sup>1</sup>, Claire Lavigne<sup>1</sup>

*1 Plantes et Systèmes de culture Horticoles, INRA, Site Agroparc, 84914 Avignon, Cedex 9, France*

In French apple orchards, the predominant conventional management strategy has favoured insecticide resistance in major pests like codling moth and an increased frequency of environmentally harmful insecticide applications. Organic agriculture as well as IPM represent alternatives to this situation. Impacts of management strategies on the avifauna were studied during three years in 15 commercial apple orchards in the region of Avignon, belonging to three different management strategies (organic, conventional and integrated) and situated in similar contexts in terms of local and landscape features. Our results show that the avifauna differ significantly among the three management strategies with abundances of 46, 30.3 and 7.6 individuals/ha for the organic, integrated and conventional orchards respectively; species richness of 18.1, 14 and 7.6 breeding species/ha respectively and Shannon diversity indexes of 3.8, 3.3 and 2.6 respectively. The functional structure of bird communities was also affected, with a lesser proportion of insectivores in conventional orchards than in the other orchards. Phytosanitary and environmental factors taken together explain 52% of the variability of the composition of bird communities. Phytosanitary treatments and the local environment of the orchards have a similar explanatory power of 11% while environment at the landscape scale explains 18.5% of the variability. We have demonstrated an important impact of phytosanitary practices on all parameters used to describe bird communities. These results highlight the influence of fruit production on avian biodiversity and its consequences in terms of protection of species of agronomical or patrimonial interest.

*Avian biodiversity, Apple orchard, Management strategy, Landscape, Biodiversity*

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### **Is the distribution of beneficial arthropods influenced by mixed hedgerows**

Jean-François Debras<sup>1</sup>, Rachid Senoussi<sup>2</sup>, René Rieux<sup>1</sup>, Elise Buisson<sup>3</sup>, Thierry Dutoit<sup>3</sup>

*1 INRA, UR 1115, Plantes et systèmes de culture horticoles, F-84000 Avignon, France 2 INRA, UR 546, Biostatistique et processus spatiaux, F-84000 Avignon, France 3 Université d'Avignon et pays de Vaucluse, IUT, UMR CNRS IRD IMEP, site Agroparc, B.P. 84911 Avignon, cedex 9, France*

Farming intensification in recent decades has led to an alarming level of degradation and loss of wildlife and its hedgerow habitat. The relationship between biodiversity and ecosystem functioning has emerged as a central issue in ecological sciences, but the situation regarding

hedgerow function as a potential source of biological control agents against agricultural pests remains poorly understood. We evaluated possible effects of the arthropod community in a neighbouring hedge on the distribution of the pest psylla *Cacopsylla pyri* L. (Hemiptera: Psyllidae) in a pear orchard *Pyrus communis* L. over three consecutive years (1999 - 2001). We measured the diversity of the arthropod community in the hedge and in the orchard at increasing distances from the hedge using Shannon index of diversity, and the Hellinger distance and Mahalanobis index to highlight dissimilarities between population distributions. Our results showed a convergence between predator populations in the orchard and the hedgerow during Psylla proliferation. There was a decreasing diversity gradient as distance from the hedge increased. Beneficial arthropod exchanges occurring between the mixed hedgerow and the pear orchard during the pest proliferation period suggest that field border management can be used in an integrated pest management strategy aimed at reducing insecticide use.

*Mixed hedge, Cacopsylla pyri, IPM, Arthropod Community, Shannon index of diversity*

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### **Changes of entomofauna in orchards under different pest management regimes**

Vladan Falta, Jitka Stará, Fratišek Kocourek

*Crop Research Institute, Department of Entomology, Drnovská 507, Prague 6, 161 06, Czech Republic*

Integrated fruit production is facing problems with intensive pesticide use accompanied by the reduction of nature enemies in agroecosystems. This results in outbreaks of pests with high reproductive potential (aphids, psyllids, leaf midges, etc.). The side effect of plant protection products on the diversity of beneficials, as well as, the effect of pest control on selected pests (mining Lepidoptera, codling moth) were evaluated in different pest control regimes (conventional, integrated, biological). Insects were sampled before and after each application using the limb jarring method. During the first season (2006) fewer Heteroptera species (cca 10x) and *Forficula auricularia* nymphs (3x) were found in conventional and IPM variant in comparison with biological regime. In the 2nd experimental year (2007) this effect was very similar with a higher total number of Hymenoptera species (x 1.5) sampled in biological regime. In contrast, ladybirds, lacewings and Cantharidae species showed relatively stable abundance. Direct influence of particular treatments on entomofauna was not so evident when the number of individuals before and after applications was collected. In spite of this, the preliminary results suggest that a shift in insect populations develops, although this process is relatively slow and more apparent changes may be expected during the next experimental seasons. As far as the direct efficiency of control of mining Lepidoptera species is concerned the most effective appears to be IPM with the use of selective insecticides. Codling moth was successfully controlled in conventional and IPM variants, and in the biological regime with applications of CpGV.

*IPM, Entomofauna, Orchards, Agroecosystems, Natural enemies*

## **Arthropods and mycorrhizal fungi associated to the rhizosphere of grapevine in Sicily**

A. Martorana, L. Torta, G. Lo Verde, E. Ragusa, S. Burruano, S. Ragusa Di Chiara

*Dipartimento S.En.Fi.Mi.Zo., Sezione di Patologia vegetale e Microbiologia agraria, Sezione di Entomologia, Acarologia e Zoologia Università di Palermo*

To evaluate the variation of AM fungi and arthropod populations and their possible interactions in mycorrhizosphere of grapevine in Sicily, a research in different tillage systems was carried out: the first data on the endomycorrhizal fungi and arthropods are reported. One vineyard in Palermo in state of neglect and two vineyards in Alcamo (TP), one organically managed and the other traditionally managed, were investigated during 2007. The index of root mycorrhization (IM) and the whole population of both AM fungi and arthropods were evaluated. The IM was similar in soils traditionally and organically managed: high in winter and in spring and lower in summer; the vineyard in state of neglect, during all seasons, showed IM variable values. In all Sicilian vineyards the highest number of spores was detected in winter, whereas in spring AM populations decreased. With respect to the arthropods low Shannon's index ( $H'$ ) was observed in all soils, while the BSQ values were found higher in vineyards traditionally and organically managed.

*Arthropods, AM fungi, Grapevine, Sicily*

## **Mixed deciduous hedgerows as sources of anthocorids and other predators of pear psyllid in the UK**

Csaba Nagy<sup>1</sup>, Jerry Cross<sup>1</sup>, Martin Luton<sup>2</sup>, Caroline Ashdown<sup>2</sup>

*1East Malling Research, New Road, East Malling, Kent ME19 6BJ UK ; 2WorldWideFruit, Acorn House, 68-69 John Wilson Business Park, Harvey Drive, Chestfield, Whitstable, Kent CT5 3QT UK*

Anthocorid predatory bugs are the key natural enemies of pear sucker but they often migrate into orchards too late and/or in too small numbers to affect adequate natural control of pear sucker populations. A new 4 year study was started at East Malling Research in April 2008 to develop conservation biocontrol methods to maximise anthocorid populations and other natural enemies of pear sucker in spring. Part of this study is to identify woody species and species mixes for hedgerows / windbreaks that act as sources of pear psyllid natural enemies, especially early in the season. Three established hedgerows with a range of species compositions and structures adjacent to pear orchards in Kent were identified and characterised. The hedgerows have a diverse range of under-story vegetation. The aim is to identify species mixes that maximise anthocorid populations in spring and foster their migration into pear orchards when pear sucker populations start to increase. The arthropods were beat sampled from the woody species and sweep net sampled from stinging nettles at 3-4 week intervals from April to September to characterise predator communities, especially anthocorids and populations of key prey species including the main aphids and psyllids that were present on each woody host species. The results of the first years work will be reported and discussed. A large data base comprising a >24,900 individuals sampled and identified

from 24 plant species has been constructed but not yet analysed. However, some trends in the data are obvious. 1) The largest numbers of anthocorids were found on hawthorn, pussy willow and stinging nettle in the early-season, and on field maple, hazel, birch, pussy willow, grey willow and stinging nettle in the late season. 2) In the early season the highest numbers of anthocorids were found on the same plants that had the highest numbers of psyllids. 3) In the late season anthocorids seemed to present mostly on plant species that had high numbers of aphids. 4) A large number of other predatory arthropods (mostly predatory Miridae, Araneae, Dermaptera, Neuroptera, Cantharidae, Coccinellidae) were found on the hedge plants which can also be potential predators of pear psyllids.

*Cacopsylla pyricola, Anthocoris, Orius, Conservation biocontrol, Pear*

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### **Species diversity, dominance and frequency of leaf-eating Lepidoptera in plum biocenose in Bulgaria**

Nyonka Velcheva<sup>1</sup>

*1 Department of Biological and Integrated pest control, Plant Protection Institute, 35 Panayot Volov str., 2230 Kostinbrod, Bulgaria*

The mating disruption technique is one of the most selective methods of controlling *Cydia funebrana* Tr. which is under developing in our Bulgaria. In this connection, a pre-study was carried out to follow the dynamics and density of the surface feeding lepidopteran larvae in abandoned plum orchards of mixed varieties and untreated trees in the Sofia region as well as in organic plum orchard near the town of Plovdiv. Species belonging to thirteen families were found altogether in abandoned orchards during the eight years of observations. Permanent inhabitants in the plum biocenose were larvae of Gelechiidae, Tortricidae and Geometridae with an index of constancy  $c=100$ . The next by frequency of occurrence were species of Coleophoridae and Noctuidae ( $c=87.50$ ), followed by Yponomeutidae ( $c=75$ ), Lycanidae ( $c=50$ ), Lymantriidae and Pieridae ( $c=25$ ). The rarest were individuals of families Ypsolophidae, Chimabachidae, Lasiocampidae and Pyralidae with  $c=12.50$ . In 1998 and 2002, the dominant species of all collected lepidopteran larvae were *Recurvaria nanella* (Denis & Schiffermüller, 1775), in 1999 - *Anarsia lineatella* (Zeller, 1839) and *Operophtera brumata* (Linnaeus, 1758) dominated in complex of surface feeding lepidopteran larvae in 2000 and 2005, *Neusphaleroptera nubilana* (Hübner, 1799) in 2003, and *Hedia nubiferana* (Haworth, 1811) in 2006 and *Argyresthia spp.* in 2007. Less biodiversity was found in the organic orchards in the Plovdiv region with the exception of registration for the first time of *Argyrotaenia ljugiana* (Thunberg, 1797) on plums for our country and the invasion of *Hyphantria cunea* (Drury, 1773) in July 2006.

*Leaf-eating Lepidoptera, Plum orchards, Bulgaria*

## Poster Session 2 : IFP

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### **Hazelnut quality and sensory evaluation in organic and conventional growing systems**

V. Cristofori<sup>1</sup>, B. Pancino<sup>2</sup>, C. Bignami<sup>3</sup>, E. Rugini<sup>1</sup>, S. Gasbarra<sup>4</sup>

*1 Dipartimento di Produzione Vegetale, Università della Tuscia, Via S. Camillo de Lellis snc, Viterbo, Italy 2 Dipartimento di Economia*

Consumer acceptance of organic products requires the association with directly perceivable search or experience quality attributes. Up to now, organically grown hazelnut (*Corylus avellana* L.) have been scarcely characterised for specific quality traits, because they are mainly utilised by the food industry. Two Italian hazelnut cultivars, 'Tonda Gentile Romana' and 'Tonda di Giffoni', grown in both conventional and organic systems, were evaluated for technological traits, incidence of defects and chemical composition. Furthermore, sensory evaluation of roasted kernels collected in both growing systems was performed in order to evaluate the differences perceived by the panelists, and thus obtain information on consumer preferences. Significant differences among cultivars and growing regimes were observed for the examined nut traits. Kernel/nut ratio was higher in both cultivars grown in the conventional system, and it was also observed a lower incidence of defected nuts. Organic nuts showed a slightly lower oil and starch content in the kernel in comparison to conventional ones, whilst in the organic nuts it was observed that there was a minor incidence of total saturated fatty acids and a high content of oleic acid in the oil. Nitrogen content in the kernel was higher in organic nuts only in 'Tonda di Giffoni'. Organic nuts also showed higher soluble sugar content in the kernel, mainly for 'Tonda di Giffoni', while no differences were observed in organic acids. In both cultivars, the organic regime positively influenced the content of phenols in the kernel. Sensory evaluation was able to reveal the differences associated with different growing regimes for attributes related to taste and flavour, and the highest score was observed for sweetness on roasted kernel of 'Tonda di Giffoni' harvested in the organic field. A positive relationship between sweetness scores and sugar concentration was also observed. The results showed that the nuts harvested in the organic system, had a high incidence of defects and minor percent kernel. However, these nuts showed high qualitative traits, mainly for superior content of soluble sugars and polyphenols. "Tonda di Giffoni" seems more suitable to be managed in organic systems than 'Tonda Gentile Romana'.

*Corylus avellana* L., Nut traits, Chemical composition, Quality, Sensory evaluation

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### **Flash grazing of hogs in apple orchards for pest management**

D. Epstein, M. Grieshop

A project to develop and evaluate an orchard system for Upper Midwest (USA) fruit growers that integrates rotational swine grazing for control of insect and disease pests, while enhancing profit potential through sales of organic pork was investigated in 2007-2008. The impact of hog grazing on aborted apples for control of one of the most serious pests of organic apples, *Conotrachelus nenuphar*, was evaluated most extensively. The number of June Drop apples for two cultivars, Idared and McIntosh, was quantified as a mean of ca. 123 apples per tree for both years. Forty-seven percent of field-collected, aborted apples in 2008 had at least one *C. nenuphar* oviposition scar, and 15.7% of drops contained viable larvae. Twenty-seven two-month old Berkshire hogs (Ca. 20-30kg), grazed prior to predicted emergence of *C. nenuphar* larvae, consumed over 98% of dropped apples in 0.4ha plots in 2007. In 2008, 24 two-month old Berkshire hogs consumed over 99% of dropped apples. Hogs were rotated among 3 grazed plots, spending 2-3 days in each grazed plot per week for three weeks. A controlled feeding experiment demonstrated that ingestion of *C. nenuphar* larvae in apples by pigs was 100 percent lethal to the larvae. Spring egg-laying injury from *C. nenuphar* in 2007, prior to start of grazing, was 11% in grazed plots, 8% in non-grazed. Summer *C. nenuphar* feeding injury, following the start of grazing in 2007, was 4.9 fold higher in non-grazed control plots ( $p=2.081E-13$ ). Spring *C. nenuphar* oviposition injury in 2008 was 8.7% in non-grazed plots and 4.1% in grazed plots ( $p=7.763E-05$ ). Summer *C. nenuphar* feeding injury was 3.4 fold higher in non-grazed plots in 2008 ( $p=1.326E-05$ ). Rooting of young hogs (under 45kg) in the tree row soil, as they foraged through the orchard, averaged 4-6 inches in depth. Rooting by hogs larger than 45kg resulted in some exposure of tree roots and some destruction of sod in the drive rows. Overall, the health status of all animals was acceptable, and did not require the use of any pharmaceuticals. Apple pulp and discarded whole apples were provided continuously, about 450 kg per day since weaning, providing over 50% of their daily food intake. Anecdotal observation in 2007 suggested superior weed control and improved nutrient availability resulted from hog grazing/rooting. Data collected during the 2008 season on weed growth, nutrition, and control of codling moth (*Cydia pomonella*) and apple scab (*Venturia inaequalis*) will be reported on in this paper.

*Conotrachelus nenuphar*, Hogs, Apple, Rotational grazing

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## **The sterile insect technique as a component of area-wide integrated pest management.**

Andrew Jessup, Marc Vreysen

*Insect Pest Control Sub-programme, FAO/IAEA Agriculture and Biotechnology Laboratory, IAEA Laboratories, A-2444 Seibersdorf, AUSTRIA*

The benefit of integrated pest management (IPM) when applied on an area-wide (AW) basis is that all habitats are treated. Such programmes are successful if the pest is suppressed to below economic or environmental thresholds and its re-establishment is prevented. Apart from horticultural production areas AW-IPM programmes often impact urbanised and native vegetation areas and waterways. The requirement for the protection of humans, fauna and flora and their communities and eco-systems demands the use of biologically sensitive technologies in AW-IPM programmes. The sterile insect technique (SIT) is a form of

biological control which uses releases of sterile mass-reared insects to suppress wild populations of the same species. Desired outcomes from SIT include a reduction in the use of toxic pesticides, improved production, quality and marketability of produce where only the target pest species is affected. To date a wide range of insect pests has been targeted, successfully, by SIT in diverse regions of the world but SIT is most effective when used as a component of AW-IPM programmes. SIT is recognised as a component of internationally accepted systems approaches to pest management. For example the FAO / International Plant Protection Convention's International Standards for Phytosanitary Measures (ISPM) numbers 3, 9, 18 and 26 have provision for the transport or deployment of sterile insects for SIT purposes. In this paper we will discuss the requirements for a thorough understanding of the biology and behaviour of the target pest and its interaction with the geography, climate and host flora of an area under pest management and the means by which SIT can be an essential component to AW-IPM.

*Pests, Sterile insect technique, Area-wide, Integrated pest management*

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### **Survey on the use of pesticides and biocontrol agents in soft fruits**

Christian Linder<sup>1</sup>, Janet Allen<sup>2</sup>, Catherine Baroffio<sup>3</sup>, Agata Broniarek-Niemiec<sup>4</sup>, Victoria Brookes<sup>5</sup>, Jerry Cross<sup>6</sup>, Cathy Eckert<sup>7</sup>, Rudolf Faby<sup>8</sup>, Bruno Gobin<sup>9</sup>, Alberto Grassi<sup>10</sup>, Adrian Harris<sup>6</sup>, Barbara Labanowska<sup>4</sup>, Emilie Lascaux<sup>11</sup>, Carlo Malavolta<sup>12</sup>, Vincent Michel<sup>3</sup>, Slobodan Milenkovic<sup>13</sup>, Thilda Nilsson<sup>14</sup>, Paivi Parikka<sup>15</sup>, Klaus Paaske<sup>16</sup>, Jean-Jacques Pommier<sup>17</sup>, Daniele Prodorutti<sup>10</sup>, Lene Sigsgaard<sup>18</sup>, Arne Stensvand<sup>19</sup>, Christer Torneus<sup>20</sup>, Nina Trandem<sup>19</sup>, Tuomo Tuovinen<sup>15</sup>, Gábor Véték<sup>21</sup>

*1*Station de recherche Agroscope Changins-Wädenswil ACW, CP 1012, 1260 Nyon 1; *2*ADAS UK Ltd, Pibworth Cottage, Aldworth, Reading, Berks RG89RU, UK; *3*Agroscope Changins-Wädenswil ACW, Centre de recherche Conthey, 1964 Conthey 1964 Conthey, Switzerland; *4*Research Institute of Pomology, Pomologiczna 18, 96-100 Skierniewice, Poland; *5*Agriculture and Agri-Food Canada, 6947 #7 Highway, PO Box 1000, Agassiz, British Columbia V0M 1A0, Canada; *6*East Malling Research, New Road, East Malling Kent ME19 6BJ, UK; *7*DLT, Centre Ctifl de Lanxade, BP 21, 24130 La Force, France; *8*V.B.O.G. Langfoerden. Spredaer Str. 2, 49377 Vechta, Germany; *9*pcfruit, Fruittuinweg 1, 3800 Sint-Truiden, Belgium; *10*IASMA Research Center – Plant Protection Department, Via E. Mach, 1 – 38010 San Michele all'Adige (TN), Italy; *11*Koppert France, 147 Avenue des Banquets, ZI Puits des Gavottes, 84300 Cavailon, France; *12*Regione Emilia-Romagna, Assessorato Agricoltura, Viale Silvani 6, 40122 Bologna, Italy; *13*Fruit Research Institute 'a?ak, Kralja Petra I/9, Serbia; *14*HS Malmöhus, Borgeby Slottväg 13, 239 91 Bjärred, Sweden; *15*MTT Agrifood Research, Plant Production Research, Jokioinen 31600, Finland; *16*Danish Institute of Agricultural Sciences, Dpt of IPM, DK-4200 Slagelse, Denmark; *17*Hortis Aquitaine, 24140 Douville, France; *18*Royal Veterinary and Agricultural University, Dpt of Ecology - Zoology Group, Thorvaldsensvej 40, 1871 Frederiksberg C, Denmark; *19*Bioforsk, Plant Health and Plant Protection Division, Høgskoleveien 7, 1432 Ås, Norway; *20*Swedish Board of Agriculture, Plant Protection Centre, P.O. Box 12, 230 53 Alnarp, Sweden; *21*Corvinus University of Budapest, Faculty of Horticultural Science, Department of Entomology, Villányi út 29–43., 1118 Budapest, Hungary

The use of plant protection products and biocontrol agents in soft fruit production has always been an important subject for the IOBC/WPRS Working Group Integrated Plant Protection in Orchards Subgroup Soft Fruits. The usage of pesticides and biological control methods varies considerably between countries and it is very difficult to get a good overview on the range of products that are applied or in development in soft fruits. In order to share and facilitate the flow of information, the Working Group Soft Fruit initiated a survey in 2007 on the usage and availability of pesticides and biocontrol agents in the different European countries. First we

identified the five most important pests and diseases in strawberry and raspberry production. Then members of the different countries listed available products on the domestic market and indicated their usage in the field. So far 15 countries have contributed to the survey. The received data are accessible on the website <http://www.any3.ch/IOBC/Softpest/index.html>. Here we will briefly present the first version of this database. In the near future, the Working group intends to integrate more countries, crops, pests and diseases in the database. However, it should be noted that the website does not intend to replace national pesticides lists. The website should simply facilitate the exchange of information among scientists, advisory services and everybody interested in the availability and use of pesticides and biocontrol agents in soft fruits.

*Soft fruits, Pesticides, Biocontrol agents, Database, Strawberry, Raspberry*

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## **Organic raspberry production in Serbia**

Slobodan Milenkovic

*Megatrend University, Belgrade, Faculty of Biofarming, Baka Topola, Maršala Tita 39*

Raspberry production in Serbia is primarily realized in central and western parts of Serbia whereby the total production ranges from 40,000 to 75,000 t by different years. Available data suggest that about 3,000 t of organic raspberry is exported, which accounts for 5% of the total production. In Serbia, the first raspberry plantings maintained according to the organic production procedure were established in 1999. So far, the production has reached some 3,000 t. This programme is promising, provided strict observance of regulations EC 2092/91 and EC 834/2007 is performed. Proper selection of suitable growing regions (hilly-mountainous) as well as conscientious producers willing to co-operate in this project are of utmost importance for the realisation of this programme. Similarly, it is very important to build up high-quality internal control systems for monitoring and education of producers. Organic production plantings are established on well-drained, loose soils containing high organic matter. Incorporation of 20 t/ha of manure into soil is a regular cultivation practice. As regards the control of diseases and pests, the following control measures are applied: setting up plantings at suitable terrains, application of appropriate cultivation practices, healthy planting material, application of sulphur and copper fungicides. The control and monitoring of pests presuppose usage of visual (Rebell traps and Moerick vessels) and pheromone traps (monitoring of *Resseliella theobaldi*). The incidence of gray mold caused by *Botrytis cinerea* is a major problem in seasons with high rainfall rates. Unfortunately, efficient biological fungicides for application on raspberry have not been registered so far.

*Raspberry, Organic production, Biopesticides*

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## **Is organic hazelnut cultivation profitable?**

B. Pancino<sup>1</sup>, V. Cristofori<sup>2</sup>

In order to analyze the economic results of the hazelnut cultivation in an organic regime, the two methods of production commonly used in the Monti Cimini hazelnut district (centre Italy) were used. These systems of production, due to the different levels of input that they require, can be considered to be “extensive” and “intensive”. The extensive technique is characterized by low-specialized plantations situated in less suited areas, whose yield is 1.5 ton/ha on average. On the contrary, the intensive technique is adopted in farms whose land dimension and configuration allow a greater mechanisation of the cultivation. In these cases, higher yields of on average 2.4 and up to 3 ton/ha can be achieved thanks to the use of fertiliser/pesticides and other technical measures. Costs and productive value were evaluated for the two techniques and, afterwards, a comparison with the conventional management was carried out, referring to a standard method of production which allows average yields of 2.7 t/ha to be achieved. The examination of the costs of production for these systems highlighted a substantial homogeneity in variable costs, which are slightly higher than 1,000 €/ha for all the three techniques considered, although remarkable variations can be observed in the different categories (raw materials, mechanization, work). On the contrary, the production which can be sold varies greatly according to the different orchard management forms. A comparison of gross margins shows that the results achieved by conventional management is intermediate between those of the two techniques in an organic regime. This result justifies the contrasting opinions of hazelnut producers on the relative convenience of the two management forms. The only certainty is that, because of public aid organic hazelnut production is able to guarantee better economic results,.

*Corylus avellana L., Cultural account, Organic agriculture*

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### **Further observation on hazelnut yielding and fruit quality under organic and conventional management.**

Alessandro Roversi, Gian Luca Malvicini.

*Institute of Fruit Growing, Catholic University S.C., 29100 Piacenza – Italy*

In some previous contributions, the authors Roversi & Sonnati (2006) and Roversi & Castellino (2007) and Roversi, Ughini, Malvicini & Sonnati (2008) have pointed out some difficulties in the organic management of filbert orchards. A further two years of investigations showed that the main problem associated with organic Filbert production is the high percentage of nuts affected by bugs and consequent very important productivity loss. To validate or not the conclusions of previous works, the comparison between organic and conventional management was carried on in three typical hazelnut orchards named “Alta Langa”, “Langa” and “Monregalese”. In these areas orchards managed conventionally and organically were chosen to record productivity and nut quality traits. In the years 2007-08, both total and average (t/ha) production were recorded for each hazelnut orchard, and 3 kg samples of nuts were taken out of the total yield of nuts achieved at each site and each studied using commercial marketing standards. In particular fruit and kernel weight, Curculio holes, empty fruit and the percentage of kernels damaged by insect's being considered. The results

were statistically analysed through conventional-organic comparisons, and tested with the t test.

*Hazelnut yielding, Fruit quality, Organic management, Bug kerne*

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### **Codling moth proof hail nets**

B. Sauphanor<sup>1</sup>, G. Severac<sup>2</sup>, L. Romet<sup>3</sup>, E. Esberard<sup>4</sup>, J.F. Toubon<sup>1</sup>, S. Maugin<sup>1</sup>

*1 INRA, UMR 1115 Plantes et Systèmes de culture Horticoles, Agroparc, F-84914 Avignon Cédex 9, France ; 2Chambre d'Agriculture du Vaucluse ; 3Groupe de recherche en agriculture biologique, Agroparc, F-84911 Avignon Cedex 9, France ; 4INRA, UEEAA Agroparc, F-84914 Avignon Cédex 9, France*

Single row hail nets (3x7.4mm) modified to wrap up whole tree canopies, named Alt'Carpo, were evaluated as a way of control of orchard lepidopteran pests. A two years study was conducted in a 10 rows experimental apple orchard in Southern France, together with large field trials in commercial orchards. The experimental orchard was insecticide free in year 1 and pesticide free in year 2. Eight rows were protected with the nets, two rows were unprotected. The nets allowed an 80% reduction of fruit injury when compared to the unprotected rows, which suffered over 70% codling moth injury. However this efficacy was lower than in commercial orchards, especially those covered with 2.2x5.4mm nets in which fruit injury did not exceed 0.1%. The outer females, issuing from unprotected rows, were proved able to lay eggs on leaves or apples touching the 3x7.4mm nets. Virgin females or synthetic lures baited traps poorly captured wild or marked and released males under the nets, while the traps placed in unprotected rows captured over 30% of the released males. Moreover, significant rates of males released under the nets were captured outside while only 1 out of 300 males released in the control rows was observed to pass through the net, proving the need for flying over the canopy for sex encounter. Despite the known alteration of communities in protected crops, no significant effect of the net was observed on rosy aphid and scab injuries on leaves or fruits. The agronomic, economic and environmental consequences of replacing chemical insecticides by synthetic barriers are discussed.

*Protected crop, Cydia pomonella, Mating behaviour, Environmental impact, Pest and disease management*

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### **Building up, management and evaluation of orchard systems: a three-year experience in apple production**

S. Simon<sup>1</sup>, B. Sauphanor<sup>2</sup>, S. Buléon<sup>1</sup>, J. Guinaudeau<sup>1</sup>, L. Brun<sup>1</sup>

*1 INRA (National Institute for Agricultural Research), UERI Gotheron, F-26320 Saint-Marcel-lès-Valence, France INRA, UMR 1115 Plantes et Systèmes de culture Horticoles, Agroparc, F-84914 Avignon Cédex 9, France*

Three apple orchard systems were planted in 2005 to assess agronomic and environmental effects of different pest management regimes: organic farming (OG), conventional supervised

(SV) and low-input (LI) systems. Three apple cultivars presenting different susceptibility to scab were planted in each system: Ariane (Vf-resistant), Melrose (low-susceptibility) and Smoothie 2832T® (susceptible), creating nine system x cultivar situations. Decision rules were defined within the framework of each system, and their possible interactions were integrated. Starting from planting, the survey included pest and disease assessments, and agronomic and environmental parameters. The OG system was the slowest to produce commercial yield, whereas the SV one showed the highest performances. Although globally low, pest and disease fruit damage at harvest was the highest in the OG system. The treatment frequency index (TFI) was the highest in the SV system, and in Smoothie plots within each system. Two-fold more treatments were applied in any SV plot and in Smoothie OG compared to Melrose LI. The LI system presented the lowest TFI and the lowest environmental impact of pesticides calculated by the I-phyARBO fuzzy expert system. Apart from Smoothie, I-phyARBO in the OG system scored between LI and SV. From the first three years of experiment, the importance of the cultivar in the management of orchard pests and diseases is outlined whatever the system. This experimental design proved to be a functional tool permitting the conception of decision rule patterns, and also to assess the agronomic, environmental and economical performances of the systems.

*Orchard system, Apple, Decision rule, Agronomic evaluation, Environmental evaluation, Pest and disease management*

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## **Effect of different type row mulches on the success of biological control of strawberry tarsonemid mite**

Tuomo Tuovinen<sup>1</sup>, Isa Lindqvist<sup>1</sup>, Pirjo Kivijärvi<sup>2</sup>

*1 Plant Production Research, MTT Agrifood Research Finland, 31600 Jokioinen, Finland; 2 Plant Production Research, MTT Agrifood Research Finland, Karilantie 2 A, 50600 Mikkeli, Finland*

Organic experimental strawberry fields were established to study the effect of mulching materials on growth, yield, fruit quality and mites. Black plastic, flax fibre mat, fresh green mass, barley straw, buckwheat husks, pine woodchips and birch woodchips were used for mulching. Strawberry tarsonemid mite was recorded in the autumn of the planting year and biological control of mites was started in the spring by introduction of *Neoseiulus cucumeris* which kept the strawberry tarsonemid mite under control. Small numbers of *Anthoseius rhenanus* and *Euseius finlandicus* were also introduced, but these species were rarely found afterwards in folded leaf samples. In the third year, one release of *N. cucumeris* took place at the beginning of June. In late August strawberry tarsonemid mite population growth was unacceptable in black plastic and barley straw mulches whereas in green mass and buckwheat husk mulches the mite was controlled by predatory mites during the whole season. Faster vegetative growth in green mass and buckwheat husk mulches in organic farming is proposed to enhance biological control of strawberry tarsonemid mite.

*Strawberry, Organic farming, Organic mulches, Phytonevus pallidus, Phytoseiidae, Neoseiulus cucumeris*

## Poster Session 2 : Pathology

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### Organic disease management in orchards with ‘newer’ apple cultivars

L. Berkett<sup>1</sup>, M. Garcia<sup>2</sup>, R. Moran<sup>3</sup>, H. Darby<sup>1</sup>, R. Parsons<sup>1</sup>, J. Hayden<sup>1</sup>, T. Bradshaw<sup>1</sup>, S. Kingsley-Richards<sup>1</sup>, M. Cromwell<sup>1</sup>

*1Dept. of Plant & Soil Science, University of Vermont, 105 Carrigan Drive, Burlington, VT 05405 USA*  
*2University of Arkansas, Fayetteville, AR 72701 USA* *3University of Maine, Monmouth, ME 04259 USA*

Although there is significant interest in organic apple production in the New England region of the USA, there are few certified organic orchards, in part, because of disease challenges associated with the predominant cultivar grown in the region (i.e., ‘McIntosh’). However, recent shifts in consumer preference for ‘newer’ cultivars have led to the planting of different apple cultivars which have different disease susceptibility. A long-term research project was initiated in 2006 to examine the opportunities and challenges of organic apple production within two production systems growers are using to change to new cultivars: planting a new orchard with young trees purchased from a nursery and/or “top-grafting” an established, older orchard to new cultivars. Cultivars being studied in replicated plots in each orchard system include: ‘Zestar!’, ‘Ginger Gold’, ‘Honeycrisp’, ‘Macoun’, and ‘Liberty’, a scab-resistant cultivar. Both orchard systems are being managed with approved, organic practices and materials. Standard foliar and fruit disease assessments for apple scab, caused by *Venturia inaequalis*, and other diseases are being conducted to determine differences in disease incidence and severity among the cultivars. Based on 2006 and 2007 foliar disease assessments, ‘Honeycrisp’ appears more resistant to apple scab than the other scab-susceptible cultivars ‘Zestar!’, ‘Ginger Gold’, and ‘Macoun’, but appears more susceptible to cedar apple rust, caused by *Gymnosporangium juniperi-virginianae*, than ‘Liberty’ and ‘Zestar!’. This research is on-going and will document disease challenges and the economic costs, returns, and risks associated with these five cultivars being grown under organic production practices within the two orchard systems.

*Organic apple production, Apple scab, Cedar apple rust, Apple diseases*

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### Investigation on survival and viability of cankers of *Nectria galligena* following removal from apple trees and pulverisation on the orchard floor

A.M. Berrie<sup>1</sup>, B.E. Ellerker<sup>1</sup>, K. Lower<sup>1</sup>, G. Saunders<sup>2</sup>

*1East Malling Research, East Malling, Kent, ME19 6BJ, UK; 2FAST, Crop Technology Centre, Brogdale Farm, Brogdale Road, Faversham, Kent, ME13 BXZ, UK*

Up until the 1970s it was normal orchard practice to remove prunings from the orchard and burn them. Any cankers pruned out would therefore have been eliminated from the orchard. Removal and burning of prunings from orchards is now rare, most being pulverised in the tree alleyways. What is not clear is the effect of this practice on canker survival and viability and the likely risk to trees from spores generated by canker debris on the ground. Previous studies by in the UK and Belgium in the late 1970s and early 1980s, focused on canker infection in the trees and indicated a minimal risk. Despite this there are still concerns among growers in the UK. The trials were set up in two Gala orchards located at East Malling Research and on a commercial farm at Teynham in Kent where canker had been a significant problem since planting. The orchards were visited in February 2005 and cankered one year old shoots collected from the Gala trees and distributed among sprout nets which were then placed back out in the orchard, in the tree row. The bags were held in place with metal pins and the positions noted so that they could be relocated for future sampling. Similarly cankered two, three, four and older wood was collected from trees and similarly distributed among sprout nets after pulverising with a tractor-trailed standard orchard pulveriser. The bags were then placed back out in the orchard, either in the tree row (East Malling) or in the grass alleyway (Teynham) and held in place with metal pins and the positions noted so that they could be relocated for future sampling. Initially, at monthly intervals, the orchards were visited and the state of the cankers assessed in terms of decay. Labelled bags containing pieces of canker from the pulverised wood or the one year old cankers were collected from the orchards and examined carefully for signs of sporing either white pustules (conidia) or red fruiting bodies (perithecia). Where present they were checked for spores. Pruned out cankers pulverised or unpulverised continued to produce perithecia for at least 16 months after being removed from the trees. The cankers produced conidia for a much shorter period of time. Perithecia were produced more abundantly on pruned out cankered young shoots. Decay of prunings appeared to take place more slowly in the tree row. Pulverised prunings left in the grass alleyway decayed more rapidly and were also overgrown by the grass. Despite this perithecia could still be found almost twelve months after the pulverising. Previous studies in Belgium and the UK indicated a minimal risk from cankered prunings dumped in the grass alleyway. However, this study shows that pulverised cankers can continue to pose a threat to apple trees for more than a year after pulverising. Ideally in areas where conditions favour canker it would be desirable to return to the practice of collecting prunings and burning to minimise the risk. This however, may not be practical. The best alternative would be to dump all prunings, including young shoots, in the grass alleyway and pulverise. Decay is more rapid and repeated mowing of prunings would increase the break down.

*Apple, Canker, Nectria galligena, Prunings, Pulverisation*

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## **Inventory of European canker in southern Sweden and *Nectria galligena* as a soil pathogen.**

Boysen Bengt

*Swedish University of Agricultural Sciences, Sweden*

In recent years pomme fruit growers in southern Sweden have reported that they have been experiencing severe outbreaks of European canker and the problem seems to be increasing. The growers mainly import new trees from nurseries in Belgium or Holland. Soon after the

trees have been planted the trees are heavily affected by canker disease. To assess the extent of the outbreaks a survey has been started which will include orchards from all parts of the Scania province. In Swedish fruit orchards it is a common management practice to leave pruned branches containing canker on the orchard floor and cut them into small pieces with a heavy duty lawn mower. The wood chips eventually get incorporated into the soil and the fungus might infect the trees via the roots. We are currently conducting experiments investigating the canker fungus' ability to survive in soil and infect apple tree roots.

*European canker, Nectria galligena, Apple, Soil pathogen, Integrated control*

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### **Integrating scab control methods with partial effects in apple orchards: the association of cultivar resistance, sanitation and reduced fungicide schedules**

Frédérique Didelot<sup>1</sup>, Luciana Parisi<sup>3</sup>, Maël Baudin<sup>1</sup>, Valérie Caffier<sup>1</sup>, Gilles Orain<sup>2</sup>, Arnaud Lemarquand<sup>2</sup>

*1 INRA Centre d'Angers, UMR PaVé, 42, rue Georges Morel, BP60057, 49071 BEAUCOUZE cedex, France ; 2 INRA Centre d'Angers, UE Bois l'Abbé-La Rétuzière, 42, rue Georges Morel, BP60057, 49071 BEAUCOUZE cedex, France ; 3 current address: INRA-UERI – Domaine de Gotheron – 26320 SAINT-MARCEL-LES-VALENCE, France*

The repeated fungicide treatments against apple scab reduce the auxiliary fauna and can favour the development of some pests. Moreover, resistance to several active ingredients has appeared in *Venturia inaequalis* populations. It is therefore crucial to improve disease control while reducing the number of treatments and the impact of fungicide spraying. To reach this aim, the planting of cultivars with partial resistance to the disease, associated with an integrated control strategy, may be an interesting alternative. However, to decrease the risks for the growers, cultivars with a high partial resistance level are required, and several methods of control must be associated. The application of such a strategy must be simple and reliable for the grower. The thresholds for chemical spraying, must be defined and validated, taking into account the cultivar resistance level and the sanitation practices applied. In order to answer these questions, we first quantified the advantage of partially resistant cultivars compared to susceptible ones in the absence of other scab control methods. Since 2005, we have studied within an experimental orchard the association of the cultivar Reine des Reinettes (which presents a good partial resistance) with a sanitation practice: reduction of foliar litter and a chemical schedule: fungicide spraying only if a medium or high Mill's risk is recorded or expected. The results obtained in 2005, 2006 and 2007 showed that, with only 5 to 6 sprayings per season (on average, twice as many sprays were applied in conventional orchards in the Loire Valley), scab control was effective with less than 2% of scabbed fruits recorded.

*Partial resistance, Apple scab, Control strategy, Sanitation practices.*

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### **Application of thermo- and chemotherapy in vitro for elimination of some viruses infecting fruit trees and small fruits**

Mirosawa Cieliska<sup>1</sup>

Research Institute of Pomology and Floriculture, Pomologiczna 18, 96-100 Skierniewice, Poland

In vitro culture is known currently as a technique used to eliminate viruses from plants. In this study, thermotherapy and chemotherapy in vitro were applied to eliminate ACLSV and PNRSV from myrobalan, PNRSV from 'Empress' plum, PDV from 'Early Rivers' sweet cherry, ACLSV from apple 'Jonagold' and pear 'Pierre Corneille', and RVCV from 'Norna' raspberry. Shoots were placed in a growth chamber where the temperature was raised, gradually, to 36°C and kept at this level for 4 weeks (thermotherapy). Chemotherapy was conducted using 10-100 mg l<sup>-1</sup> Virazole® (ribavirin) applied into the proliferation medium. Combining both methods was also used. ELISA assays for ACLSV, PNRSV and PDV were conducted one year after therapy. The rooted raspberry plants were planted in a greenhouse and observed for possible RVCV symptoms. Thermotherapy in vitro was highly effective for PNRSV and ACLSV elimination but it was not efficient for obtaining PDV-free sweet cherry and RVCV-free raspberry. Efficiency of chemotherapy varied depending on concentration of Virazole®, virus and species of infected plant. Virazole® at a concentration of 25-100 mg l<sup>-1</sup> was effective in eliminating ACLSV from myrobalan and PNRSV from plum, but was not successful in eliminating PNRSV from myrobalan and PDV from sweet cherry shoots. 25-50 mg l<sup>-1</sup> of Virazole® eradicated ACLSV from the majority of treated apple and pear shoots. No symptoms of vein chlorosis had been observed for two years on most plants treated with 25-50 mg l<sup>-1</sup> of Virazole®. Combining thermotherapy and chemotherapy contributed to elimination of all studied viruses from most treated shoots.

*In vitro culture, Thermotherapy, Chemotherapy, ACLSV, PNRSV, PDV, RVCV*

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### ***In vivo* antagonism of *Acremonium byssoides*, endophyte in *Vitis vinifera*, towards *Plasmopara viticola***

Gaetano Conigliaro, Valeria Ferraro, Alessandra Martorana, Santella Burrano

*Dipartimento S.En.Fi.Mi.Zo., Sezione di Patologia vegetale e Microbiologia agraria Università di Palermo, Viale delle Scienze 2, 90128 Palermo; santella@unpa.it*

The endophytism of *Acremonium byssoides* in *Vitis vinifera* was recently ascertained in Sicily. In particular, the hyphomycete was observed in leaves of three vine cultivars (Regina Bianca, Catarratto and Insolia). Moreover, in the leaves of cultivar Insolia inoculated with *P. Viticola*, the *A. byssoides* showed an antagonistic activity (hyperparasitism and antibiosis) towards asexual and sexual structures of the oomycete. In spring 2002 and 2007 "Insolia" vines, infected by the endophyte, suffered repeated attacks by *P. Viticola*, that lasted until the formation of gametic structures of pathogen. The aim of our research was to ascertain, *In vivo*, the effect of *A. byssoides* on viability of oospores, the only means of *P. Viticola* overwintering. The "mosaic spotted" leaves were collected in October from vines colonized (cv. Insolia) or not (cv. Catarratto) by *A. byssoides* and exposed to natural climatic conditions. The oospores viability was assayed by germination tests. The differentiated oospores in endophyte-free leaves showed the highest mean germination value, whereas the other ones were degenerated and did not germinate at all. This study shows that the interaction between

*A. byssoides*, *V. vinifera* and *P. Viticola* could assume a determinant role to contain the mildew infections in our environment.

*Grapevine, Endophytism, Antagonism, Downy mildew.*

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### **Fungal and bacterial endophytes in *Olea europaea* L.**

V. Ferraro, G. Conigliaro, L. Torta, S. Burrano, G. Moschetti

*Dipartimento S.En.Fi.Mi.Zo., Sezione di Patologia vegetale e Microbiologia agraria Università di Palermo, Viale delle Scienze 2, 90128 Palermo*

The composition of the endophytic community in leaves and twigs of the olive-tree (*Olea europaea* L.) was studied in Sicily (Italy). Two sampling areas were selected: one in San Cipirello (PA) and the other one in Racalmuto (AG). The olive-yards were similar for plant age, cultivar and agricultural management. Isolation assays were made from samples collected from each locality in spring, summer and autumn during 2007 and 2008. Quantities of fungal and bacterial isolates were different in relation to the sampled sites. The prevailing fungal genera in almost all samplings were *Alternaria*, *Cladosporium*, *Diplodia*, *Phoma*, *Septoria*, *Stemphylium* and its teleomorph *Pleospora*. Regarding bacterial genera, *Bacillus* and *Pseudomonas* were also detected. The colonization frequencies were dependent on the sampling site. Our preliminary results showed a potentially constant composition of endophytic community of *O. europaea* in Sicily, the degree of endophytic infection depending on season, and both, geographical and environmental factors. Further studies will be carried out in order to complete fungal and bacterial identification at species level and to investigate the interaction between endophytic microorganisms, host and environment.

*Olea europaea, Fungi, Bacteria, Endophytism*

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### **Population variability of strawberry powdery mildew (*Podosphaera aphanis*) in different geographical regions**

N. Harvey, A.M. Berrie, X.-M. Xu

*East Malling Research, East Malling, Kent, ME19 6BJ, UK*

Strawberry powdery mildew, caused by *Podosphaera aphanis*, is one of the most important diseases worldwide. Mildew lesions were sampled from a number of cultivars at several sites in the UK; a limited number of lesions was also sampled from China, the USA, Italy and Israel. SSR markers were developed and used to genotype sampled isolates for determining population variability; the ITS region of 20 samples selected from different countries was sequenced. Both SSR and ITS data indicated that there were significant differences between samples from the USA and the other countries. In the UK, there was significant population differentiation between mildew samples from different cultivars at the same sites, or between mildew samples from the same cultivar at different sites.

### **Evaluation of fruit genetic resources for disease resistance**

David Szalatnay, Kaspar Hunziker, Brion Duffy, Markus Kellerhals

*Agroscope Changins-Wädenswil, P.O. Box 185, CH-8820 Wädenswil, Switzerland*

Based on the Convention on Biodiversity (CBD) and the Global Plan of Action, the Swiss Federal Office of Agriculture is implementing a National Plan of Action for the conservation and sustainable use of plant genetic resources. After a nation-wide inventory of the fruit genetic resources, the decentralised collections are being completed and the characterisation of the accessions is under way. Considering international standards such as the ECPGR descriptors, guidelines for phenotypic description were developed. Selected genotypes were tested for fire blight (*E. amylovora*) resistance in the greenhouse. Results display considerable variation in resistance and susceptibility, respectively. Conclusions can be drawn in respect to resistant varieties suitable for juice and cider production on standard trees. Moreover, the project aims at defining accessions that might be useful for cultivation to develop and promote new products with traditional varieties and for breeding towards broadening the genetic basis for disease resistances, tree architecture and fruit quality. In addition, a large number of accessions will be tested for their scab (*V. inaequalis*) and powdery mildew (*P. leucotricha*) field resistance in a field trial. In conclusion, variation of disease resistance in fruit genetic resources is exploited for breeding as well as cultivation purposes. A total of 160 apple and pear accessions belonging to the Swiss pool of germplasm are being evaluated for fire blight resistance and 600 accessions for scab and mildew resistance.

Keywords?

### **Activity of Physpe (laminarin) in control of strawberry diseases**

Beata Meszka<sup>1</sup>, Anna Bielenin<sup>1</sup>, Adam Slowinski<sup>2</sup>

*1 Research Institute of Pomology and Floriculture, Skierniewice, Poland; 2 Arysta LifeScience, Poland*

The most important strawberry fruit rot problem in Poland is grey mould caused by *Botrytis cinerea*. Infections of flowers and decay of fruits can result in losses exceeding 50% or more of a yield. Severity of leaf diseases - leaf spot (*Mycosphaerella fragariae*) and powdery mildew (*Sphaerotheca macularis*) depends on susceptibility of cultivar and weather conditions. Some strawberry cultivars: Senga Sengana, Kent, Malling Pandora, Kama are seriously affected by *M. fragariae* and other: Elsanta, Marmolada, Honeoye and Camarosa by *S. macularis*. Fungicide sprays are usually necessary to control diseases, but resistance problem and the opposition in the public, because of residue in fruits and the environment, require alternative strategies to be developed (Peng et al., 1990; Sutton, 1990). In the present study the efficacy of Physpe (laminarin) in control of main strawberry diseases in field

conditions was tested. Laminarin, a linear  $\beta$ -1,3 glucan is extracted and purified from the brown alga *Laminaria digitata* (Aziz et al., 2003). It is known as an elicitor of plant activity against fungal infection. This biological product was tested in Poland conditions during 2006 and 2008 seasons. When applied to strawberry plants just after 10% of flowers was opened, repeated at 5-7 day intervals and 2-3 times before harvest, laminarin reduced *B. cinerea* infection by approximately 50 to 80 % depending on site of experiment. Its effectiveness against *M. fragariae* was on average 55% and against *S. macularis* - 80%. The use of Physpe in mixed programme, with fungicides sprays, can be acceptable for commercial use, especially in control of less susceptible cultivars. It gives possibilities to reduce number of chemical treatments against main strawberry diseases.

*Laminarin, Grey mould, Leaf spot, Powdery mildew, Control strategy*

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### **Prediction of *Xanthomonas arboricola* pv. *pruni* infection on peaches**

Riccardo Bugiani<sup>1</sup>, Simona Giosuè<sup>2</sup>, Vittorio Rossi<sup>2</sup>

*1 Servizio Fitosanitario, Regione Emilia-Romagna, Via di Saliceto 81, 40128 Bologna, Italy; 2 Horta Srl, Spin off company of Università Cattolica del Sacro Cuore, Via E. Parmense 84, 29100 Piacenza, Italy; 3 Istituto di Entomologia e Patologia vegetale, Università Cattolica del Sacro Cuore, Via Emilia Parmense 84, 29100 Piacenza, Italy*

*X. arboricola* pv. *pruni* (Xap) is present on *Prunus* spp. in some European countries, and it is listed as an A2 quarantine pest by EPPO; its importance in Northern Italy has increased in the last decade. An empiric model predicting Xap infection has been developed in late '90s. Occurrence of the first seasonal infection was monitored in peach orchards of Romagna, in 1992 to 2008, and compared to model predictions: an infection was predicted when there were at least 3 successive rainy days, with temperature between 14 and 19°C; symptom's onset was expected after one to four weeks of incubation. Xap symptoms appeared in 10 out of 17 years, between 19 May and 5 July. The model always correctly predicted the correspondent infections, with an average incubation of three weeks. In these 10 years, five early infection periods were predicted by the model that did not result in actual infection. In five years the disease did not appear at all; in 4 of these years the model did not predict infection all the season long, while in one year it wrongly predicted two possible infection periods. In two years the disease was not observed in the experimental plots, but traces of symptoms appeared in the vicinity; in both cases the model predicted only one infection period in early May. In conclusion, the model was very accurate in predicting no infection. Prediction of infection was also accurate because no infection occurred, where there was no Xap predicted, but there were some false positive predictions.

*Disease modelling, Bacterial spot, Weather, Infection period, Validation*

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### **Monitoring of virus and phytoplasma diseases by laboratory diagnostic methods (PCR, RT-PCR, DAS-ELISA) in apple and pear after sanitation processes**

Lubos Talacko, Frantisek Paprstein, Jiri Sedlak

Sanitation of the apple cultivar ('Rubinstep') and pear cultivars ('Astra', 'Bohemica', 'David', 'Elektra', 'Erika', 'Lada', 'Lucasova') was carried out by in vitro thermo- and chemotherapy. In the course of sanitation, the plant material was periodically tested to verify the suitability of selected methods. The presence of pathogens in selected initial trees was detected by PCR, RT-PCR and DAS-ELISA before the beginning of sanitation in 2005. Nineteen clones of the apple cultivar 'Rubinstep', 20 clones of pear cv. 'Elektra', 11 clones of pear cv. 'Erika', 17 clones of pear cv. 'Astra', 16 clones of pear cv. 'Bohemica', 12 clones of pear cv. 'David' after chemotherapy and 10 clones of apple cv. 'Rubinstep', 18 clones of pear cv. 'Elektra', 7 clones of pear cv. 'Lada' and 4 clones of pear cv. 'Lucasova' after chemotherapy were tested in years 2006-2008. The occurrence of the viruses Apple chlorotic leafspot virus (ACLSV), Apple stem grooving virus (ASGV), Apple stem pitting virus (ASPV), Apple mosaic virus (ApMV) and phytoplasmas Candidatus '*Phytoplasma pyri*' and Candidatus '*Phytoplasma mali*' was monitored. The clones, which remained infected with viruses or phytoplasmas after therapy, were later discarded. Those in vitro clones that proved to be pathogen-free after repeated testing were further multiplied and in vitro rooted. Achieved results are preliminary. Other sanitation and testing of apple cultivars used in the project will be carried out in the following years.

Apple, Pear, Sanitation, ASPV, ASGV, ACLSV, ApMV, AP, PD, PCR, RT-PCR, DAS-ELISA

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### **Eutypa dieback as an important disease in red currant (*Ribes rubrum*) and gooseberry (*Ribes uva-crispa*) in the Netherlands**

Marcel Wenneker<sup>1</sup>, Peter Vink<sup>2</sup>, Ilse Heurneman<sup>3</sup>, Marcel van Raak<sup>3</sup>, Anne Sophie van Bruggen<sup>3</sup>

*1 Applied Plant Research, Research Unit Fruit, Wageningen University & Research Centre, P.O. Box 200, 6670 AE Zetten, the Netherlands; 2 Applied Plant Research, Research Unit Flower Bulbs, Wageningen University & Research Centre, P.O. Box 85, 2160 AB Lisse, the Netherlands; 3 Plant Protection Service, P.O. Box 9102, 6700 HC Wageningen, the Netherlands*

Over decades, growers in the Netherlands have problems with a disease that causes dying branches and stem cankers in red currant. For many years it was assumed that this disease was related to fungi such as *Nectria cinnabarina*, *Phomopsis spp.* and the insect *Synanthedon tipuliformis*. However, recently it was found by Applied Plant Research and the Plant Protection Service that the causal organism is the fungus *Eutypa lata*. The disease is considered of major economic importance, especially as red currant growing is rapidly expanding in the Netherlands. *E. lata* was identified with three detection methods (visual, plating and DNA). Symptoms of *Eutypa* do not usually appear until currant plants are at least three to four years old. These cankers are always associated with old pruning wounds. Eventually, the entire branch is killed. High disease incidences and annual losses of 10% - 30% of the productive branches are reported. In some cases entire fields have to be replanted. *Eutypa* is well known as one of the most destructive diseases of grapes. The importance of this disease in currant growing was not known. Research is focusing on the evaluation of control measures; e.g. chemical and biological control treatment of pruning wounds, and

disease management such as sanitation practices. Also, the epidemiology of *Eutypa* is studied. Recently, high densities of ascospores of *Eutypa* were found in a spore trap placed in a red currant field in the Netherlands. In the subsequent field survey, fruiting structures (stromata) and ascospores were found on dead infected red currant wood.

*Eutypa lata*, Canker, Control strategies, Currants

## Poster Session 2 : Pesticides and Resistance

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### **Chlorantraniliprole (DPX-E2Y45, Rynaxypyr®) (Coragen®20SC and Altacor®35WG) - a new diamide insecticide for control of codling moth (*Cydia pomonella*) and other top fruit Lepidopteran pests**

Andrea Bassi<sup>1</sup>, Axel Dinter<sup>2</sup>, Kristin Brugger<sup>3</sup>, Niels-Martin Frost<sup>4</sup>, John Wiles<sup>5</sup>, Jean Luc Rison<sup>6</sup>

*1*DuPont Italy Srl, Via Piero Gobetti 2/C, 20063 Cernusco sul Naviglio (MI) Italy, *2*DuPont de Nemours Deutschland (GmbH), DuPont Str. 1, D-61352 Bad Homburg v.d.H., Germany, *3*E. I. du Pont de Nemours and Company, Wilmington, Delaware 19898, USA, *4*DuPont Denmark, *5*Du Pont (UK) Limited, Wegwood Way, Stevenage, Hertfordshire, SG1 4QN, UK, *6*Du Pont de Nemours (France) SAS, ERDC, 24, Rue du Moulin, Nambesheim, F-68740

Chlorantraniliprole (DPX-E2Y45, Rynaxypyr®) is a new compound from DuPont belonging to a new class of selective insecticides (anthranilic diamides) featuring a novel mode of action (group 28 in the IRAC classification). By activating the arthropod ryanodine receptors it stimulates the release and depletion of intracellular calcium stores from the sarcoplasmic reticulum of muscle cells causing impaired regulation, paralysis and ultimately death of sensitive species. Extensively tested in the field since 2002, it is registered in the USA, Australia, Canada, China and it is close to market introduction in all the main top fruit producing countries. The product general features have been presented in previous, referenced papers. It has very low toxicity for mammals (both acute and chronic), high biological activity on the sensitive species with strong ovi-larvicidal efficacy and good residual properties, excellent performance on codling moth and other chewing pests, stability of performance across the different climatic and farming conditions, no cross-resistance detected to any existing insecticide and minimal impact on pollinator and beneficial arthropod species. Published studies indicate that chlorantraniliprole may have significant mating disruptive effects on *C. pomonella* adults when both males and females are exposed to the residues equivalent to the recommended field rate. This paper focuses on the product features that best fit IFP (Integrated Fruit Protection) criteria and may enhance IFP options while ensuring higher efficacy standards. After reviewing some toxicity data, examples from field/semi-field and laboratory tests are provided regarding comparative performance assessment, minimal impact on beneficial arthropods and bees and a possible reduction in the number of applications versus current standards.

*Insecticide, Chlorantraniliprole, Rynaxypyr®, Ryanodine receptor, Beneficial arthropods, Mating disruption, Codling moth, Bees*

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### **No evidence in codling moth for cross-resistance between chemical insecticides and *Cydia pomonella* granulovirus**

Annegret Schmitt<sup>1</sup>, Isabella Bisutti<sup>1</sup>, Benoît Sauphanor<sup>2</sup>, Johannes A. Jehle<sup>3</sup>, Jürg Huber<sup>1</sup>

*1* JKI, Institute for Biological Control, 64287 Darmstadt, Heinrichstr. 243, Germany; [annegret.schmitt@jki.bund.de](mailto:annegret.schmitt@jki.bund.de); *2* INRA, Agroparc, 84914 Avignon, France; *3* DLR Rheinpfalz, Laboratory for Biotechnological Crop Protection, Breitenweg 71, 67435 Neustadt/Wstr., Germany

Codling moth larvae from 23 orchards located in five European countries were tested for their susceptibility/resistance to the *Cydia pomonella* granulovirus (CpGV-M) in standardized laboratory bioassays. Farmers observed in several of these populations reduced susceptibility to CpGV-M treatment. For each *C. pomonella* strain, the percentage of larvae surviving CpGV-M concentrations of 104 to 106 OB/ml were calculated 14 days after start of the trial and used for prediction of percentage of resistant individuals in the collected population. The mortality was corrected using Abbott's formula, with the average mortality determined in the controls of all 14-day trials performed (mortality due to other reasons than virus). In general, the results from the bioassays were in accordance with the observations in the field. Most orchards from which the farmer reported failure of the CpGV-M treatment contained resistant codling moth populations. The percentage of resistant individuals in a population ranged roughly from 30 to 90%. However, in some apparently susceptible populations there were also hints for the presence of a very small fraction of resistant individuals. Several of these European populations were tested for susceptibility to eight insecticides including different classes of insect growth regulators and neurotoxic compounds. High mortality was recorded to most insecticides, independent of resistance to CpGV. A reduced susceptibility to azinphos, diflubenzurone, and tebufenozide was recorded in several populations. Overall, there was no indication for the occurrence of cross-resistance between CpGV-M and insecticides in the tested populations. First laboratory tests showed that populations of *C. pomonella* resistant to CpGV-M were susceptible to new CpGV strains. This study was funded by the EU, CRAFT project 32857; Further information can be found under [www.sustaincpgv.eu](http://www.sustaincpgv.eu).

*Codling moth, Cydia pomonella Granulovirus, Chemical insecticides, Resistance*

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## **Overview of insecticidal resistance in *Cydia pomonella* and *Adoxophyes orana* in Switzerland**

Denis Pasquier, Pierre-Adrien Roux, Pierre-Joseph Charmillot, Patrik Kehrlj,

*Agroscope Changins-Wädenswil, Protection de végétaux-Entomologie, Route de Duillier, CP 1012, 1260 Nyon, Suisse*

The codling moth, *Cydia pomonella*, and the summer fruit tortrix moth, *Adoxophyes orana*, are two major pest insects in Swiss apple orchards. Using field observations and laboratory bioassays we could establish that these two species developed simple, cross- and multiple resistances to various classes of insecticides over the last decade. The first resistant *C. pomonella* was detected in 1996 and since then several other cases were discovered all over the country. In some populations the effectiveness of commonly used insecticides is nearly zero and insects evolved cross-resistance to nearly all insecticide classes applied. As a consequence, mating disruption and granulose viruses were successfully implemented as alternative control strategies against codling moths. In orchards where these two strategies have been implemented, insecticides are regaining their efficiency. Since 2004 resistance to

insect growth regulators and to insect growth inhibitors can also be found in *A. orana*. As a result of their slower larval development, the flight of these resistant moths is significantly delayed. Delayed flight activity might therefore serve as a reliable indicator of insecticide resistance in summer fruit tortrix moths. In conclusion, the key to successfully managing insecticide resistance is to reduce selection pressure. This can be achieved by incorporating cultural, biological and pheromonal control practices, by minimising the use of insecticides and by altering their mode of action.

*Tortricidae, Pomiculture, Pesticide use, Resistance management*

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### ***Cydia pomonella* (Lep: Tortricidae) resistance and cross-resistance to various classes of insecticides in Central Europe**

František Kocourek

*Crop Research Institute, Department of Entomology, Drnovská 507, Prague 6, 161 06, Czech Republic*

Insecticide bioassays were used to investigate resistance of *Cydia pomonella* (L.) to insecticides with various types of active ingredients. The efficacy baselines of selected insect growth regulators (fenoxycarb), insect growth inhibitors (diflubenzuron, teflubenzuron), organophosphorous insecticides (phosalone) and neonicotinoids (thiacloprid) against the eggs, first- and fifth-instar larvae of sensitive laboratory strains of codling moth were determined. The lethal concentration ratio quantified the relation between the efficacy of selected insecticides against fifth-instar larvae found by topical application and against first-instar larvae found by diet-treated bioassay. According to concentration-mortality baseline, 50% lethality concentration values and 90% lethality concentration values were determined for all the tested insecticides. The bioassay was used to monitor the resistance of codling moths collected in 2003 – 2005 in two apple orchards with different intensities of chemical control. Resistance ratios to the tested insecticides were determined for both field populations of codling moth. For the population of codling moth from an apple orchard in Velké Bílovice, cross-resistance to fenoxycarb, teflubenzuron and phosalone was detected after the topical application of insecticides to fifth-instar larvae. The population of codling moth from Prague-Ruzyn was slightly resistant to phosalone and teflubenzuron. No resistance to diflubenzuron was detected in either tested population. This work was funded by the Czech Science Foundation, the Czech Republic, grant 522/04/P181. Partial funding was also obtained from the Ministry of Agriculture, the Czech Republic, project 0002700603.

*Cydia pomonella, Resistance, Insecticides*

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## **Efficacy of chlotianidyna (neonicotinoid group) in the control of the strawberry root weevil (*Otiorhynchus ovatus*) on strawberry.**

Barbara Labanowska

*Research Institute of Pomology and Floriculture, Pomologiczna street 18, 96-100 Skierniewice, Poland*

Soil pests are of very high importance on strawberry plantations in Poland. White grubs (*Melolontha melolontha*) cause main damages on youngest plantations but great losses on older plantations are a result of two weevil species feeding on roots: strawberry root weevil (*Otiorhynchus ovatus*) and black vine weevil (*Otiorhynchus sulcatus*). The efficacy of two new insecticides containing chlotianidyna, belonging to neonicotinoid group: Apacz 50 WG and Apacz TI 435 GR were tested in the control of strawberry root weevils on strawberry plantations. Apacz 435 GR applied at the rate 10 kg and 15 kg/ha onto the soil under plants in the spring before strawberry blossom, reduced the number of the strawberry root weevils. In two experiments Apacz 435 GR used at the higher rate (15 kg/ha) decreased pest population by about 72 %. This insecticide used at the lower rate (10 kg/ha) also reduced the pest density by 61.3 or 78.7 %. Results obtained with Apacz 435 GR were statistically similar to those obtained with standard insecticide – Diazinon 10 GR (80 kg/ha). Apacz 50 WG applied at the rate 150 g and 200 g/ha on strawberry plantation before blossom reduced strawberry root weevil population by 98.5 - 99.6 %. Apacz 50 WG applied at the rate 150 g and 200 g/ha on strawberry plantation just after harvest, when the strawberry root weevils are feeding on leaves and laying eggs, reduced the number of pest by 72.1-84.9 %. The results obtained with Apacz 50 WG were similar to those obtained with standard insecticide – Diazinon 10 GR or Dursban 480 EC.

*Otiorhynchus, Apacz, Chemical control, Strawberry, Root weevil*

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## **Trials for the development of alternative control strategies against the codling moth (*Cydia pomonella*) in pome fruits in Austria in 2007**

Christa Lethmayer, Hermann Hausdorf, Josef Altenburger

*AGES, Austrian Agency for Health and Food Safety, Institute of Plant Health, Spargelfeldstraße 191, A-1226 Vienna, Austria, christa.letmayer@ages.at*

The development of future alternative control strategies against the codling moth (*Cydia pomonella*) is an important subject for the pome fruit production both nationally and internationally. The reasons are not only the increasing resistance of *C. pomonella* against plant protection products and against virus products, but also the expiry of the registration of important plant protection products especially for integrated production. In Austria great problems are expected from 2008 onwards due to the loss of the most commonly used organophosphate insecticide against the codling moth at present. Therefore, in 2007 control trials against the codling moth were carried out by the Institute of Plant Health (AGES) in coordination with the chambers of agriculture of Lower Austria and Styria. Trials were conducted according to the EPPO-guideline PP 1/7(3) comprising 8 variants including one untreated control. Four plant protection products with fenoxycarb, methoxyfenozide,

chlorpyrifos and indoxacarb as active substances were used in different numbers of application and combinations. The untreated control plots showed very high infestation levels (66% infestation). Although the other treatments resulted in different efficacy levels in the reduction of the pest, the economic damage threshold (1% infestation) was exceeded in every treatment. Due to the fact that infestation levels of the codling moth and resistance problems increased during the last years it can be concluded that more effective control strategies have to be developed to ensure the quality and quantity of pome production for the future.

*Codling moth, Pomefruit, Control strategy, Plant protection products*

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### **Microencapsulation and piperonyl butoxide: tools in resistance management of the green peach aphid**

Emanuele Mazzoni<sup>1</sup>, Carlotta Gobbi<sup>2</sup>, Ferdinando Pavesi<sup>1</sup>, Valerio Borzatta<sup>2</sup>, Piero Cravedi<sup>1</sup>

*1 Istituto di Entomologia e Patologia vegetale - Università Cattolica del Sacro Cuore – Piacenza – Italy – emanuele.mazzoni@unicatt.it ; 2 ENDURA – Research and Development Department – Ravenna – Italy – cgobbi@endura.it*

Insecticide resistance can be a serious threat to the application of Integrated Pest Management. The Green Peach-Potato Aphid, *Myzus persicae* (Sulzer) is a serious pest in peach orchards. Insecticide treatments have selected many populations that have different degrees of insecticide resistance due to different resistance mechanisms. These resistance mechanisms can interfere with many classical insecticide classes, but, fortunately, till now, there is no clear evidence for resistance to neonicotinoids. The severity of this problem is also increased by the reduction of the available active ingredients that can lead to an abuse of a single group of insecticides. Many populations of *M. persicae*, both in Italy and in Europe, over-express a carboxylesterase (E4/FE4) that reduces in various degrees the efficacy of several insecticides by hydrolysis and / or by sequestration. Recently, many authors have demonstrated that piperonyl butoxide (PBO) can efficiently interfere with esterase activity overcoming insecticide resistance. Several microencapsulated products (in polyurea or cyclodextrin) with PBO and various active ingredients have been tested in laboratory bioassays against a susceptible and against an esterase resistant population of *M. persicae*. A comparison was done with the commercial formulated products alone or mixed with PBO. The results achieved with the different formulations are discussed in term of increased mortality, application rate as well as offsprings reduction. According to the results achieved, the use of these types of microencapsulation together with PBO could be an interesting tool to be included in resistance management strategies against the green peach-potato aphid.

*IPM, Myzus persicae, Insecticide resistance, Piperonylbutoxide*

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### **Susceptibility to abamectin of pear psylla, *Cacopsylla pyri* (L.) (Hemiptera: Psyllidae) in pear orchards of north-east Spain**

Xavier Miarnau<sup>1,2</sup>, Miquel Artigues<sup>2</sup>, Maria José Sarasúa<sup>1,2</sup>

1 Universitat de Lleida. Departament de Producció i Ciència Forestal. Av. Rovira Roure, 191, 25198 Lleida, Spain; 2 Centre UdL-IRTA de R+D. Departament de Protecció de cultius. Av. Rovira Roure, 191, 25198 Lleida, Spain

*Cacopsylla pyri* (L.) (Hemiptera: Psyllidae) is a key pest of pear orchards in the fruit growing area of north-east Spain. Chemical control is the most common method used against pear psylla, but the number of insecticides registered to control it has been reduced in the last years. The high selection pressure with abamectin, applied repeatedly over the whole area, can result in the appearance of resistance, as has happened with other products. With the aim of monitoring future changes in the susceptibility of *C. pyri* to abamectin, we used topical application bioassays in adults, and residual application in nymphs to obtain current data on the susceptibility in the area. We collected 15 populations from different orchards in Lleida, Huesca and Girona, where heavy use of insecticides (including abamectin) is the common practice. The bioassays were carried out from October 2004 to September 2006. To check the evolution of abamectin treatments in the last years we analyzed the records of the treatments from the different orchards. We obtained the current data, LC50 and LC90 of all the populations (adults and all instars nymphs). No evidence of a high level of resistance has been found. However there are a few populations that presented a lower susceptibility, as well in adults as in nymphs. The populations with the lowest level of susceptibility in nymphs were the same that presented the lowest level of susceptibility in adults and they came from the fields with the highest number of insecticide applications.

*Cacopsylla pyri*, Pear psylla, Abamectin, Resistance, Bioassays, Treatment records

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## **Plant infusions to limit the development of pests or diseases : results on *Aphis pomi***

Sophie-Joy Ondet

GRAB, Groupe de Recherche en Agriculture Biologique. Site Agroparc, 84911 Avignon cedex 9, France

We started research on physiomedicalism in 2003, in order to limit the development of pests or diseases in an environment-friendly manner. The potential of indigenous medicinal plants is largely explored and used for human and veterinary medicines, but lately work has started to look at their potential for providing pesticides for use on cultivated plants. Our preliminary tests target has been *Aphis pomi* in apple orchards. To ensure the feasibility of growers using them in the future our preparations are home-made, from dry medicinal plants. From the literature, six plants were selected and then tested to see if they would limit the development of *Aphis pomi* : *Artemisia absinthium* L., *Artemisia vulgaris* L., *Saponaria officinalis* L., *Mentha x piperata* L., *Salvia officinalis* L., *Tanacetum annuum* L. The best results of 2006 and 2007 trials were obtained with the infusions of *Mentha x piperata* and *Artemisia vulgaris*. Results are discussed.

*Organic farming, Physiomedicalism, Plant infusions, Aphis pomi*

### **Comparison of susceptibility and nycthemeral rhythms between reared insects of Mediterranean fruit fly (*Ceratitis capitata*) and wild population of Algeria treated with a fenthion insecticide.**

Salah Oukil<sup>1, 2</sup>, Renè Causse<sup>2</sup>

*1 INRAA Laboratoire de Protection des Végétaux CRP Mahdi Boualem BP 37 Baraki 16210 Alger, Algérie; 2 UMR- INRA/ UAPV. Ecologie des invertébrés, 84914 Avignon Cedex 9, France*

Fenthion toxicity was studied with topical application and lethal dose LD 50 and DL 80 were assessed on various *C.capitata* Wiedemann populations. Toxicity was lower in wild individuals than in reared insects, among which individuals irradiated at 90 Gy gamma ray were significantly more susceptible. A nycthemeral variation in the susceptibility to this insecticide was characterized, with some peculiarities related to the origin of the insects and the LD considered.

*Ceratitis capitata, Tephritidae, Wild population, Insecticide, Fenthion, Irradiation, Lethal dose, Nycthemeral variation.*

### **Preliminary resistance screening of abamectin on pear psylla (Hemiptera: Psyllidae) in Northern Italy**

S. Civolani<sup>1</sup>, R. Peretto<sup>1</sup>, C. Chieco<sup>1</sup>, M. Chicca<sup>1</sup>, M. Leis<sup>1</sup>, E. Pasqualini<sup>2</sup>

*1 Department of Biology and Evolution - University of Ferrara (Italy); 2 DiSTA (Department of Agroenvironmental Science and Technologies) - University of Bologna (Italy)*

Civolani S.1, Peretto R.1, Chieco C.1, Chicca M.1, Leis M.1, Pasqualini E.2 1 Department of Biology and Evolution - University of Ferrara (I) 2 DiSTA (Department of Agroenvironmental Science and Technologies) - University of Bologna Preliminary resistance screening of abamectin on pear psylla (Hemiptera: Psyllidae) in Northern Italy . In northern Italy (Emilia-Romagna Region), integrated pest management (IPM) has been adopted for several years to control pear psylla, *Cacopsylla pyri* L. (Hemiptera: Psyllidae), a relevant pest of pear (*Pyrus* spp.) orchards. After the outlawing of amitraz in 2005, the most common active ingredient now used for control is abamectin, a mixture of avermectin B1a and avermectin B1b. After the development of *C. pyri* resistance to different active ingredients in several European growing areas, an evaluation using a range of laboratory tests (topical application on adults, spray application on eggs, leaf dip test on young and old larvae) were carried out during 2007 and 2008 to assess *C. pyri* susceptibility to abamectin, using populations of this pest which had been obtained, from several orchards where a range of control strategies were being applied. The results are discussed.

*Cacopsylla pyri, Abamectin, Resistance, Pear*

## Strategies and timing of protection practices against *Cydia pomonella* (L.) in apple orchards

Daniel Plénet<sup>1</sup>, Camille Picard<sup>1</sup>, Jean-François Toubon<sup>1</sup>, Olivier Martin<sup>2</sup>, Rachid Senoussi<sup>2</sup>, Benoît Sauphanor<sup>1</sup>

*1 INRA, UMR 1115 Plantes et Systèmes de culture Horticoles, Agroparc, F-84914 Avignon Cédex 9, France, 2 INRA, UMR 1115 Plantes et Systèmes de culture Horticoles, Agroparc, F-84914 Avignon Cédex 9, France*

Codling moth (*Cydia pomonella*) is the target of over 10 insecticides a year in south-eastern France. Data was collected in 2006 year, from 71 randomised pear and apple orchards in a small production area near Avignon, in order to understand the management practices against this species. We first investigated the timing and frequencies of insecticide applications in relation with national recommendations. The orchards were classified according to three management strategy: conventional with exclusive use of chemical insecticides; MD associating mating disruption with chemical pesticides; ORG, organic orchards. For each plot and day, the probability to apply an insecticide was determined by a logistic model taking into account the mean variables being able to influence farmers' decisions to set off the application. The numbers of insecticide applied against *C. pomonella* were significantly affected by the host plant species and by the protection strategies in apple orchards. In conventional and ORG orchards, the application frequencies were slightly enhanced during the high risk periods of each generation of the pest. In MD orchards, the frequencies of treatments correctly followed the recommendations and were reduced during the low-risk periods, at the beginning and end of each generation. The strategies strongly modified the choice of the active ingredients. Their alternation was weak, especially for organophosphates in conventional and for granulosis virus in ORG orchards. The understanding of the farmer practices appeared as an essential goal to identify the constraints to the adoption of integrated pest management strategies.

*Cydia pomonella* L., Pesticide management practices, Application frequency, Mating disruption, Organic orchards, Timing of spray application

## Insecticide resistance of *Cydia pomonella* (L.) (Lepidoptera: Tortricidae) eggs and first larval instars in Spanish field populations

Marcela Rodríguez, Dolors Bosch, Tânia Marques, Jesús Avilla

*Department of Crop and Forest Sciences, and Center UdL-IRTA for R+D, University of Lleida, Av. Rovira Roure 191, 25198 Lleida, Spain*

To know the efficacy of insecticides on Codling moth (*Cydia pomonella* (L.) (Lepidoptera: Tortricidae)) Spanish field populations of this insect were collected from orchards with heavy damage and the mortality caused by the LC90 of a susceptible strain (S\_Lleida) was recorded. Five ovicides and 7 larvicides were tested on eggs and first instar larvae (L1), respectively, from field populations. Commercial and technical products were used for L1 and eggs, respectively. Eggs were topically treated (0.1 µl/egg) and L1 were exposed to semiartificial diet treated on its surface (2 µl/cm<sup>2</sup>). Every insecticide showed an efficacy significantly lower than its efficacy for S\_Lleida for at least one population. The majority of the field populations

were significantly less sensitive to the insecticides than S\_Lleida was (96 % and 70% for ovicides and larvicides, respectively). Fenoxycarb and thiacloprid were the most effective ovicides, and lambda cyhalothrin, alpha cypermethrin and chlorpyrifos-ethyl were the most effective larvicides. For three field populations, an inverse relationship between the efficacy of azinphos-methyl and chlorpyrifos-ethyl was observed. To know the role played by detoxification mechanisms, esterase (EST), mixed-function oxidase (MFO) and glutathione-S-transferase (GST) activity was evaluated on L1. Seventy percent of field populations showed a MFO activity significantly higher than the susceptible one, but only one of them also showed higher EST and GST activity.

*Cydia pomonella, insecticide resistance, field populations, eggs, L1, detoxication enzymatic activity.*

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### **Molecular detection of pest resistance to insecticides**

Myriam Siegwart, Juliette Goussopoulos, Jérôme Olivares

*PSH – Ecologie de la Production Intégrée, INRA Site Agroparc, 84914 Avignon Cedex 9, France*

Insecticide resistance occurs at three levels in insects : i) stopping penetration through barrier tissues ii) conjugation, storage, and metabolisation in internal tissues iii) modification of the molecular target site. The detection of these biological adaptations more often realise by the way of biotests. This technique allows to characterise the resistance level of a population to a given compound, but is not informative about the mechanism. Therefore, it limits the investigation potential and the resistance management becomes more difficult. In this case, molecular detection can be interesting, making easy the identification of target mutations, expression or structure modifications of detoxifying enzymes. Acetylcholine esterase and sodium channel are two important molecular targets of organo-phosphosphates, carbamates and pyrethroids insecticides. The study of their genes sequences allows the development of molecular tools in order to screen field populations. We already developed some molecular tools to detect and control easily pyrethroid resistance in *Cydia pomonella*. Now we are investigating the molecular structure of target sites in different pest species, including *Cydia molesta*, *Dysaphis plantaginea*, *Bactrocera oleae*, aiming to define new molecular tools for resistance detection. The first results are presented and discussed.

*Resistance, Insecticides, Molecular detection, Acetylcholine esterase, Sodium channel*

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### **New isolates of CpGV overcome virus resistance of codling moth**

Daniel Zingg

*Andermatt Biocontrol AG, Stahlermatten 6, 6146 Grossdietwil, Switzerland*

Since 2004 codling moth (*Cydia pomonella*) populations with resistance towards the Mexican isolate of *Cydia pomonella* granulovirus (CpGV) have been found in Austria, France, Germany, Holland, Italy and Switzerland. In the following years Andermatt Biocontrol developed Madex Plus and several other new virus isolates, which can overcome the

resistance. The new isolates were selected on virus resistant codling moth populations in the laboratory. The virus isolates were tested on sensitive and virus-resistant codling moth populations in laboratory bioassays and in field trials. All tested new virus isolates showed a good efficacy on sensitive codling moth larvae comparable to or better than the Mexican isolate. Also all the new virus isolates gave good control of Mexican isolate-resistant codling moth populations. Andermatt Biocontrol is thus able to offer products based on new virus isolates that present the solution against virus resistance.

*Codling moth, Cydia pomonella, Granulovirus, CpGV, Resistance, New isolates*

## Poster Session 2 : Plant – Pest Interaction

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### **A virtual fruit model simulating quality and storage potential for the peach-brown rot system: design and use to define technical scenarios meeting IFP guidelines**

Caroline Gibert

*Unité PSH, INRA, site Agroparc, 84914 Avignon, France*

Based on experiments on nectarine fruits grown under various cultural conditions (variable fruit crop loads and irrigation regimes), cuticular cracks were quantified and their contribution to fruit quality via the surface conductance to water vapour diffusion, and to fruit contamination by brown rot was examined by a modelling approach. The evolution of conductance, of its components, and of cuticular crack surface area driven by fruit growth, and the probability of fruit infection in relation to the cuticular crack surface area and the conidial density, were modelled and the equations integrated into an existing “virtual fruit” model simulating organoleptic quality traits. The resulting integrated model allows simulating both quality and storage potential performances in response to distinct fruit growing conditions. Several virtual technical scenarios, considered as reflecting various cultural practices (cultivar choice, time of thinning, fruit crop load, irrigation, disease preservation strategy), were evaluated by analysing simulated performances at harvest on the corresponding revenue (according to the commercial grade), on the fruit quality profile (sweetness index, flesh dry matter content, flesh per fruit fresh mass ratio, cuticular crack density) and their environmental impacts. The most interesting scenarios, providing a correct trade-off between these traits, comprised water stress during final fruit swelling but require an evolution of market standards. Our model could allow testing some innovating technical scenarios emphasizing the reduction of inputs (water and pesticides) while managing a good fruit quality profile.

*Peach, Brown rot, Cuticular crack, Conductance, Fruit growth, Fruit quality, Irrigation, Thinning, Modelling*

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### **Codling moth (*Cydia pomonella* L.) egg-laying behaviour on two *Malus* sp. preferred and non preferred for egg-laying and leaf surface metabolite signals.**

Nadia Lombarkia

*INRA, UMR 1272 PISC, Route de Saint-Cyr, 78026 Versailles Cedex France, e-mail: nlombarkia@yahoo.fr, derridj@versailles.inra.fr. Fax: + (33) 01.30.83.31.19*

Plant chemical cues are important for host and organ selection for egg-laying. We already demonstrated that a leaf surface six metabolite pattern influence *Cydia pomonella* (C. p.) egg-laying. Which behavioural steps are used by C. p. after landing on the leaf surface to detect such signals? Are they different on host and non host *Malus* sp.? We chose *Malus domestica* (var. Reine des Reinettes) which is susceptible to egg-laying and *Malus floribunda* (clone Baugène) which is not laid on by this species. The behaviour was observed in controlled conditions on trees and no-choice conditions with two days egg-laying females (15 to 20). C. p. could land on both plants and several sites within plants. After landing and contact with their legs, C. p. could lay eggs or fly away depending on site. Acceptance and egg-laying together take a very short time ( $299,57 \pm 89,44$  (sec)). The exploration sequences consisted in walking, stopping a while, scanning with the ovipositor while walking or stopping. When there was egg-laying there was a longer time of exploration of the landing sites which was explained by a slower speed of locomotion and mainly by the presence of the scanning behaviour. The time duration of scanning varied with the plant organ ( $2,75 \pm 1,25$  (sec) on fruits and  $0,70 \pm 0,52$  (sec) on leaves). On the leaf surface of Baugène, ratios of the six metabolites within the pattern were different from those from Reine des Reinettes and their quantities much higher. This could be at the origin of non host inherent attributes of Baugène.

*Codling moth, Egg-laying behaviour, Malus, Primary metabolites, Cydia pomonella*

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## **Apple resistance to arthropod herbivores: genetic basis and modification by environmental factors**

Karsten Mody<sup>1</sup>, Sibylle Stöckli<sup>1</sup>, Cesare Gessler<sup>2</sup>, Silvia Dorn<sup>1</sup>

*1 ETH Zurich, Institute of Plant Sciences / Applied Entomology, 8092 Zurich, Switzerland; 2 ETH Zurich, Institute of Integrated Biology / Plant Pathology, 8092 Zurich, Switzerland*

Arthropod herbivores reduce the quantity and quality of apple yield. Resistant apple varieties hold promise to increase the sustainability of pest management in orchards, but little is known on the genetic basis of apple resistance to most arthropod herbivores. Knowledge on the apple genome and QTL (quantitative trait locus) analysis is now facilitating the identification of gene regions associated to resistance. 160 F1-progeny plants of a cross of the apple varieties 'Fiesta' and 'Discovery' were surveyed at three different sites in Switzerland. Herbivore infestation per genotype as a measure of resistance was quantified for the apple aphids *Dysaphis plantaginea*, *Dysaphis cf. devectora* and *Aphis pomi*, the apple rust mite *Aculus schlechtendali*, and the codling moth *Cydia pomonella*. The influence of the environmental factor drought stress on apple resistance to a chewing and a sap-feeding herbivore (caterpillar; aphid) was studied in laboratory experiments considering different intensities of pulsed drought stress. Significant QTLs for resistance to *D. plantaginea*, *D. cf. devectora*, *A. schlechtendali*, and *C. pomonella* were detected. SSR alleles associated to the QTLs may be applied to identify and breed resistant apple cultivars. Environmental factors like (a) within-canopy variation in climate, and (b) neighborhood-effects affected herbivore distribution in the field. In the laboratory, pulsed drought stress resulted in non-monotonic resistance responses of apple trees. Low-stress plants showed the highest and high-stress plants the lowest resistance. The study revealed the genetic basis of apple resistance to different arthropod herbivores and the modifying influence of environmental parameters that may impede QTL detection.

## **Peach breeding for multiple resistances to pests and diseases contributes to integrated fruit production**

T. Pascal<sup>1</sup>, P. Lambert<sup>1</sup>, J.L. Poëssel<sup>1</sup>, V. Decroocq<sup>2</sup>, M.H. Sauge<sup>3</sup>

*1 INRA, UGAFL, BP 94 - 84143 Avignon-Montfavet Cedex (France) 2 INRA, IBVM, UMR GDPP, Virologie, BP81, 33883 Villenave d'Ornon (France) 3 INRA, UPSH, Domaine St Paul, Site Agropar*

In spite of the worldwide decline in peach production, a constant stream of new varieties are being provide to fruit growers. For the greater part most of these new varieties being produced by private peach breeders, and as a consequence very few are selected on the basis of their resistance to pests or diseases, while the demand of consumers continues to be directed towards a quality fruit product which is free of pesticide residues. Within the framework of one INRA multidisciplinary group (Avignon-Bordeaux), we have developed for several years a wide applied breeding program aiming at improving the resistance of the peach tree to three of its main enemies: the green peach aphid (*Myzus persicae*), peach powdery mildew (*Sphaerotheca pannosa* var. *persicae*) and sharka disease (Plum Pox Virus). This work is globally conducted in a research context oriented towards varietal innovation including fruit quality and durable resistances building. In this way, two complementary approaches have been preferentially held for respectively improving the genetic gain by time unit and a better understanding of peach-enemies relationships. First, a genetic approach integrating the quantitative trait loci or major genes mapping for the development of molecular assisted selection. Second, a functional approach (i) leaning on the study of the insect behaviour and the plant metabolites involved in the resistance to *M. persicae* (ii) coupled to a candidate-genes research mainly developped for PPV resistance. Whole of first results and perspectives are discussed.

*Prunus persica, Myzus, Powdery mildew, Sharka, Genetic linkage map*

## Poster Session 2 : Population Modelling

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### **GEP, a tool to help decision making for pest control advisers in Lleida (Spain)**

Manel Ribes-Dasi<sup>1</sup>, Ramon Torà<sup>2</sup>, Jesús Avilla<sup>3</sup>

*1 Departament d'Enginyeria Agroforestal, Universitat de Lleida, Av. Rovira Roure 191, 25198 Lleida, Spain. 2 Servei de Sanitat Vegetal, Generalitat de Catalunya, Av. Rovira Roure 191, 25198 Lleida, Spain. 3 Department of Crop and Forest Sciences, and Center UdL-IRTA for R+D, University of Lleida, Av. Rovira Roure 191, 25198 Lleida, Spain*

GEP is a new tool developed by the University of Lleida, IRTA and the Catalan Plant Protection Service to furnish Pest Control Advisers (PCAs) with up-dated information on the spatial distribution of pests in the fruit growing area of Lleida. It is the consequence of the work carried out since 1998, which has been regularly presented in the IOBC WG meetings. The Pest Control Advisers maintain and check the net of pheromone traps, send the results to the Plant Protection Service and the UdL, and receive back the processed information within 3 days. The system has been improved by the use of Google Earth™ maps.

*GEP, Advisory system, Spatial distribution*

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### **MRV-Carpocapsa: a phenological model as a decision support system for codling moth (*Cydia pomonella* L.) in Emilia-Romagna (Italy)**

Alda Butturini, Rocchina Tiso, Mauro Boselli

*Regione Emilia-Romagna, Servizio Fitosanitario, Via di Saliceto 81, 40128 Bologna, Italy*

A warning service for pests and diseases of the most important crops was set up in Emilia-Romagna Region (Italy) in 1997. Integration of information obtained by forecasting models and field surveys are used to develop warnings concerning the risk of pest/disease attack. For the control of *Cydia pomonella* a phenological time-distributed delay model is available. Biological parameters were defined in 1991 in lab-trials. On the basis of hourly temperature, the model can simulate the development of the first and second generation. It gives as output the cumulative percentages of egg-laying, egg-hatching, pupation and adult emergence as well as the age structure of the population. The model has been fully tested during 1992-1998 and therefore has been effectively used for ten years in Emilia-Romagna to optimize control strategies in IPM. From the first use in 1998, quality control of simulated data was executed by comparison with observations in orchards. As pheromone traps do not always describe population dynamics properly, it was decided to assess oviposition activity. Weekly field observations were carried out over 1998 – 2008 in an untreated orchard near Bologna. The eggs were examined to determine the exact phase of embryonic development. Then the egg

laying dates were estimated taking into account specific degree-days for each embryonic phase. Results from the comparison between the simulated data and those observed in the field are reported. Altogether, actual and simulated oviposition curves agree fairly well over the last eleven years despite the different climatic conditions recorded in this period.

*Cydia pomonella, Codling moth, Simulation model*

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### **Development of a dynamic population model as a decision support system for Codling Moth (*Cydia pomonella* L) management**

Marc Trapman<sup>1</sup>, Herman Helsen<sup>2</sup>, Matty Polfliet<sup>3</sup>

*1 Bio Fruit Advies, Dorpsstraat 31, Zoelmond, the Netherlands, 2 Applied Plant Research, Wageningen UR, Zetten, the Netherlands; 3 Fruit Consult, Zetten, the Netherlands*

In 2004 RIMpro-Cydia was developed as a dynamic population model that simulates the within-year biology of a local codling moth population. The model is meant to be used by growers and advisors to optimize the control of codling moth populations in organic and integrated managed orchards. The model is based on literature data and unpublished research data. Fractional boxcar trains are used to mimic the dispersion in the developmental processes. The model is run in real time on the data input of local weather stations, starting on 1 January. The output of the model was compared with the results of field observations in four years in untreated orchards. The progress in egg deposition as predicted by the model was in general agreement with the field data. The start of the egg deposition period was predicted well. The end of the egg deposition period was predicted when, in the field, about 10% of the eggs were still to be laid in some years. There was no consistency in the relation between cumulated pheromone trap catches and the cumulative egg deposition as calculated from the field data.

*Codling moth, Cydia pomonella, Simulation model*

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### **COSMOS, a spatially explicit model to simulate the epidemiology of *Cosmopolites sordidus* in banana fields**

Fabrice Vinatier<sup>1</sup>, Philippe Tixier<sup>1</sup>, Christophe Le Page<sup>2</sup>, Claude Bruchou<sup>3</sup>, Françoise Lescourret<sup>4</sup>

*1 CIRAD, UPR 26, B.P. 214, F-97285, Le Lamentin, Martinique, France fabrice.vinatier@cirad.fr 2 CIRAD, UPR GREEN, 254 Phayathai road, Pathumwan, 10330, Vietnam; 3 INRA, Unité de Biostatistique, 94914 Avignon cedex 9, France; 4 INRA, Unité PSH, 94914 Avignon cedex 9, France*

In French West Indies, cyclones can cause severe damages to banana plants, and banana pests are thus confronted to a lack of resources. Here, we investigate with a spatial model the effect of a catastrophic disturbance, like a cyclone, on the demography and spatial dynamics of a population of banana weevil (*Cosmopolites sordidus*) in French West Indies. The individual-based model called COSMOS describes the epidemiology of *C. sordidus* in the field. Each

biological parameter of the model was estimated from literature and experimental data. The model was validated at the micro-parcel scale, comparing using the Kolmogorov-Smirnov test observed and simulated distributions of attacks. 12 out of 18 micro-parcels were similar. An exhaustive sensitivity analysis, using the Morris method, allowed evaluating the importance of each parameter in the distribution of attacks. According to model simulations at the field scale, the time necessary for an entire collapse of populations following a shortage of resources is approximately one year, depending only on the mortality rate of adults. Spatial clustering of populations emerges from the model, because of successive grow-up and decline of population associated with limited dispersal capabilities. The model developed here helps us to understand the key factors of the epidemiology of a tropical pest and the dynamics resulting from a major disturbance.

*Individual-based model, Pattern-oriented modelling, Parameter estimation, Population dynamics*

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### **Effects of thermoperiodic conditions on the developmental rates of strains of codling moth larvae resistant and susceptible to chemical and viral (CpGv) insecticides.**

Ana Scomparin<sup>1</sup>, Marc Saudreau<sup>2</sup>, Hervé Sinoquet<sup>2</sup>, Benoît Sauphanor<sup>3</sup>, Odair Fernandez<sup>1</sup>, David G. Biron<sup>2</sup>

*1 Departamento de Fitossanidade – FCAV/UNESP, Rod. Prof. Paulo D. Castellane, km. 5 14884-900 Jaboticabal, SP, Brazil 2 UMR 547 PIAF, INRA - Université de Clermont-Ferrant France; 3 INRA, Unité PSH, 94914 Avignon cedex 9, France*

The codling moth, *Cydia pomonella* (L.) (Lepidoptera: Tortricidae), is a worldwide pest at caterpillar stage in apple and pear orchards that requires frequent control treatments. The relationship between temperature and developmental rate of codling moth has been evaluated in a number of studies. The developmental rate of *C. pomonella* is supposed to be directly proportional to air temperature between the lower and upper developmental thresholds of 9.7-10 °C and around 32-35°C, respectively, with a maximum developmental rate at approximately 30°C. However, some review papers suggest that insect species have a higher developmental rate when they are reared in thermoperiodic conditions as compared with constant temperatures. Thus, in this study, the developmental rate and the zero temperature threshold of larval codling moth were determined in thermoperiodic conditions for strains resistant and non-resistant to chemical and viral (CpGv) insecticides. These strains were: (i) Sv (susceptible strain), (ii) Rd fb (resistant to diflubenzuron), (iii) RD (resistant to deltamethrin), RGV (resistant to *C. pomonella* four *C. pomonella* strains: (i) the x-intercept method i.e. an extrapolation of the best-fit linear approximation of the reciprocal of development time ( $1/d_i$  where  $d_i$  is the time for the development) and (ii) the thermal unit test. Our study supports the “thermoperiod hypothesis” and suggests that the effect of thermoperiod on the developmental rate of the *C. pomonella* larva should be taken into account in the development of phenological models.

*Thermoperiod, Codling moth, Developmental rate, Insecticide resistance*

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### **Raspberry cane midge *Resseliella theobaldi*: 3 years of flight monitoring in Swiss raspberry cultures**

Catherine A. Baroffio

*Agroscope Changins-Wädenswil ACW, Centre de Recherche Conthey, 1964 Conthey, Switzerland*

The raspberry cane midge *Resseliella theobaldi* is a major pest of Swiss raspberries. The midge population dynamics have been studied for 3 years in the Valais region using a sex pheromone identified and synthesised by EMR and NRI. Four to five generations were observed in raspberries grown at low altitude and three to four in crops grown in the mountains. Based on these observations and in order to find a substitute to diazinon, the only registered insecticide for this pest, an efficacy trial was conducted in 2008. Beside diazinon, two insecticides were tested. Only thiacloprid and diazinon gave a significant reduction of the pest compared to the control. The trial will be completed in 2009.

*Soft fruits, Raspberry, Monitoring, Resseliella theobaldi*

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### **Management of oriental fruit moth and codling moth with spray applications of microencapsulated sex pheromone**

Daniele Demaria, Graziano Vittone, Fabio Molinari

*CReSO, Consorzio di Ricerca e Sperimentazione per l'Ortofrutticoltura piemontese, Cuneo, Italy; Università Cattolica del Sacro Cuore di Piacenza, Istituto di Entomologia e Patologia Vegetale, Piacenza, Italy*

Codling moth (*Cydia pomonella* L.) and Oriental Fruit Moth (*Grapholita molesta* Busck) are the main pests of apples and peach, respectively. Various formulations of a synthetic sex pheromone of both species have been developed in order to manage these pests in apple and peach orchards. The most common use of sex pheromones has been with hand-applied dispensers, but their application is labour intensive and growers are interested in alternative approaches. Two sprayable microencapsulated formulations of sex pheromone have recently been commercialized. They can be applied either alone or mixed with different chemicals. Our studies conducted in 2007 and 2008 showed that this method was very effective for both codling moth and oriental fruit moth and gave the same results as insecticides and hand-applied pheromone dispensers.

*Sprayable sex pheromone, Oriental Fruit Moth, Grapholita molesta, Codling Moth, Cydia pomonella, Peach, Apple*

## **Isomate C Plus Dispensers as an Alternative Means for Control of Codling Moth, *Cydia pomonella* L., in Apple Orchards of Bulgaria**

Hristina Kutinkova<sup>1</sup>, Jörg Samietz<sup>2</sup>, Vasilij Dzhuvinov<sup>1</sup>, Vittorio Veronelli<sup>3</sup>, Andrea Iodice<sup>3</sup>

*1 Fruit Growing Institute, Ostromila 12, 4004 Plovdiv, Bulgaria 2 Swiss Federal Research Station Agroscope Changins- Wädenswil ACW, Switzerland 3 CBC(EUROPE) Ltd. Via E. Majorana, 2, I-20054 Nova Milanese Milano, Italy*

In the years 2006-2008 trials on control of codling moth (CM), *Cydia pomonella* (L.) (Lepidoptera: Tortricidae), by mating disruption (MD), using Isomate C plus dispensers (ShinEtsu, Japan), were carried out in an isolated 1-ha apple orchard in southeast Bulgaria and compared to a reference orchard with conventional treatments. Dispensers were hung in the upper third of tree canopies, at the density of 1000 pieces per ha, before CM flights started. Dynamics of CM flights was monitored by pheromone traps installed in the reference orchard and watching for trap shut down inside the trial plot. Fruit infestation was periodically assessed till the harvest time. Hybernating population was estimated in autumn, by counting diapausing CM larvae in corrugated cardboard bands. Every year, Isomate-C plus dispensers completely inhibited CM captures in pheromone traps inside the trial plot. Fruit damage remained at a low level until late July and only increased slightly in August. At harvest the percentage of damaged fruits was below 1%. The hibernating population stayed at a low level. In the reference orchard the final fruit damage was, in spite of numerous conventional treatments, high (5-15%), apparently due to resistance of CM to insecticides. Therefore, mating disruption may serve as an alternative means for control of codling moth in Bulgarian apple orchards. Contrary to reports from other countries, this study has shown that good results from MD can be obtained even on a small-size plot, when isolated from external sources of infestation and initial CM population is low.

*IPM, Apple, Codling moth, Mating disruption, Isomate C plus*

## **A field unit for automatic monitoring of insect behaviour**

Federica Trona<sup>1</sup>, Gianfranco Anfora<sup>1</sup>, Roberto Oberti<sup>2</sup>, Ezio Naldi<sup>2</sup>, Claudio Ioriatti<sup>1</sup>, Gino Angeli<sup>1</sup>

*<sup>1</sup>Plant Protection Department, FEM Research Center, via E. Mach <sup>1</sup>, San Michele all'Adige (TN), Italy; <sup>2</sup>Institute of Agricultural Engineering, University of Milano, via Celoria <sup>2</sup>, Milano, Italy*

The aim of this work was the development of a field unit for automatic recording and related data analysis of insect orientation towards an attractive pheromone source. Currently the evidence of male behaviour under mating disruption is still speculative, due to the difficulty to conduct field observations which unequivocally show the operative mechanisms. This monitoring system provides behavioural data, in order to optimize the effectiveness of control strategies based on semiochemicals. Specifically, the unit records frequencies of the visits, temporal dynamics and trajectories around the attractive source. The operating principle of the unit is based on the acquisition and real-time analysis of near infrared images relative to an area of 80 x 80 cm around the source; the functioning is fully autonomous and remotely

controlled via GSM network. We chose as study model the behaviour of codling moth, *Cydia pomonella* (L.), in an apple orchard managed with mating disruption (Isomate C Plus, 1000/ha). The operation of the unit was verified by analysing the approach of the males toward three different attractive sources: a standard monitoring lure (1 mg of E8,E10-dodecadien-1-ol), an Isomate CP Plus dispenser and two calling females. The infrared camera was placed in the middle of a field tunnel. For each trial 10 virgin, 2-3-day-old males were released. The recordings went on for 2 days, from 7.00 pm to the midnight.

*Cydia pomonella* L., Mating disruption, Pheromone, Infrared camera

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# REGISTRATION LIST

**ADALET Hazir**

Plant Protection Research Institute  
TURKEY  
E-mail: adalethz01@yahoo.com

**AGNELLO Arthur**

Cornell Univ  
USA  
E-mail: ama4@cornell.edu

**ALAPHILIPPE Aude**

INRA UERI  
FRANCE  
E-mail:  
Aude.alaphilippe@gotheron.INRA.fr

**ALLEN Janet**

ADAS UK Ltd  
ENGLAND  
E-mail: janet.allen@adas.co.uk

**ALTINDILSI F. Ozlem**

Plant Protection Research Institute  
TURKEY  
E-mail: altindisli@yahoo.com

**AMARAWARDANA Lakmali**

University of Greenwich  
UNITED KINGDOM  
E-mail: hl68@gre.ac.uk

**APENITE Ilze**

Latvian Plant Protection Research  
Centre  
LATVIA  
E-mail: ilze.apenite@laapc.lv

**ARDIZZONI MARCO**

CBC  
ITALY

**Atigues Miquel**

University of Lleida "  
SPAIN  
E-mail: miquel.aritgues@irta.cat

**AVILLA Jesus**

University of Lleida  
SPAIN  
E-mail: jesus.avilla@irata.cat

**BAENS Igna**

Biobest  
BELGIUM  
E-mail: igna.baens@biobest.be

**BALDESSARI Mario**

FEM Iasma  
ITALY  
E-mail: mario.baldessari@iasma.it

**BARATELLA Valentina**

UNIVERSITA DELLA TUSCIA  
ITALY  
E-mail: vbaratella@unitus.it

**BARIC Bozena**

Faculty of Agriculture  
CORATIA  
E-mail: baric@agr.hr

**BAROFFIO Catherine**

Plantes médicinales et aromatiques  
SWITZERLAND  
E-mail:  
catherine.baroffio@acw.admin.ch

**BASSANETI Carlo**

CBC  
ITALY

**BASSI Andrea**

Dupont and Irac  
ITALY  
E-mail:  
andrea.bassi@ITA.dupont.com

**BELIEN Tim**

Pcfruit Fruittuinweg 1  
BELGIUM  
E-mail: tim.belien@pcfruit.be

**BENGT Boysen**

Swedish University of Agricultural  
Sciences  
SWEDEN  
E-mail: bengt.boysen@ltj.slu.se

**BERGH Chris**

Virginia Tech  
USA  
E-mail: cbergh@vt.edu

**BERGOUGNOUX Patrick**

DE SANGOSSE  
FRANCE  
E-mail: bergoup@desangosse.com

**BERKETT Lorraine**

University of Vermont

USA

E-mail: lorraine.berkett@uvm.edu

**BERRIE Angela**

East Malling Research  
UNITED KINGDOM  
E-mail: angela.berrie@emr.ac.uk

**BIRCH Nick**

SCRI EPI  
SCOTLAND  
E-mail: N.Birch@scri.ac.uk

**BIRON David**

INRA PIAF  
FRANCE  
E-mail: dbiron@clermont.INRA.fr

**BOLLER Ernst**

Agroscope Waedenswill  
SWITZERLAND  
E-mail: ernst.boller@acw.admin.ch

**BORIOLI Pascal**

GRCETA DE BASSE DURANCE  
FRANCE  
E-mail: contact@grceta.fr

**BORVE Jorunn**

Norwegian Institute for Agricultural  
and Environmental Research  
Bioforsk  
NORWAY  
E-mail: jorunn.borve@bioforsk.no

**BOSCH Dolors**

University of Lleida"  
SPAIN  
E-mail: dolors.bosc@irta.cat

**BOULLENGER Amélie**

BCP CERTIS "  
UNITED KINGDOM  
E-mail:  
Boullenger@certiseurope.co.uk

**BOUVEROUX Jurgen**

Biobest  
BELGIUM  
E-mail: info@biobest.be

**BOUVIER Jean-Charles**

INRA  
FRANCE  
E-mail: jbouvier@avignon.INRA.fr

**BROWN Mark**  
US Dept Agriculture  
USA  
E-mail: mark.brown@ars.usda.gov

**BRUN Laurent**  
INRA UERI  
FRANCE  
E-mail: lbrun@avignon.INRA.fr

**BRUNI Roberto**  
Istituto Tecnico Agrario C ULPIANI  
ITALY  
E-mail: roberto.bruni@tele2.it

**BUCHLEITHER Sascha**  
Beratungsdienst ökologischer obstau  
weinsberg  
GERMANY  
E-mail: buchleither@oekoobstau.de

**BUGIANI Ricardo**  
Servizio fitosanitario  
ITALY  
E-mail: rbugiano@regione.emilia-  
romagna.it

**BUSSI Claude**  
INRA UERI  
FRANCE  
E-mail: bussi@avignon.INRA.fr

**CAFFIER Valérie**  
INRA  
FRANCE  
E-mail: vcaffier@angers.INRA.fr

**CAPOWIEZ yvan**  
INRA  
FRANCE  
E-mail: capowiez@avignon.INRA.fr

**CARVALHO César**  
Federal de Lavras  
BRAZIL  
E-mail: cfcarvalho@ufla.br

**CASAGRANDE Enzo**  
AgriSense BCS  
UNITED KINGDOM  
E-mail:  
Enzo.Casagrande@agrisense.co.uk

**CASSANELLI Stefano**  
University of Modena and Reggio  
Emilia  
ITALY  
E-mail: stefano.cassanelli@unimore.it

**CAVAGNERO Guido**  
ITALY

E-mail:  
guidocavagnero@lagrotecnico.it

**CAZENAVE antoine**  
Sumi Agro  
FRANCE  
E-mail:  
antoine.cazenave@sumitomocorpe  
urope.com

**CHEVALIER Alexis**  
Station experimentale de Creysse  
FRANCE  
E-mail:  
a.chevallier.creysse@wanadoo.fr

**CHUNG Bu Keun**  
Gyeongnam Agri Res and  
Extension Services  
KOREA  
E-mail: bkchung@mail.knrda.go.kr

**CIESLINSKA Miroslawa**  
Research Institute of Pomology and  
Floriculture  
POLAND  
E-mail:  
miroslawa.cieslinska@insad.pl

**CIGOLINI Manuela**  
Istituto di Entomologia e  
Patologia vegetale  
ITALY  
E-mail: manuela.cigolini@inicatt.it

**CONIGLIARO Gaetano**  
Viale delle Scienze  
ITALY  
E-mail: gaeconigliaro@unipa.it

**CORMIER Daniel**  
Institut de Recherche et de  
développement en  
agroenvironnement "  
CANADA  
E-mail: daniel.cormier@irda.qc.ca

**COULOMB Philippe**  
ENIGMA  
FRANCE  
E-mail:  
coulomb.enigma@wanadoo.fr

**CRAVEDI Piero**  
Istituto di Entomologia e  
Patologia vegetale  
ITALY  
E-mail: piero.cravedi@inocatt.it

**CRISTOFORI Valerio**  
Universita Della Tuscia via camillo  
de llelis  
ITALY

**CROSS Jerry**  
East Malling Research  
UNITED KINGDOM  
E-mail: jerry.cross@emr.ac.uk

**DAMOS Petros**  
Aristotle University of Thessaloniki  
GREECE  
E-mail: damos@agro.auth.gr

**DARDANELLI Brunella**  
ITALY  
E-mail:  
brunelladardanelli@lagrotecnico.it

**DE CRISTOFARO Antonio**  
Department of animal, plant and  
environmental sciences  
ITALY  
E-mail: decrist@unimol.it

**DE Jong Peter Franz**  
WAGENINGEN UR  
THE NETHERLANDS  
E-mail: peterfrans.dejong@wur.nl

**DEBRAS Jean-François**  
INRA  
FRANCE  
E-mail: Jean-  
Francois.Debras@avignon.INRA.fr

**DEMARIA Daniele**  
Creso  
ITALY  
E-mail:  
daniele.demaria@cresoricerca.it

**DERRIJ sylvie**  
INRA Versailles  
FRANCE  
E-mail: derridj@versailles.INRA.fr

**DIB Hazem**  
INRA  
FRANCE  
E-mail: hazem.dib@avignon.INRA.fr

**DIDELOT FREDERIQUE**  
INRA UMR PaVé  
FRANCE  
E-mail: didelot@angers.INRA.fr

**DOYE Eric**  
Markenhof

GERMANY  
E-mail: eric.doye@pheromontest.de

**DUCHEMIN jean François**  
SUMI AGRO France  
FRANCE  
E-mail: duchemin-sumi-  
agro@orange.fr

**DZHUVINOV Vasily**  
Fruit Growing Institute  
BULGARIA  
E-mail: vcd@valan.net

**EIKEMO Håvard**  
Bioforsk  
NORWAY  
E-mail: haavard.eikemo@bioforsk.no

**EPSTEIN David**  
MI State University MI  
UNITED STATES  
E-mail: epstei10@msu.edu

**ESCUADERO COLOMAR Lucia**  
**Adriana**  
IRTA-Mas Badia  
SPAIN  
E-mail: adriana.escudero@irta.es

**FEDERICA TRONA**  
FEM  
ITALY  
E-mail: federica.trona@iasma.it

**FERRARO Valeria**  
Viale delle Scienze  
ITALY  
E-mail: vafer77@libero.it

**FITZGERALD Jean**  
East Malling Research  
UNITED KINGDOM  
E-mail: jean.fitzgerald@emr.ac.uk

**FLEURY Dominique**  
Ecole d'Ingénieurs de Changins  
SWITZERLAND  
E-mail:  
Dominique.Fleury@eichangins.ch

**FOUNTAIN Michelle**  
East Malling Research  
UNITED KINGDOM  
E-mail: michelle.fountain@emr.ac.uk

**FRANCK Pierre**  
INRA  
FRANCE  
E-mail: pfranck@avignon.INRA.fr

**FUKUMOTO Takehiko**  
Shin Etsu Chemical Company

**GADOURY David**  
Cornell University  
USA  
E-mail: dmg4@cornell.edu

**GENARD Michel**  
INRA  
FRANCE  
E-mail: mic@avignon.INRA.fr

**GESSLER Cesare**  
ETH-Zürich  
SWITZERLAND  
E-mail: cesare.gessler@agrl.ethz.ch

**GIBERT Caroline**  
INRA UMR 406  
FRANCE  
E-mail:  
gibert.caroline@avignon.INRA.fr

**GIOSUE Simona**  
Università Cattolica del Sacro  
Cuore  
ITALY  
E-mail: simona.giosue@unicatt.it

**GLEASON Mark**  
Department of Plant Pathology  
Iowa State University  
USA  
E-mail: mgleason@iastate.edu

**GOBIN Bruno**  
PCS  
BELGIUM  
E-mail: bruno.gobin@pcsierteelt.be

**GOMEZ Laurent**  
INRA  
FRANCE  
E-mail:  
laurent.gomez@avignon.INRA.fr

**GRASSI Alberto**  
IASMA Research Centre  
ITALY  
E-mail: alberto.grassi@iasma.it

**GRAZIANO Vittone**  
Creso  
ITALY

**GROSS Michael**  
Biohelp GmbH

Austria 4,  
E-mail: michael.gross@biohelp.at

**GUINAUDEAU Johnny**  
INRA Ueri  
FRANCE  
E-mail:  
jguinaudeau@avignon.INRA.fr

**GUT Larry**  
Michigan State University  
USA  
E-mail: gut@msu.edu

**HEIJNE Bart**  
Wageningen UR/Applied Plant  
Research (PPO)  
THE NETHERLAND  
E-mail: bart.heijne@wur.nl

**HELSEN Herman**  
Wageningen UR, Applied  
THE NETHERLAND  
E-mail: herman.helsen@wur.nl

**HOLB Imre J**  
Univeristy of Debrecen  
HUNGARY  
E-mail: holb@agr.unideb.hu

**HUSHALLING stale**

**IODICE Andrea**  
CBC (EUROPE) LTD.  
ITALY  
E-mail: aiodice@cbceurope.it

**IORIATTI Claudio**  
FEM  
ITALY  
E-mail: claudio.ioriatti@iasma.it

**JAASTAD Gunnhild**  
The Norwegian Institute for  
Agricultural and Environmental  
Research  
NORWAY  
E-mail:  
Gunnhild.jaastad@bioforsk.no

**JEHLE Johannes**  
DLR Rheinpfalz, Abt.  
E-mail: Johannes.jehle@dlr.rlp.de

**JESSUP Andrew**  
FAO/IAEA agriculture and  
biotechnology  
AUTRIA  
E-mail: a.jessup@iaea.org

**JORDAN Marie-Odile**  
INRA  
FRANCE  
E-mail: moj@avignon.INRA.fr

**JUAN Delphine**  
Enigma  
FRANCE  
E-mail: juan.enigma@wanadoo.fr

**KEHRLI Patrik**  
Agroscope Changins-Wädenswil  
SWITZERLAND  
E-mail: patrik.kehrli@acw.admin.ch

**KELLERHALS Markus**  
Agroscope Changins-Wädenswil PO  
SWITZERLAND  
E-mail:  
markus.kellerhals@acw.admin.ch

**KERIK Cox**  
Cornell University  
UNITED STATES  
E-mail: kdc33@cornell.edu

**KHARAZI PAKDEL Aziz**  
Campus of Agriculture and Natural  
Resource  
IRAN  
E-mail: pakdel@ut.ac.ir

**KNIGHT Alan**  
USDA-ARS  
USA  
E-mail:  
Alan.Knight@ARS.USDA.GOV

**KOCH Uwe T.**  
Universität Kaiserslautern  
GERMANY  
E-mail: ukoch@rhrk.uni-kl.de

**KOCOUREK Frantisek**  
Crop research institute  
CZECH REPUBLIC  
E-mail: kocourek@vurv.cz

**KOEPPLER Kirsten**  
Julius Kuehn Institute (JKI),  
GERMANY  
E-mail: kirsten.koeppler@jki.bund.de

**KOHL Jürgen**  
Plant Research International  
THE NETHERLAND  
E-mail: jurgen.kohl@wur.nl

**KRAWCZYK Greg**  
PSU FREC  
UNITED STATES

E-mail: gxk13@psu.edu

**KRAZZ Iris**

**KUTINKOVA hristina**  
Fruit growing institute  
BULGARIA  
E-mail: kutinkova@abv.bg

**LABANOWSKA Barbara**  
Research Institute of Pomology and  
Floriculture  
POLAND  
E-mail: blabanowska@insad.pl

**LACORDAIRE Anne-Isabelle**  
Koppert France  
FRANCE  
E-mail: ailacordaire@koppert.fr

**LAEMMER Christian**  
TOTAL FLUIDES "  
FRANCE  
E-mail:  
christian.laemmer@total.com

**LECA Alexandre**  
INRA clermont  
FRANCE  
E-mail:  
Alexandre.Leca@clermont.INRA.f  
r

**LESCOURRET Françoise**  
INRA 1115  
FRANCE  
E-mail: lescou@avignon.INRA.fr

**LESKEY Tracy**  
USDA-ARS Appalachian Fruit "  
USA  
E-mail: tracy.leskey@ars.usda.gov

**LETHMAYER Christa**  
Austrian Agency for Health and  
Food Safety  
AUSTRIA  
E-mail: christa.lethmayer@ages.at

**LICHOU Jean**  
CTIFL "Fruits et technologie  
FRANCE  
E-mail: lichou@ctifl.fr

**LINDER Christian**  
Agroscope ACW  
SWITZERLAND  
E-mail:  
christian.linder@acw.admin.ch

**LINGREN Bill**  
TRECE  
UNITED STATES  
E-mail: sstimson@trece.com

**LLORENTE Isidre**  
University of Girona  
SPAIN  
E-mail: isidre.llorente@udg.edu

**LOMBARKIA Nadia**  
Université  
ALGERIE  
E-mail: nlombarkia@yahoo.fr

**LOPEZ FERBER Miguel**  
LGEI  
FRANCE  
E-mail: miguel.lopez-ferber@ema.fr

**MACHARDY William**  
University of New Hampshire  
USA  
E-mail:  
william.machardy@verizon.net

**MAIGNET Pascal**  
BIOTOP  
FRANCE  
E-mail: pmagnet@biotop.fr

**MALAGNINI Valeria**  
FEM IASMA Research Centre  
ITALY  
E-mail: valeria.malagnini@iasma.it

**MANICARDI Gian Carlo**  
University of Modena and Reggio  
Emilia  
ITALY  
E-mail:  
giancarlo.manicardi@unimore.it

**MARTORANA Alessandra**  
Viale delle Scienze  
ITALY  
E-mail: a.martorana\_1979@libero.it

**MAZZONI Emanuele**  
Università Cattolica S. Cuore Via  
Emilia parmense,  
ITALY  
E-mail: emanuele.mazzoni@unicatt.it

**MEKBIB Sissay Bekele**  
SOUTH AFRICA  
E-mail: sbmekbib@nul.ls

**MELANDRI Massimiliano**

Coop Terremerse  
ITALY  
E-mail: mmelandri@terremerse.it

**MESZKABeata**

Research Institute of Pomology and  
Floriculture  
POLAND  
E-mail: bmeszka@insad.pl

**MILENKOVIC Slobodan**

Faculty of biofarming ,  
SERBIA  
E-mail: sloboento@yahoo.com

**MODY Karsten**

ETH-Zürich "Institute of Plant  
Sciences  
SWITZERLAND  
E-mail:  
karsten.mody@ipw.agr.ethz.ch

**MOERKENS Rob**

UNIVERSITY OF ANTWERP  
BELGIUM  
E-mail: rob.moerkens@ua.ac.be

**MOLINARI Fabio**

Università Cattolica S.C.  
ITALY  
E-mail: fabio.molinari@unicatt.it

**MONDINO Davide**

ITALY  
E-mail:  
davidemondino@lagrotecnico.it

**MONTEIRO LinoI**

**INRA**  
FRANCE  
E-mail:  
lino.monteiro@avignon.INRA.fr

**MONTESINOS Emilio**

University of Girona  
SPAIN  
E-mail: emilio.montesinos@udg.edu

**NAGY Csaba**

East Malling Research  
UNITED KINGDOM  
E-mail: csaba.nagy@emr.ac.uk

**NILSSON Thilda**

HIR-Malmohus  
SWEDEN  
E-mail: thilda.nilsson@hush.se

**OGAWA Kinya**

Shin Etsu Chemical Company

**JAPAN**

E-mail: agawa@shinetsu.jp

**OLSZAK Remigiusz**

Institute of Pomology and  
Floriculture  
POLAND  
E-mail:  
Remigiusz.Olszak@insad.pl

**ONDET sophie-joy**

GRABFRANCE  
E-mail: sophiejoy.ondet@grab.fr

**OSTRKAPA MEDURECAN**

**Zeljka**  
Croatian Agricultural Extension  
Institute  
CROATIA  
E-mail:  
zeljkica.ostrkapa.medjurecan@hzp  
ss.hr

**OUKIL Salah**

INRA laboratoire de protection des  
végétaux CRP  
ALGERIE  
E-mail: s\_oukil@hotmail .com

**OULDSIDI Mohamed Mahmoud**

INRA PSH  
France  
E-mail : oudsidi.  
mohamed@avignon.INRA.fr

**OUREDNIKOVA Jana**

Research and Breeding Institute of  
Pomology  
CZECH REPUBLIC  
E-mail: ourednickova@vsuo.cz

**OZSEMERCI Fatma**

Bornova Plant Protection Research  
Institute  
TURKEY  
E-mail:  
fatmaozsemerci@yahoo.com

**PAJAC Ivana**

Faculty of Agriculture  
CROATIA  
E-mail: baric@agr.hr

**PALLINO Pinco**

BBB0  
ENGLAND  
E-mail: ppalino@bbbo.com

**PAPADOPOULOS Nikolaos**

University of Thessaly

**GREECE**

E-mail: nikopap@uth.gr

**PARISI Luciana**

INRA UERI  
FRANCE  
E-mail: lparisi@avignon.INRA.fr

**PASCAL Thierry**

INRA  
FRANCE  
tpascal@avignon.INRA.fr

**PASQUALINI Edison**

University of Bologna  
ITALY  
E-mail: edison.pasqualini@unibo.it

**PASQUIER Denis**

Agroscope Changins-Wädenswil  
SWITZERLAND  
E-mail:  
denis.pasquier@acw.admin.ch

**PATOCCHI Andrea**

Agroscope Changins-Wädenswil  
SWITZERLAND  
E-mail:  
andrea.patocchi@acw.admin.ch

**PEEVA Penka**

Plant Protection Institute  
BULGARIA  
pip.peeva@gmail.com

**PENARRUBIA Esther**

IRTA-Mas Badia  
SPAIN  
E-mail: esther.penarrubia@irta.es

**PERVEN Servane**

INRA  
FRANCE  
E-mail:  
servane.perven@avignon.INRA.fr

**PEUSENS Gertie**

PCfruit fruittuinweg  
BELGIUM  
E-mail: gertie.peusens@pcfruit.be

**PHILION Vincent**

IRDA  
CANADA  
E-mail: vincent.philion@irda.qc.ca

**PLENET Daniel**

INRA  
France

E-mail:  
daniel.plenet@avignon.INRA.fr

**PLUCIENNIK Zofia**  
INSAD  
POLAND  
E-mail: Zofia.Pluciennik@insad.pl

**PRADOLESI Gianfranco**  
Coop Terremerse  
ITALY  
E-mail: gpradolesi@terremerse.it

**PRANTL Markus**  
Südtiroler Beratungsring Für Obst-  
Und Weinbau  
ITALY  
E-mail:  
markus.prantl@beratungsring.org

**PRODORUTTI Daniele**  
Fondazione Edmund Mach-IASMA  
ITALY  
E-mail: daniele.prodorutti@iasma.it

**RAMBORG Suend Oluf**  
Horticultural Advisory service  
ODENSE  
E-mail: svr@landscentret.dk

**RANCANE Regina**  
Latvian Plant Protection Research  
Centre  
LATVIA  
E-mail: regina.rancane@laapc.lv

**RAZOV Josip**  
University of Zadar  
CROATIA  
E-mail: jrazov@unizd.hr

**REISSIG W. Harvey**  
Cornell University Entomology  
USA  
E-mail: whr1@cornell.edu

**RIBES DASI Manel**  
University of Lleida " "  
SPAIN  
E-mail: manelo@eagrog.udl.cat

**RICCI Benoît**  
INRA  
FRANCE  
E-mail: bricci@avignon.INRA.fr

**RICCI Pierre**  
INRA Sophia  
FRANCE  
E-mail: pierre.ricci@sophia.INRA.fr

**RIVIERE Nathalie**  
Chambre d'agriculture  
FRANCE  
E-mail: nathalie.riviere@lot-et-  
garonne.chambagri.fr

**ROBIN Fabrice**  
BASF SE  
GERMANY  
E-mail: fabrice.robin@basf.com

**RODRIGUES Raul**  
Escola Superior Agrária de Ponte  
de Lima  
PORTUGAL  
E-mail: raulrodrigues@esa.ipvc.pt

**ROSSI Vittorio**  
Istituto di Entomologia e  
Patologia vegetale  
Facolta di Agraria UCSC  
ITALY  
E-mail: vittorio.rossi@unicatt.it

**ROUVIERE Jean-Baptiste**  
ENIGMA  
FRANCE  
E-mail: jbrouviere@hotmail.fr

**ROVERSI Alessandro**  
Institute of fruit growing  
Catholic university"  
ITALY  
E-mail:  
alessandro.roverisi@unicatt.it

**SAGNES Jean louis**  
Chambre d'agriculture  
FRANCE  
E-mail: jl.sagnes@tarn-et-  
garonne.chambagri.fr

**SAMBADO Paolo**  
CBC (EUROPE) LTD  
ITALY  
E-mail: psambado@cbceurope.it

**SANTOMAURO Agostino**  
Dipartimento di protezione delle  
Piante e microbiologia applicata  
ITALY  
E-mail:

**SAUDREAU Marc**  
INRA Clermont-Ferrand  
FRANCE  
E-mail:  
marc.saudreau@clermont.INRA.fr

**SAUGE Marie-Hélène**  
INRA  
France  
E-  
mail:marie.helene.sauge@avignon.IN  
RA.fr

**SAUPHANOR Benoît**  
INRA  
FRANCE  
E-mail: sauphano@avignon.INRA.fr

**SAVINO Francesco**  
CBC (EUROPE) LTD  
ITALY  
E-mail: fsavino@cbceurope.it

**SCALABRE Jean luc**  
TRECE  
UNITED STATES  
E-mail:

**SCHILDBERG Barbara**  
Federal College and institut for  
Viticulture And Pomology  
klosterneuburg  
AUTRICHE  
E-mail: ebarbara.shildberg

**SCOMPARIN Ana**  
INRA Clermont Ferrand  
FRANCE  
E-mail:  
ana.scomparin@yahoo.com.br

**SHEARER Peter**  
Oregon State University  
USA  
peter.shearer@oregonstate.edu

**SIEGWART Myriam**  
INRA  
FRANCE  
E-mail:  
myriam.siegwart@avignon.INRA.fr

**SIGSGAARD Lene**  
University of Copenhagen  
DENMARK  
E-mail: les@life.ku.dk

**SIHAM Myriam**  
CTIFL  
FRANCE  
E-mail: siham@ctifl.fr

**SIMON Sylvaine**  
INRA Gotheron  
FRANCE  
simon@avignon.INRA.fr

**SIMPSON Robert**  
R A Simpson  
SCOTLAND  
E-mail: ra.simpson@virgin.net

**SJOBORG Patrick**  
SLU Swedish University of  
agricultural sciences  
SWEDEN  
E-mail: patrick.sjoberg@ltj.slu.se

**STENSVAND Arne**  
Institute for Agricultural and  
Environmental Research  
NORWAY  
E-mail: arne.stensvand@bioforsk.no

**STERK Guido**  
Biobest N.V.  
BELGIUM  
info@biobest.be

**TALALCKO Lubos**  
Research and Breeding Institute of  
Pomology Holovousy Ltd.  
CZECH REPUBLIC  
E-mail: talacko.vsuo@seznam.cz

**TASSIN Marco**  
FEM IASMA RESEARCH  
CENTER"  
ITALY  
E-mail: marco.tasin@iasma.it

**TEDESCHI Rosemarie**  
Università degli Studi di Torino –  
Facoltà di Agraria Di.Va.P.R.A.  
ITALY  
E-mail: rosemarie.tedeschi@unito.it

**THISTLEWOOD Howard**  
Pacific agri food research centre,  
Agriculture and Agri Food  
CANADA  
E-mail: thistlewoodh@agr.gc.ca

**TISO Rocchina**  
Servizio fitosanitario "RegioneEmila  
Romagna  
ITALY  
E-mail: rtiso@regione.emilia-  
romagna.it

**TORNEUS Christer**  
Swedish Board of Agriculture  
Elevenborgsvägen  
SWEDEN

E-mail: christer.torneus@sjv.se  
**TOUBON Jean-François**  
INRA  
FRANCE  
E-mail: toubon@avignon.INRA.fr

**TOUPS Ina**  
Kompetenzzentrum Gartenbau  
Rheinpfalz  
GERMANY  
E-mail: ina.toups@dlr.rlp.de

**TRAPMAN Marc**  
Bio Fruit Advies  
THE NETHERLAND  
E-mail:  
marc.trapman@biofruitadvies.nl

**TRILOFF Peter**  
Marktgemeinschaft Bodenseeobst  
GERMANY  
E-mail: peter.triloff@lindavino.de

**TRIMBLE Mitch**  
Agriculture and Agri-Food Canada  
CANADA  
E-mail: trimbler@agr.gc.ca

**TUOVINEN Tuomo**  
MTT AGRIFOOD RESEARCH  
FINLAND  
FINLANDE  
E-mail: tuomo.tuovinen@mtt.fi

**TURQUET Marion**  
Hortis Aquitaine  
FRANCE  
E-mail: marion.turquet@hortis.fr

**VAN LAER Sitijn**  
Pcfruit  
BELGIUM  
E-mail: stijn.vanlaer@pcfruit.be

**VARELA Nélia**  
Centre UdL-IRTA of R+D  
University of Lleida"  
SPAIN  
E-mail: neliavarela@gmail.com

**VAVRA Radek**  
RBIP Holovousy  
CZECH REPUBLIC  
E-mail: vavra.vsuo@seznam.cz

**VELCHEVA Nyonka**  
Plant Protection Institute  
BULGARIA

E-mail:  
**VERONELLI Vittorio**  
CBC (EUROPE) LTD  
ITALY  
E-mail: vveronelli@cbceurope.it

**VILAJELIU MARIANO**  
IRTA-MAS BADIA  
FUNDACIÓ MAS BADIA  
SPAIN  
E-mail: mariano.vilajeliu@irta.cat

**VITTONI Graziano**  
Creso  
ITALY  
E-mail:  
daniele.demaria@cresoricerca.it

**VOGT Heidrun**  
Julius-Kuehn-Institute  
GERMANY  
E-mail: Heidrun.Vogt@jki.bund.de

**WALGENBACH James**  
Mountain Horticultural Crops  
Research & "  
USA  
E-mail: jim\_walgenbach@ncsu.edu

**WARLOP francois**  
GRAB  
FRANCE  
E-mail: francois.warlop@grab.fr

**WENNEKER Marcel**  
Wageningen University and Research  
Centre"  
THE NETHERLAND  
E-mail: marcel.wennerker@wur.nl

**WIEDMER Robert**  
Südtiroler Beratungsring Für Obst-  
Und Weinbau  
ITALY  
E-mail:  
robert.wiedmer@beratungsring.org

**YOALEM David**  
East Malling Research  
UNITED KINGDOM  
E-mail: david.yohalem@

**ZINGG Daniel**  
Andermatt Biocontrol AG  
SWITZERLAND  
E-mail: zingg@biocontrol

