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Plenary Session 1:

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

Jesus Avilla Ernst Boller, Carlo Malavolta, Frank Wijnands, Robert Baur..... 3

Abstract: 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.

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

Marc Trapman 4

Abstract: 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 nutrial 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.

Designing cropping systems to achieve Integrated Fruit Production goals

Françoise Lescouret, Benoît Sauphanor..... 5-8

Abstract: 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 designing cropping systems for integrated fruit production. In this contribution, we expose the two ways of this design: expert-based and model-based. Then, we point out the areas of research that should be strengthened to design IFP cropping systems on sound bases. The first is the analysis of current protection practices. The second is the study of crop-pest-enemies interactions under the influence of crop and pest management. The third is landscape studies. We conclude on the multi-disciplinary nature of research for IFP purposes.

Developing a Protocol and a Marketing Niche for EcoApples in NY State

W. Harvey Reissig, Arthur Agnello, Daniel Cooley, Jon Clements, Michael

Rozyne, Thomas Green 9-12

Abstract: In 2007, Cornell University, University of Massachusetts, Red Tomato™ (a nonprofit 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 result 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 \$1.9 million in 2008. The program grew from 6 New England growers with 475 acres in 2005 to 635 acres and 9 growers in 2008. 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 and 2008, 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.

Analyzing the results of a biodiversity experiment: Enhancing parasitism of *Platynota idaeusalis* (Lepidoptera: Tortricidae)

Mark Brown, Clarissa R. Mathews, Greg Krawczyk..... 13

Abstract: A common goal of conservation biological control is to enhance biodiversity and increase abundance and effectiveness of predators and parasitoids thus increasing sustainability of pest management. Although many studies report an increase in abundance of natural enemies, it has been difficult to document increases in rates of biological control. To enhance parasitism of the leafroller, *Platynota idaeusalis* (Tortricidae), alternate food was provided by interplanting peaches with extrafloral nectaries into apple orchards. Laboratory studies showed that the presence of peach extrafloral nectar increased longevity and parasitism rates by *Goniozus floridanus* (Bethyliidae), the dominant parasitoid in West Virginia, USA. In orchard studies we found the total number of Hymenopteran parasitoids was higher on peach trees than on adjacent apple trees. Abundance of Hymenoptera was also significantly higher on the side of traps facing

away from rather than toward peach trees, indicating attraction to peach trees producing extrafloral nectar. However, total parasitism rates of *P. idaeusalis* by all species of parasitoids were not affected by the presence of peach extrafloral nectar in any field studies. Insect injury to 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 control orchard. Although interplanting with peach trees did not result in detectable increased biological control, the experiment did have beneficial results for pest management. By collecting data on the response of an ecosystem service (e.g., fruit quality) we were able to document a reduction in damage of two pests by the interplanting of peach trees with extrafloral nectaries into apple orchards. This demonstrates the need for a more holistic approach to evaluating habitat manipulation experiments. Without information on the response of yield quality we would have concluded that the experimental addition of peaches had no effect on insect pest damage. But, the yield data showed that pentatomids and scales responded with decreased damage, through an as yet undetermined mechanism, from the experimental manipulation. A cost:benefit analysis of the habitat manipulation is needed before recommendations can be made. It appears promising, however, that the sustainability of apple ecosystems can be enhanced by increasing its biodiversity with the addition of peach trees with extrafloral nectaries.

Genetic modification of apple to control diseases

Cesare Gessler, Giovanni Broggin, Gabriella Parravicini, Paolo Galli, Iris

Szankowski, Roberta Paris, Andrea Patocchi 15-16

Abstract: 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.

Entomology Session 1: Arthropod pests – tree fruits

Dispersal estimates of codling moth fertilized females in a French farm based on kinship assessments

Pierre Franck, Jérôme Olivares, Hubert Defrance, Sylvaine Simon, Claire Lavigne

19-23

Abstract: Until now, population dynamics of Lepidoptera pests were mainly inferred from the monitoring of adult males using pheromone traps. Here, we analysed the dynamics of dispersal of codling moth fertilized females, which is more closely connected with the agronomic attacks. The dispersal of the fertilized females was estimated using genetic inferences of full-sibs among their offspring. We collected 6824 larvae using geo-referenced band traps in nine orchards (differing in host-plants and insecticide practices) from an experimental farm (90 ha) for five generations (2003-2006). Heterogeneity in the densities of larvae was mainly explained by inter-generation (twice higher for the diapausing larvae generation) and inter-orchard (50 times higher in untreated apple orchards) differences. A sub-sample of 1064 individuals was genotyped with a set of 13 microsatellite loci for kinship inferences. Three hundred forty pairs of individuals were unambiguously determined as full-sibs. Ninety-six % of the full-sibs were collected within orchards, 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. These results confirm the relatively sedentary behaviour of the codling moth females in spite of their ability to disperse over very long distances and to lay their eggs on different host-plants.

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

Herman Helsen, Matty Polfliet, Marc Trapman

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Abstract: 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.

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

Valeria Malagnini, Federico Pedrazoli, Chiara Papetti, Valeria Guilandri, Elisa Bozza, Federica Fiamingo, Rosaly Zasso, Claudio Ioriatti

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Abstract: 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.

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

Arthur Agnello, Harvey Reissig.....27-30

Abstract: 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 (17–32 acres) 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 (20–40 acres) 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%. Pesticide spray recommendations were followed in only 6 of the 12 total sample-based plots, owing to cutbacks in some growers' pest management programs resulting from early season hail damage to the crop. Nevertheless, fruit damage at harvest showed no significant differences between the sample-based program and the grower standard preventive program, either in total percent damage or in any USDA grade categories (X-Fancy, Utility, and Cull). A partial budget analysis will be conducted to determine grower returns in the standard vs. research plots.

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

Petros Damos, Matilta Savopoulou-Soultani.....31-32

Extended Abstract: The peach twig borer *Anarsia lineatella* Zeller (Lepidoptera: Gelechiidae) is one of the major economic pests of stone fruits worldwide (Balachowsky et Mesnil 1935, Jones 1935, Bailey 1948, Summers 1955, Balachowsky 1966, Damos and Savopoulou-Soultani 2008a). In Northern Greece, a great variety of peach (*Prunus persica*) cultivars (early, middle and late ripening, table and industrial) are cultivated and exported worldwide, so that peach production is considered to be essential for the economy. Efforts are made to improve pest control using Integrated Pest Management (IPM) in order to achieve high standards in products. In northern Greece, *A. lineatella* has 3 or usually 4 generations per year depending on prevailing temperatures (Damos and Savopoulou-Soultani 2007). During the past few years *A. lineatella* has been increasingly damaging to peach cultivation and, along with *Grapholitha molesta* (Lepidoptera: Tortricidae), they have been key targets for implementation of effective control strategies in terms of IPM in northern Greece. Larvae feed primarily on buds and tender shoots of

the host tree after emergence from hibernacula, where they overwinter as larvae (Balachowsky et Mesnil 1966, Damos and Savopoulou-Soultani 2008b). Sustainable crop productions try to minimize energy input flows in agroecosystems in order to maintain a long term benefit for all enabling parts: agroecosystems, biodiversity, farmers, consumers, as well as society in general. As far as specific plant protection strategies are concerned, it is common sense that the application of insecticides would also lead to better pest management and to lower production cost only when economically justified. However, early warning and forecasting systems, which are indispensable in pest management strategies, have not been fully developed for *A. lineatella* in peach orchards. What is not clear is the population density of these species sufficient to cause economic injury to the plant. Under this framework, field studies were conducted for three successive years (2005, 2006 and 2007) in peach orchards of northern Greece in order to examine relationships between densities of *A. lineatella* populations and peach (*Prunus persica*) yields. Moreover, natural populations of *A. lineatella* were observed 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). Regression analysis was used, first to determine if injury could be predicted from *A. lineatella* males captured on pheromone traps and second, if early shoot flagging caused by larvae of the first generation was correlated with fruit damage of the forthcoming generations (Knight and Croft 1987, Knight and Hull 1989, Savopoulou et al. 1989). Numbers of moths captured on sex pheromone traps and fruit damage varied during the 3 years of observation, ranging from 50 to 250 individuals per trap ($F=5.563$, $df=2.11$, $P<0.05$ and $F=50.299$, $df=2.11$, $P<0.05$, for first and second flight respectively). Shoot flagging and fruit damage was significantly lower in 2006 when compared to 2005 and 2007 ($F=2.772$, $df=2.11$, $P<0.05$ and $F=14.809$, $df=2.11$, $P<0.05$, for shoot flagging and fruit damage respectively). Mean shoot strike injury ranged from 5-15%, while fruit damage levels ranged from 5-10% during the three years of observation. According to the linear model, the increase in moth density during the first flight should result in a significant reduction in yield ($y=0.436x+10.22$, $R^2=0.635$, $P<0.05$). Regression of male moths captured during the second flight and observed yield loss was also significant ($y=0.5231x+17.204$, $R^2=0.792$, $P<0.05$). Moreover, according to the linear model derived by counting the number of shoot strikes, during the first observation period, a forthcoming yield loss can be estimated ($y=27.389x-6.304$, $R^2=0.711$, $P<0.05$). Finally, a significant relationship was also observed between the numbers of second generation larvae and yield loss ($y=163x$, $R^2=0.890$, $P<0.05$). The slope from the above regression can be used in the calculation of EIL and the fixed ET (Higley and Pedigo 1993, 1996). Results suggest that relative damage on fruits caused by *A. lineatella* can be estimated using either male trap captures or by observing early shoot flagging symptoms. Additionally, pesticides should not be applied if population of *A. lineatella* causing damage is lower than management cost. Developing a relationship between pest abundance and damage to crops is essential for the calculation of EIL leading to informed management decisions.

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

An update on brown spot of pear

Emilio Montesinos, Isidre Llorente 33

Abstract: 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.

Basis for new strategies in integrated control of brown spot of pear (*Stemphylium vesicarium*, teleomorph *Pleospora allii*)
Isidre Llorente, C. Moragrega, L. Ruz, G. Santamaria, A. Vilardell, P. Vilardell, E. Montesinos..... 35-39

Abstract: 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 the integrated control. To characterize the inoculum, 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 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 relationship between disease levels at leaf fall and the production of pseudothecia was determined.

Drought and oxidative stress determine the sensitivity of the pear towards Brown spot infections
Stijn Vanlaer, M. Höfte, P. Creemers 40

Abstract: 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.

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

Håvard Eikemo, D. M. Gadoury, R. A. Spotts, O. Villalta, P. Creemers,

A. Stensvand 41-44

Abstract: 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 fit well with the data from Southern Victoria, while the data from Norway, Belgium and most years from Northern Victoria show a lag phase in the beginning of the season that was not present in the two models. 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^2 values for the various models in many cases, but where differences were noted they more often favored 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.

Entomology Session 2: Arthropod pests – soft fruits

Developing an effective trap and lure to monitor *Lygus rugulipennis*

Michelle Fountain, Jerry Cross, Gunnhild Jaastad, Dudley Farman, David Hall, 47-51

Abstract: *Lygus rugulipennis*, the European tarnished plant bug (Miridae), is an important pest of strawberries, raspberries and cucumbers causing malformation of fruit. 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 overall aim of this project is to develop a long-lived, practical lure, attractive to these species, in order to monitor populations so that effective spray timings and spray applications can be made to control the pests in fruit crops. 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 these elicit electroantennographic (EAG) responses from males in analyses by linked gas chromatography–electroantennography (GC-EAG). Using ratios similar to those produced by the female at the time of ‘calling’, when males are attracted to females, we have demonstrated the attractiveness of the volatiles to male *L. rugulipennis* in the field. We also tested a number of home-made and commercially available traps for monitoring mirids. Green cross-vane funnel traps were the most effective and practical of those tested.

Interactions among predatory insects in strawberry production

Jean Fitzgerald, Chantelle Jay 52

Abstract: 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.

Developing Integrated Pest Management programmes for protected strawberry crops in Southern France

Amelie Boullenger, Marion Turquet, Stéphanie Girou, Clare Sampson 53-57

Abstract: Integrated Pest Management (IPM) strategies which 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 to 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 numbers of chemical treatments were significantly reduced in comparison to an adjacent tunnel where pests were controlled using insecticides. 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.

Pathology Session 2: Storage diseases

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

Jorunn Børve, Dag Røen, Arne Stensvand 61-64

Abstract: In Norway, organic apple growers only have sulphur available as a 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 on storage decay 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*). In mean of three years 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, had 6, 14, 35, 33, and 35% bitter rot, respectively. Similar numbers for lenticell rot (in mean of two years) 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.

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

Arne Stensvand, Dag Røen.....65-67

Abstract: *Colletotrichum acutatum* causes bitter rot (often named anthracnose) in cherry and apple. It is the most important fruit decay in sour cherry in Norway and may give severe losses also in sweet cherry and apple. We have found the fungus in all fruit and berry crops grown commercially in the country and on many ornamentals and a few weeds. Single spore isolates frequently developed the ascigerous stage of the fungus (*Glomerella acutata*) in culture, but it was not detected on apple or cherry plant material. If still attached to the tree, fruits and fruit stalks of sour cherry infected the previous year produced conidial inoculum throughout the entire following season. Also newly infected sour cherry flowers produced conidial inoculum until harvest. Up to 80% of the fruit spurs on sweet cherry had buds infected with *C. acutatum* in spring. Apple buds also contained the fungus, but to a much lower extent. More than 90% of the sweet cherry leaves could be infected with *C. acutatum* around harvest in heavily infected orchards. Symptoms on leaves never appeared in the orchards. We also found such asymptomatic leaf infections in apples. Most of the inoculum seemed to be present on the fruit trees themselves. However, initial inoculum in newly established, disease free plantings may be introduced from older fruit trees, ornamentals and weeds in or in close vicinity to the orchards.

Early season control of storage rots of apple

Angela M. Berrie, B. E. Ellerker, K. Lower, J. D. Robinson 68

Abstract: 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.

Entomology 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 Bohnenblust.....71-74

Abstract: During the last five years, codling moth, *Cydia pomonella* L., reestablished 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, the codling moth has become the driving force for insecticide treatments applied in orchards. When the codling moth developed resistance to older insecticides, it forced growers to seek new methods to control this pest and adopt newer methods such as mating disruption or bio-rational compounds to provide adequate control. Although both tactics have been used for a long time in organic orchards, no experience existed in conventional orchards in Pennsylvania. Therefore, a multi-year project was initiated to evaluate such methods in conventional orchards where both methods were incorporated into standard pest control practices. During three consecutive seasons, various rates and combinations of the codling moth granulosis virus (CpGV) and mating disruption were utilized in orchards and provided excellent control of internal fruit feeders, even

when CpGV was applied as alternate row middle applications. CpGV laboratory and field bioassays conducted on apples and nectarines revealed a toxicity of the codling moth granulosis virus against neonates of Oriental fruit moth.

Pheromone-Based Management Strategies for the Dogwood Borer, *Synanthedon scitula* (Harris) (Lepidoptera: SesIIDae)

Tracy Leskey, Christopher Bergh, James F. Walgenbach, Aijun Zhang 75

Abstract: 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, an 88:6:6 v/v/v (Z,Z)-3,13 octadecadienyl acetate (ODDA):(E,Z)-2,13-ODDA:(Z,E)-3,13-ODDA, and a behavioral antagonist of dogwood borer ,(E,Z)-3,13-ODDA, 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. We removed large numbers of males from orchards at all locations from high and low density mass trapping plots over two years. However, infestation in high and low density mass trapping plots was not reduced to the level of chlorpyrifos-treated plots. The most promising approach for pheromone-based management of dogwood borer appears to be mating disruption. An antagonist-based dispenser deployed at a rate of 250/ha effectively disrupted mate-finding by male dogwood borer. In plots with mating disruption dispensers, captures in pheromone-baited traps were virtually eliminated and no males were captured in traps baited with virgin females. We are currently evaluating the efficacy of disruption formulations for dogwood borer based on the sex pheromone blend and the antagonist.

Volatiles initiate egg-laying in common green lacewings

Gunnhild Jaastad, Liv Hatleli, Geir K. Knudsen, Miklos Tóth 77-82

Abstract: Adults and larvae of the common green lacewing *Chrysoperla carnea* feed on many insect 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 the scent of flowers, and that the presence of aphids on crop plants enhances oviposition by adults. In the present study, the effect of a three compound blend of phenylacetaldehyd, acetic acid and methyl salicylate was tested for its effect on oviposition by *C. carnea* in two areas in Norway. In both 2007 and 2008 a significantly higher number of *C. carnea* eggs were laid inside delta traps with the ternary blend compared to control traps. From 16 May to 15 June 2007 a total of 110 and 177 eggs were found inside 5 baited delta traps in each of two orchards in Western Norway. No eggs were found in control traps. Similar results were obtained in one orchard in Eastern Norway. When lures with the ternary blend were attached directly to the tree, the number of eggs did not significantly increase. Use of attractive volatiles to enhance egg laying, and to increase biological control by lacewings are discussed.

Sucrose as an apple tree resistance inducer against *Cydia pomonella* L.

Sylvie Derridj, François Moulin, Eric Ferré, Hubert Galy, Arnaud Bergognoux, Ingrid Arnaud, Jacques Auger 83-87

Abstract: The studies of plant insect relationships are necessary for research of new control methods. We showed that the soluble carbohydrates and sugar alcohols exuded on the leaf surface

influence *Cydia pomonella* L. egg-laying and neonate larval behaviour. The metabolite pattern and quantities can explain apple tree resistance to egg-laying. The plant resistance can be obtained by modifying the pattern with spraying sucrose solutions on apple tree. This was done in several orchards and varieties, over three years alone and/or in association with chemical or biological controls.

The spraying of 100 ppm sucrose or 10 ppm did not differ, and the addition of sucrose to treatments, leads to increase the practical efficacy and the ABBOTT one. The practical efficacy = (% of damage on the treatment reference - % of damage with sucrose addition)/% of damage on the treatment reference, was 30% over three years and several varieties. These results open a research field on pesticide alternatives and on improvement of biological controls. Enhancement of this technology should be obtained by studies of dose effects, duration and time period efficacy. Knowledge of genes concerned in this induction would be helpful for resistance selection.

Attractiveness of Mixtures of Pheromone and Host Plant Volatiles to *Cydia molesta* (Busck) (Lepidoptera: Tortricidae)

Nelia Varela, Jesús Avilla, César Gemeno..... 88

Abstract: 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.

Improving the effectiveness of mating disruption for tree fruit pests

Larry Gut, Peter McGhee, Piera Siegert, Michael Reinke, James Miller..... 89

Abstract: 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.

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

Marco Tasin, Carmela Sicher, Stefano Contrini, Silvia Schmidt, Claudio Ioriatti 90

Abstract: Codling moth *Cydia pomonella* (L.) is regarded as a major pest of pome fruit worldwide. The implementation of mating disruption for its control has been increasing during the last two decades (Witgall et al., 2008; Angeli et al., 2007). Due to increased regulatory restrictions of conventional insecticides and other environmental issues, in some fruit growing districts mating disruption is now deployed on well over 50% of the pome fruit area and it is considered an integral part of pest management programs for this species (Thomson et al., 2009). The evaluation of the efficacy of the commercial formulation used for mating disruption appears to be a relevant factor for further support the use of this technique. In this work we evaluate the use of net-cages (Doye & Koch, 2005) as a field method for the evaluation of the efficacy of mating disruption. A pheromone treated plot and an untreated area were provided with four 2 m net-cages each equipped with a trap. 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, and 20) were released with the aim to evaluate the effect of male density on trap catch. Release of males was replicated three times. As a general result, the number of males captured in the female baited traps was dependent on the number of released males in the cage (Linear regression, $R^2=0.996$; ANOVA, $P<0.001$). A different pattern was, however, observed between the untreated and the pheromone treated plot. While in the control plot the captures could be represented by a linear curve with no apparent saturation ($R^2=0.959$), in the pheromone plot we observed a logarithmic trend with a tendency to saturation ($R^2=0.968$). Although the treatment did not affect the number of males caught in the blank traps (ANOVA, $P>0.05$), a higher proportion of males was trapped with the lowest male dose in the control plot indicating that this dosage may be strongly biased by accidental captures. The efficacy of the pheromone formulation was calculated as catch inhibition by comparing the fraction of males caught by female baited traps in the treated and control plots. The inhibition of captures due to the treatment was 68% with a release of 20 males and 96% with the dose of 5 males. From these preliminary results it appears that a dose of 20 males per cage is necessary to highlight behavioural differences of searching males due to a pheromone treatment. Further research on factors such as trap architecture, presence of plants in the cage and volume of the cage may be of help for the optimization of this method.

Pathology Session 3: Organic and integrated disease control in apple orchards

Recent progress in integrated sanitation practices to manage apple scab

William E. MacHardy 93-96

Abstract: Sanitation practices to control apple scab, caused by *Venturia inaequalis* (Cke.) Wint., are aimed at reducing the primary inoculum, with the expectation that there will be an approximate reduction in primary scab, but the reduction in primary scab may be much less than expected. Two recent publications are reviewed that allow an analysis of the major factors that influence the relationship between the reduction in ascospores trapped and leaf litter (the source of ascospores) and the reduction in primary scab on spur leaves and on older leaves and fruit in sanitized compared to non-sanitized plots. Suggested guidelines for sanitation trials based on the analyses are presented.

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

Peter Triloff 97-102

Abstract: The most frequent factors responsible for failures in controlling apple scab (*Venturia inaequalis*) are the amount of fungal inoculum, poor strategy and timing of fungicide spray applications and the intrinsic, incomplete efficacy of the fungicides. Despite the progress made in

apple scab control fungicides remain a highly underestimated risk because their less than 100% efficacy in the field is not gradable enough to match the enormous variation of inoculum, resulting in a high risk of poor control as the inoculum increases. The application of more than one fungicide spray per infection period is the only effective way of adapting the efficacy of scab control to high inoculum levels. A protectant is applied shortly before rain and a curative compound after the rain event if a severe infection has built up. The curative compound controls the spores which passed the protectant fungicide resulting in a significant increase of efficacy compared to just the protectant before the rain. When curatives are not available, a protectant may be applied during the window of germination, a time period when the ascospore release of the day has almost terminated but no, or just a few, spores have infected. The time window is determined using the simulation software RIMpro in conjunction with the weather forecast. This method has been introduced in organic fruit production (OFP) at Lake Constance area in 2002 and has improved the results of primary scab control to, or above, the level obtained in IFP. After having become standard in OFP, the method is also used in IFP after the detection of wide spread resistance to Anilinopyrimidines at Lake Constance area in 2005.

Assessment of fungicide protection strategies in experimental apple orchards

Laurent Brun, J. Guinaudeau, C. Gros, L. Parisi., S. Simon 103-107

Abstract: In order to protect apple trees against scab, powdery mildew and post-harvest diseases, a large number of fungicides are applied in apple orchards from green-tip stage to harvest. To satisfy society's demand to decrease the number of plant protection 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 against powdery mildew is based on the assessment of disease levels present in the orchard (use of a percentage threshold of leaves infected with powdery mildew). The application of these decision rules 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 at fall and a large number of fungicide treatments during the season. No fungicide protection treatment for post-harvest diseases was applied in organically grown orchards nor in the low-input system for the two cultivars considered not to be highly susceptible to these diseases. These different protection strategies are assessed in terms of disease control and economic costs.

Brown rot disease development and management perspectives in organic apple orchards

Imre Holb..... 108

Abstract: 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 first, to monitor and analyze summer disease development of brown rot in time; second, to investigate environmentally friendly disease control approach against brown rot; and third, 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, then continuously increased 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 (β), area under disease progress curve (*AUDPC*), and final disease incidence (Y_f). Y_f in the tree was highly correlated with incidence on dropped fruit on the orchard floor, showing strong evidence of 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 an integrated control approach resulted in a significantly lower fruit rot incidence on all cultivars compared with general brown

rot management schedules. The above epidemiological and control results were incorporated into a novel brown rot management strategy for organic apple orchards.

Recco results on the control of scab in organic apple cultivation

Bart Heijne, Peter Frans de Jong 109

Abstract: 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 Recco 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 7.5kg potassium bicarbonate plus 4kg sulphur as a tank mix was as effective as 0.2kg copper in two years and even as effective as 0.5kg copper in a third year of experiments. Similarly, the treatment schedule of 7.5l yucca extract plus 4kg 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.

Effect of *Cladosporium cladosporioides* H39 on conidia production of *Venturia inaequalis* under orchard conditions

Jürgen Köhl, Wilma Molhoek 111-115

Abstract: New methods for control of apple scab during summer epidemics are needed for organic farming, since the use of copper fungicides will be restricted in the future. The fungal antagonist *Cladosporium cladosporioides* H39, pilot-formulated as a water dispersible granule, was applied in an apple orchard during summer 2008. Applications of *C. cladosporioides* H39 significantly reduced conidia production by the apple scab pathogen *Venturia inaequalis* by up to 67%. Applications of sulphur were less effective with a maximum reduction of *V. inaequalis* conidiation by 27%.

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 119-124

Abstract: 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 various 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. 5th instar larvae in cocoons were exposed within cardboard strips on which nematode solutions were sprayed under laboratory conditions to check the importance of temperature on the control of codling moth with entomopathogenic nematodes. This test under laboratory conditions was completed with a spray application on the ground in an orchard, where 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, the mortality rate was higher with *S. feltiae* (55%) than with *S. carpocapsae* (40%). The application on orchard soil confirmed this.

On the other hand, the toxicity of several plant protection products used in orchard has been evaluated using the method developed by the IOBC working group on "Pesticides and Beneficials". Three insecticides including Carpovirusine® and two fungicides have been evaluated. The carpovirusine exhibited the lowest toxicity level among the tested products. The

main life history parameter of nematodes affected by the tested products was fecundity. However, nematode mortality and infectivity were not reduced significantly.

These trials allow consideration of integration of entomopathogenic nematodes in a codling moth control strategy, with foliar and ground application. The selected nematodes species would be *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.

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..... 125

Abstract: 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.

Assessing the role of Syrphidae in the suppression of woolly apple aphid in Virginia, USA
Chris Bergh 127-130

Abstract: The fate of individual woolly apple aphid colonies on the branches of 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 from late May to early June, 2008, in Virginia, USA. Colonies on trees in the orchards either became extinct or were severely disrupted by predation by day 14. Two syrphid species, *Heringia calcarata* and *Eupeodes americanus* were the predominant arthropod predators recorded in colonies. Colonies on trees in the cage showed no decline, despite the presence of large numbers of the parasitoid, *Aphelinus mali*.

Habitat and prey preferences of the two predatory bugs *Anthocoris nemorum* (L) and *A. nemoralis* (Fabricius) (Anthocoridae: Hemiptera-Heteroptera)
Lene Sigsgaard 131

Abstract: 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

midsummer 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.

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

Mario Baldessari, Gino Angeli, Vincenzo Girolami, Alberto Pozzebon, Paola Tirello, Carlo Duso..... 132

Abstract: 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.

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..... 134

Abstract: 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 phenological 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.

Fire blight research: Warming up to new ideas and solutions

Vincent Phillon..... 135

Abstract: 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.

Entomology Session 5a: Earwigs

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

Bruno Gobin, Rob Moerkens, Herman Helsen, Kurt Jordaens, Herwig Leirs, Gertie Peusens..... 138

Abstract: 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.

Side effects of pesticides on the European earwig *Forficula auricularia* L.

(Dermaptera: Forficulidae)

Gertie Peusens, Herman Helsen, Bruno Gobin 139

Abstract: 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.

Impact of four insecticides on the European earwig, *Forficula auricularia* L., in an apple orchard

Heidrun Vogt, Jürgen Just, Anderson Grutzmacher..... 141-145

Abstract: 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 reductions (Henderson & Tilton method) in the earwig numbers as compared with control populations. One week after treatment these were 67% for indoxacarb, 56% for thiacloprid, 52% for spinosad and 40% for flonicamid. Whereas significant population reduction was observed with indoxacarb up to four weeks, effects of the other insecticides decreased much quicker.

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

Ina Toups, Jürgen Zimmer, Martin Trautmann, Nicole Fieger-Metag, Sascha Buchleither, Horst Bathon..... 147-151

Abstract: The woolly apple aphid (*Erisoma lanigerum* Hausm.) has been recognised 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, Germany runs from 2007 to 2009 in cooperation with different research facilities in Germany to develop an on-farm strategy to control the woolly apple aphid in organic fruit growing. Earwigs (*Forficula auricularia* L.), as natural predators of woolly apple aphids, climb the trees when they turn into L3-Larvae in the end of May/beginning of June. By then the population of woolly apple aphid may reach high infestation levels. To control the woolly apple aphid until the earwigs appear 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. They showed good efficacies for applying oil preparations by brush in the first year. The efficacy of releasing earwigs is inconsistent and depended on the infestation intensity. In the second year the trials have been expanded by a comparison of oil application by spaying and by brush in combination with releasing earwigs. On high infestation levels the oil application by brush proved to be more effective.

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

Rob Moerkens, Bruno Gobin, Gertie Peusens, Laurent Crespin, Herman Helsen, Herwig Leirs 152

Abstract: 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.

Entomology Session 5b: Pesticide resistance

Codling Moth Insecticide Resistance Management in North Carolina Apples

James Walgenbach, Leonardo Magalhaes, Vonny Barlow, Michael Roe 154

Abstract: 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.

A new CpGV isolate overcoming *Cydia pomonella* resistance to Granulovirus:

improvement of the virus efficiency by selection pressure on resistant hosts

Marie Berling, Christine Blachere-Lopez, Olivier Soubabère, Jean-Baptiste Rey, Sophie-Joy Ondet, Yannis Tallot, Miguel Lopez Ferber, Benoît Sauphanor,

Antoine Bonhomme 155-159

Abstract: Since 2004, some codling moth (*Cydia pomonella*) populations resistant to the Mexican isolate of *Cydia pomonella* granulovirus (CpGV-M) were detected in different organic orchards in Western Europe. A resistant laboratory colony of codling moth (RGV) was built by introgression of the resistance character in a susceptible laboratory colony (Sv). The resistance of the RGV colony to the CpGV-M came over 60,000-fold when compared to the susceptible laboratory colony (to Sv). To overcome this resistance, the efficiency of CpGV isolates from various origins was investigated. Two of them (I12 and NPP-R1) presented an increased activity on RGV larvae. NPP-R1 reduces the resistance factors of RGV to 7-fold and 46-fold at the LC₅₀ and LC₉₀. 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 NPP-R1 on RGV larvae had a sharply reduced proportion in the CpGV-M genotype and an increased efficiency on RGV. Carpovirusine samples were formulated with these isolates for field experiment. Results from 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.

Resistance Management: A Global Industry Response from the Insecticide

Resistance Action Committee

Andrea Bassi 160

Abstract: 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.irc-online.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.

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*

Kerik Cox, S. A. Villani, W. Köller 162

Abstract: 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.

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

Kerik Cox, S.A. Villani, W. Köller 163

Abstract: 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.

Validation of an apple scab fungicide spray action threshold to help reduce captan residue levels on fruits

Vincent Phillon 164

Abstract: 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.

Can *Venturia inaequalis* populations show a reduced sensitivity to a multisite fungicide? The case study of captan in French orchards

Luciana Parisi, Pascale Expert, Isabelle Nock, Tania Louis-Etienne, Noëllie Bourdoiseau, Frédérique Didelot.....165-168

Abstract: Since 2000, the control of apple scab, which is mainly based on chemicals in French orchards, has faced several cases of control failure. One of the causes of this situation could be the emergence of a reduced sensitivity of *V. inaequalis* to multisite fungicides. As multisite fungicides are not known to induce resistance in fungal pathogens, such a possibility has not been investigated. Between 2002 and 2006, different experiments showed an in vivo reduced efficiency (27.6 to 48% on incidence and severity of the disease) of 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 for Mancozeb (96.5 to 100%) 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 show consistent elements, but not clear evidence of a reduced sensitivity of *V. inaequalis* to multisite fungicides. They support the need for applied and basic research on this question.

Breeding high quality disease resistant apple varieties

Markus Kellerhals, Andrea Patocchi, Brion Duffy, Jürg Frey.....169-173

Abstract: Breeding for high quality apples combined with excellent agronomic features and durable disease resistance is a highly relevant approach for sustainable production systems. This includes multi-disease resistance against the most important apple problems: scab (*Venturia inaequalis*), powdery mildew (*Podosphaera leucotricha*) and fire blight (*Erwinia amylovora*). A promising strategy to develop apple cultivars with durable multi-disease resistance is the pyramiding of major genes. The presence of pyramided resistance can be detected by marker-assisted selection. For many known apple scab resistance genes, molecular markers are available. We focus on new achievements for breeding scab and mildew resistant and fire blight tolerant apple cultivars.

Recent advances in epidemiology of strawberry powdery mildew

David Gadoury, A. Stensvand, R. C. Seem, C. Heidenreich, M. L. Herrero, M. Welser, A. Dobson, H. Eikemo, B. Asalf..... 174

Abstract: 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.

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

Crescenza Dongiovanni, Agostino Santomauro, Claudia Giampaolo, Michele Di Carolo, Francesco Faretra..... 175-182

Abstract: 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, either alone or in mixture with kresoxim-methyl; metrafenone; myclobutanil, either alone or in mixture with sulphur or meptyldinocap; penconazole; proquinazid; pyraclostrobin+metiram; quinoxifen, either alone or in mixture with sulphur; sulphur; tebuconazole; trifloxystrobin. The climatic conditions during both the trials were particularly favourable to the pathogen, so that prevalence values of 97-100% of infected bunches in the untreated plots were reached at the end of both trials. Under such disease-conducive conditions, all the tested spray schedules always allowed a statistically significant reduction of disease incidence as compared to the untreated check. In particular, the best results were obtained when kresoxim-methyl+boscalid, pyraclostrobin+metiram, proquinazid or quinoxifen had been applied during the periods of highest disease pressure.

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

David Yohalem, Tom Passey..... 183-186

Abstract: 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.

Armillaria root rot on highbush blueberry in Northern Italy: monitoring, identification and inoculum sources

Daniele Prodorutti, Alberto Pellegrini, Davide Gobbin, Thalia Vanblaere, Ilaria Pertot..... 187-190

Abstract: Highbush blueberry plants infected by *Armillaria* spp. were reported in north-eastern Italy (Province of Trento). After inspection, 13 blueberry orchards were found to be infected in the Valsugana valley. *Armillaria* sp. samples were collected from blueberry plants, from bark spread on the blueberry rows and from infected trees and stumps in the orchard surroundings. The species determination was performed using a species-specific multiplex PCR approach. Efficacy trials with potential biocontrol agents against *Armillaria* sp. were carried out on young blueberry plants. The average percentage of stunted plants in the infected fields was 11%, while the percentage of dead plants was generally very low (average of 1.5%). The most frequent species infecting blueberries were *A. gallica* and *A. mellea*: in each field one species largely dominated

the other. The tested *Trichoderma* strains, especially *T. atroviride* SC1, were the most effective biocontrol agents against *A. gallica* and *A. mellea*.

Plenary Session 2: 50th Anniversary lecture and IOBC business

The Working Group „Integrated Protection of Fruit Crops“ is celebrating its 50th Anniversary

Ernst Boller, Albert K. Minks, Jerry V. Cross, Joop C. van Lenteren, Theo Wildbolz..... 193-194

Abstract: The Working Group looks back at 50 years of successful work. The fruit entomologists are the pioneers within WPRS with respect to the development of integrated plant protection (IPP) and integrated production (IP) and their introduction into practice.

Developments occurring during the early 1970s brought a change in the general approach reflected in the change of name in 1974 from “Integrated control in orchards” to the broader term “Integrated plant protection in orchards”. A further milestone was the establishment of the holistic concept of Integrated Production as has been described in the “Message of Ovronnaz” which should be considered as a historic landmark for IOBC as a whole.

The publications of the WG reflect the broad range of its activities and its important function as scientific platform for information exchange and joint programs: 13 proceedings of International Symposia on Integrated Plant Protection and Production in orchards, 14 technical handbooks (brochures) and 41 WPRS Bulletins covering specific topics of the various subgroups. The first international symposium organised by the working group took place in Wageningen in 1961 with 36 participants from 9 countries, the most recent symposium was held in Avignon in 2008 with 250 participants and celebrating the 50th anniversary. Hundreds of experts have participated in the WG’s activities over the past 50 years. The impact of these activities on the development and application of IPP and IP in practise was and still is significant. Concepts and tools developed by the WG became not only general WPRS standards but have influenced significantly the international standards for Integrated Plant Protection. The WG has generated the approach and practical implementation of Integrated Production in the major crops of the WPRS region.

A summary of important events is given in the following table. The full text of this historic review is published on the IOBC/WPRS homepage www.iobc-wprs.org

Entomology Session 6: Integrated Fruit Production

Peach orchard management strategies: aphid communities as a case study

Servane Penvern, Stéphane Bellon, Joël Fauriel, Benoît Sauphanor..... 196

Abstract: 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.

Adapting to New Control Strategies and Area-Wide Management for Cherry Fruit

Flies in British Columbia, Canada

Howard Thistlewood, Noubar Bostanian, Sue Senger, Naomi DeLury 197-203

Abstract: 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 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. 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. We present some recent results from experiments and experiences of fruit-growers. These include the compatibility of reduced risk pesticides with the key predatory mites of fruit-growing in western and eastern Canada, of the use of GF120 Fruit Fly Bait, the importance of alternate host plants, and new knowledge of CFF flight and movement.

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

Mariano Vilajeliu, Adriana Escudero, Pere Vilardell, Lluís Batllori, Simó Alegre,

Georgina Alins, M. Dolores Blázquez, Marcos Miñarro, Enrique Dapena 205-208

Abstract: Researchers of two Spanish research institutes, IRTA in Catalonia (North-East region with Mediterranean climate) and SERIDA in Asturias (North-West region with Atlantic climate) have been working in collaboration on projects involving organic apple production since 2002, with the aim of finding optimum production methods. In this paper, trials for the control of apple scab (*Venturia inaequalis* (Cke.) Wint.), rosy apple aphid (*Dysaphis plantaginea* Pass.) (Homoptera: Aphididae) and codling moth (*Cydia pomonella* L.) (Lepidoptera: Tortricidae) are described. These common pest species were successfully controlled by products and methods allowed by the European organic rules (EC 834/2007).

Pathology Session 6: Nectria Canker

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

Bart Heijne, Peter Frans de Jong, Pieter Jans Jansonius 210

Abstract: 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 100kg/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 50kg/ha of slaked lime was applied in a comparable experiment in the following year. A comparison between 25, 50 and 100kg/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.

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

Peter Frans de Jong, Adrie Boshuizen, Marcel Wenneker..... 211

Abstract: 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.

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

Marcel Wenneker, Nina Joosten..... 212

Abstract: 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.

Plenary Session 3

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

Nick Birch, Stuart Gordon, Tom Shepherd, Wynne Griffiths, Graham Robertson, Trefor Woodford, Rex Brennan.....215-217

Abstract: Raspberry beetle adults are attracted to flowers of their hosts primarily by colour and odour (floral volatiles). SCRI scientists have investigated this chemical ecology interaction for several years, using a multi-disciplinary approach involving phytochemistry, insect behaviour, and GC-EAG electrophysiology. We will present a historical overview, explaining how these techniques have allowed us to identify the key flower attractants from a complex mixture of volatiles emitted by raspberry flowers. We will then go on to explain how recent (EU-CRAFT, Horticulture Development Council) and current (Defra HortLINK) work has progressed the optimization of raspberry beetle traps for U.K. growers needing IPM solutions due to demands

for zero pesticide residue levels on fruit. We will explain how we are developing and testing slow release lures and different trap designs, together with collaborators at East Malling Research, Natural Resources Institute, AgriSense Ltd and also with Norwegian scientists, testing prototype traps on organic soft fruit farms.

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

Pierre Ricci, Marco Barzman..... 218

Abstract: 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) – 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.

Poster Session 1: Arthropod Pests

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

Jesus Avilla, Daniel Casado, Andrea Patocchi, Jörg Samietz, Klaus Paaske, Claire Lavigne, Benoît Sauphanor, Luciana Parisi, Bart Heijne 220

Abstract: ENDURE (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.

Investigations on the bark beetle species (Coleoptera: Scolytidae) in cherry and peaches in the East Mediterranean Region of Türkiye.

Hazir Adalet, Naim Öztürk, M. Rifat Ulusoy.....221-225

Abstract: This two-year long study was carried out in cherry and peach orchards in Adana, Mersin, Osmaniye and Kahramanmaraş provinces in the East Mediterranean Region of Türkiye in 2004-2005. In this study the species of bark beetles -Scolytid species-, the distribution and the infection rates of this pest were determined.

As a result of this study, five species of the Scolytidae family, which are one of the major pests of cherry and peaches 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 in the beginning of May (3rd-5th of May) and survived until mid-September. It was found that 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 Kahramanmaraş were determined to be 4.3, 5.6, 7.0 and 7.4% respectively. The area where the survey was conducted was found to be infected at an average of 5.8%.

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

Ilze Apenite.....226

Abstract: 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. - cypermetrin) 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.

Preliminary trials for a continuous rearing of *Bactrocera oleae* (Rossi) on its natural host *Olea europaea* L. in laboratory and future perspectives

Valentina Baratella, Antonio Franco Spanedda.....227-231

Abstract: A simple and affordable small-scale rearing technique to supply olive fruit fly (*Bactrocera oleae* Rossi) instars continuously throughout the year, even when fresh fruits are not available naturally to oviposit, is essential to optimize biological studies. Olive fruits came from a typical olive grove of northern Lazio (Cura di Vetralla, VT, central Italy), organically managed. Cages, feeders and instruments were specially designed. The fruits were kept fresh for more than 1 year in special “muffs” of straw and tulle, assembled directly on fruiting branches. The rearing started in 2005, as soon as emergencies occurred. Adults were collected from the field and moved 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 occur. Temperature and RH were maintained at 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 gave 13 continuous reproductive cycles in the lab, 1 generation every 40 days on average. An exception was the 9th generation (27 August-27 September) which lasted 31 days because of accidental high temperatures ($26\text{-}27^{\circ}\text{C}$). This is the first method which has succeeded in obtaining olive fly generations continuously on its natural host. Fine tuning this technique will make it suitable for every other study (i.e. physiological, biological and behavioural studies, parasitoid rearing and release, sterile insect technique, etc.).

The current issue Codling moth control in the Croatian apple orchards

Božena Baric, Ivana Pajac, Dinka Grubišić 232

Abstract: 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.

Loquat and pomegranate thrips in the eastern Mediterranean region of Turkey

Refik Bozbuga, Naime Z. Elekçioğlu 233-236

Abstract: A thrips survey was conducted during 2006-2007 in pomegranate and loquat trees in the Eastern Mediterranean Region of Türkiye 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.

Two Spotted Mite, *Tetranychus urticae*, a new pest in Persimmon Orchards; approaches to reduce its density

Bu-Keun Chung, Mitsuhiro Kawashima, Chuleui Jung 237

Abstract: 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.

Investigations on the occurrence of the quarantine fruit fly species *Rhagoletis cingulata* and *Rhagoletis indifferens* on *Prunus avium* and *Prunus cerasus* in Austria
Alois Egarter, N. Zeisner, H. Hausdorf, C. Lethmayer, S. Blümel..... 238

Abstract: 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 Austria. *R. cingulata* originates from the eastern and *R. indifferens* from the western part of North America. Both species are important pests of cherries in North America and potentially in European cherry orchards, causing severe quality problems after fruit infestation. While *R. cingulata* mainly infests various *Prunus* species, *R. indifferens* also occurs on *Crataegus* sp. and on *Rhamnus* sp. After the first findings of American cherry fruit flies in Europe in 1983 in Switzerland, *R. cingulata* was also detected during surveys in other European countries, such as the Netherlands, Germany, Hungary, Slovenia and Croatia. Recent findings of *R. cingulata* were located near the south-eastern border of Austria while no findings of *R. indifferens* were reported from this region until now. The survey in Austria was carried out in the main cherry production areas and in those areas where high invasion potential was most probable. Sampling sites were located in variable orchards in the eastern part of Austria, along the border to Hungary and Slovenia. Fruit flies were baited and caught with yellow panels of the type Pherocon® AM. Traps were placed in cherry trees to catch adult flies, which emerged under or near the sampling trees. In 2007, two traps were installed and replaced weekly at each of the seven sampling sites from May 2nd until 2 weeks after the last seasonal occurrence of the fruit flies. In 2008, the survey was carried out on 6 cherry production sites including 4 new monitoring sites compared to 2007. Traps were replaced in fortnight intervals from the end of May in 2008 until 2 weeks after the last seasonal occurrence of the fruit flies. Identification of the caught individuals was carried out morphologically. In both years, a high number of European cherry fruit flies (*R. cerasi* Linné), which is considered an important cherry pest in Austria, was caught in many traps. In 2007, at each of two of the sampling sites, 1 individual of *R. cingulata* was found. No further non-native fruit flies were caught. We assumed that the captured specimens were separately introduced specimens and that there were no established populations in the monitoring area during the seasons 2007 and 2008.

Autumn control of aphid pests of tree and bush fruit crops
Jerry Cross, Michelle Fountain, Adrian Harris, Richard Harrington..... 239-242

Abstract: 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, Marco Pagani, Graziano Vittone, Fabio Molinari 243-245

Abstract: 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, to control the red spider mite. In cases of use of certain insecticides this mite again became a local problem. In 2003 and 2005 in North-West of Italy inexplicable spread of infestations of this mite both on apple and peach orchards has been recorded. Our studies conducted in 2006, 2007 and 2008 assessed that *Panonychus ulmi* Koch (Acari: Tetranychidae) is still the main species in the orchards of north-west Italy and *Amblyseius andersoni* (Acari: Phytoseiidae) is its main antagonist. Hypothesis of an involvement of grass chemical control in infestation outbreaks of red spider mite was not confirmed and, it seems that it can be excluded as a cause of red spider mite infestation outbreaks.

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

Adriana Escudero-Colomar, Mariano Vilajeliu, Esther Peñarrubia-María, Lluís Batllori..... 246

Abstract: 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.

Ostrinia nubilalis Hübner (Lepidoptera, Pyralidae) as a threat for apple

Daniele Demaria, Graziano Vittone, Fabio Molinari 247-250

Abstract: Over the last few years, damage to fruits due to the European Corn Borer, *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 a better way to monitor the insect and perhaps modify the pests management strategy to control *O. nubilalis*. Field surveys confirmed that the main damage occurs in orchards close to corn fields or, in a few cases, in orchards with the grass *Echinochloa crus-galli*. Researches demonstrated that

pheromone-baited mesh cone traps are more efficient than delta sticky traps for monitoring the flight of European corn borer and that in the Piedmont area the 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 happens 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 pest management strategy.

Preliminary studies about the effect of '*Candidatus Phytoplasma mali*' on the psyllid

Cacopsylla melanoneura (Homoptera: Psyllidae)

Claudio Ioriatti, Valeria Malagnini, Federico Pedrazzoli,

Valeria Gualandri, Flavia Forno, Alberto Pozzebon..... 251

Abstract: *Cacopsylla melanoneura* Förster (Homoptera: Psyllidae), a 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.

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

Aziz Kharazi-Pakdel, Javad Karimi 252

Abstract: *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.

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

Christa Lethmayer 253

Abstract: The walnut husk fly *Rhagoletis completa* (Tephritidae, Diptera), originating from North-America, is listed as a quarantine pest on the 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, and 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 on information of the Tyrolean Plant Protection Service. Sticky yellow traps were used to catch the fruit flies and were set up and recorded from the end of June at 14-day intervals.

In the first half of July the first individuals were caught and the first presence of *R. completa* was demonstrated for Austria. In autumn, fruits that were infested by the walnut husk fly were found in other regions of Austria (Vienna, Styria, Carinthia), too. Monitoring in other parts of Austria will be continued in 2009.

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

Remigiusz.W. Olszak, Zofia Pluciennik 254

Abstract: 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.

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

Jana Ourednickova 255-258

Abstract: A field trial was conducted in 2008 in the Czech Republic to test the efficacy of kaolin (aluminosilicate mineral) against over wintered adults of *Cacopsylla pyri*. It aimed to prevent the females laying their eggs. Ekol (90% coleseed oil) was also tested in order to suffocate adults and eggs. In addition, the insecticides Sanmite 20 WP (pyridaben), Insegar 25 WP (fenoxycarb) and Calypso 480 SC (thiacloprid) were applied to reduce nymphs. These treatments were repeated on the first and the second generation. Efficacy was compared with an untreated control. Beating tray samples were taken in both plots (control, treatment) to monitor the density of adults. Egg-laying and nymph infestation were visually monitored. The *Cacopsylla pyri* population was not reduced under a damaging level. This observation might be explained by a high initial infestation level and the immigration of pear suckers from the untreated control plot. However, during the vegetation period it was observed that there were lower number of adults, nymphs and eggs on

treated trees compared to the untreated control. The population density was significantly decreased, but not under the economic threshold (10 eggs or nymphs / 100 leaves). Yield was not decreased and no honeydew and sooty moulds were observed on the fruits.

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

Nikos Papadopoulos, M. Kleopatra, S. Papanastasiou, A. Diamantidis,

I. Kounatidis, P. Mavragani, K. Bourtzis, B. I. Katsoyannos 259

Abstract: 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.

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

J. Raul Rodrigues, Laura M. Torres..... 260

Abstract: 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 Smoothee) 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.

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

Josip Razov, Bozena Baric, Miklós Tóth261-265

Abstract: During some of the last fifteen years in the coastal part of Croatia it was observed that scarab beetles from the subfamily Cetoniinae caused damage to ripening peaches. With further analysis it was shown that these species were *Cetonia aurata* and *Potosia cuprea*. In 2007 we monitored their appearance and population dynamics, and we calculated the damage they caused. This was done in two locations in Zadar, Ravni kotari region. The Csalomon® VARb3k traps with baits consisting of 100µl phenethyl alcohol+100µl methyl eugenol+100µl trans anethol were used. The total number of trapped beetles from the two locations was 569 *Cetonia aurata* and 200 *Potosia cuprea*. The damage percentage ranged from 0% up to 7%.

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

Patrick Sjöberg, Christer Tornéus, Birgitta Rämert, Ylva Hillbur..... 266

Abstract: 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) has been banned (end of 2008; KemI 2008), a further increase of tortricid populations can be expected. In order to get a picture of species composition and population densities among the tortricids, an inventory of seven species, *Adoxophyes orana*, *Archips podana*, *Archips rosana*, *Cydia pomonella*, *Hedya nubiferana*, *Pandemis heparana* and *Spilonota ocellana* was made in 11 orchards in southern Sweden (Skåne) in 2008. Population densities were estimated by bud sampling (April 20-25), pheromone trapping (May 5-September 22) and assessment of fruit damage (September 9-12). In all orchards *A. podana* was the dominating species followed by *A. rosana* and *P. heparana*. Generally trap catches of *C. pomonella* were low, but flight activity was recorded over a longer period of time. Similar flight curves were observed for *P. heparana* and *S. ocellana*. Trap catches of *H. nubiferana* were very low at all sites. *A. orana* only occurred in one of the orchards and exhibited two peaks in flight activity, indicating that there were two generations. Infestation levels of tortricid larvae were low in bud samples, possibly due to sampling being done too early in the season. Average fruit damage was 5%, varying from 1.6 to 21%. The inventory will be the basis for development of future management strategies and forecasting tools.

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, Federica Tota, Graziano Vittone, Alberto Alma267-271

Abstract: In recent years, high percentages of declining plants showing symptoms ascribable to the European stone fruit yellows (ESFY) disease were recorded in plum and apricot orchards in Piedmont, north western Italy. Since 2006, visual inspections were carried out in dozens of orchards to assess the incidence of symptomatic plants in early spring (premature budbreaks) and late summer (yellowing and leafroll). Surveys with yellow sticky traps and beating tray were carried out from the beginning of March until the beginning of June to monitor the presence of *Cacopsylla pruni* 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 an early infection possibly occurring in the nurseries.

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

Heidrun Vogt, Kirsten Köppler, Werner Dahlbender, Günter Hensel.....273-277

Abstract: 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 onward. In 2003, a few specimens of *R. cingulata* were reported on yellow traps in cherry orchards in the Rhineland-Palatinate area. Since 2004, 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. In Germany, *R. cingulata* is emerging 3-4 weeks later than does 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.

Poster Session 1: Biocontrol Agents

Selectivity of phytosanitary products used on citrus orchards to *Chrysoperla*

externa (Hagen, 1861) (Neuroptera: Chrysopidae)

Maurício Sekiguchi Godoy, César Carvalho, Geraldo Andrade Carvalho281-285

Abstract: The effect of some phytosanitary products used on citrus orchards on *Chrysoperla externa* was evaluated. The maximum dosages of thiametoxan, imidacloprid, milbemectin, pyriproxyfen and spiroticlofen were sprayed on eggs of this chrysopid in a Potter tower, with toxicity evaluations on this and subsequent development phases. The experiment was conducted at 25±2°C, 70±10% RH and 14-hour photophase in a complete randomized design with six treatments and thirty replicates. Survivorship of contaminated eggs, larvae, pupae and adults originating from contaminated eggs was evaluated. Additionally, number and viability of F1 generation eggs were evaluated. Imidacloprid and spiroticlofen were statistically different from control with egg viability of 76.7% for both products, with 96.7% for control. As for thiametoxan, milbemectin and pyriproxyfen, they did not influence egg survival rate, with 93.3%, 80.0% and 80.0%, respectively. Spiroticlofen received the slightly noxious (class 2) classification.

First record of the parasitoid *Copidosoma varicornis* (Nees) (Hymenoptera:

Encyrtidae) in Greece

Petros Damos, Matilda Savopoulou-Soultani287-288

Extended abstract: Biological control has been a fundamental element of the Integrated Pest Management (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. The objective of this study was to record and observe the impact of native beneficial species on the overwintering population of the peach twig borer *Anarsia lineatella* Zeller (Lepidoptera: Gelechiidae) in IPM orchards. In previous studies we reported the presence of numerous beneficial arthropods, belonging to different families observed in overwintering sites (hibernacula) of *A. lineatella* (Damos and Savopoulou-Soultani 2008a). Substantial mortality because of parasitic wasps belonging to parasitoids of the family Braconidae was also reported (Damos and Savopoulou-Soultani 2008b). In this study, we report the mortality of *A. lineatella* overwintering larvae caused by the endoparasitoid *Copidosoma varicorne* (Hymenoptera: Encyrtidae).

The faunistic survey was conducted in two important regions in central Macedonia of northern Greece (Veria 40.32°N-0.22.18°E and Velvendo 40.16°N-0.22.04°E). Hibernacula of overwintering larvae were collected randomly from conventional and IPM peach orchards. All collected material was transferred to the Laboratory of Applied Zoology and Parasitology of the Aristotle University of Thessaloniki. Overwintering larvae of *A. lineatella* were placed at constant laboratory conditions for development (20°C, 16:8h L:D and 65±5%RH). Individuals of *C. varicorne* were reared from overwintering *A. lineatella* larvae during 2005, 2006 and 2007. A number of dry samples were sent to the Natural History Museum of London for a confirmative

taxonomic identification. This is the first record of *C. varicorne* in Greece.

Hymenoptera is one of the richest in species groups in the Palaearctic region (Werner 2001, Ghahari et al. 2006), while Copidosomatine encyrtids are well known for their unique polyembryonic development and larval soldier caste in which a single zygote generates multiple embryos by clonal proliferation (Zhurov et al. 2004). Comprehensive classification of Encyrtidae (Trjapitzin, 1989) placed *Copidosoma* in the tribe Copidosomatini, subtribe Copidosomatina, together with *Paralitomastix* Mercet 1921 and *Copidosomopsis* Girault 1915 (Guerrieri and Noyes 2005).

Species of the genus *Copidosoma* Ratzeburg 1844 have been recorded as parasites on more than 20 Lepidoptera families, including members of the Gelechiidae and Tortricidae (Daane et al. 1993, Guerrieri and Noyes 2005). Encyrtidae species are considered as important parasitoids and are generally widespread, including species that have the potential to be used as biocontrol agents of lepidopteran pests (Guerrieri and Noyes 2005). In addition, species recorded as *Paralitomastix varicornis* (Mercet 1921) or *Encyrtus varicornis* Nees by original designation are synonyms with *Copidosoma* (Kazmi and Hayat 1998, Guerrieri and Noyes 2005), while on a recent detailed revision of the European species of Encyrtidae by Guerrieri and Noyes (2005), the species *C. varicornis* is also synonymous with *C. varicorne* which is the valid name. The species has also been recorded as *P. varicornis* in Northern Italy as a cause of mortality in overwintering *A. lineatella* larvae (Molinari et al. 2005), while in the USA the Encyrtidae *Paralitomastix pyralidis* (Ashmead) has been recorded as parasitizing overwintering larvae of *A. lineatella* (Daane et al. 1993).

Overwintering larval parasitization was especially high during the winter of the year 2006-2007. Moreover, although mortality of *A. lineatella* larvae due to *C. varicorne* parasitization was relatively low (5-15%), the species was present on samples collected from all different IPM peach orchards in northern Greece. This fact indicates a stable presence of *C. varicorne* in peach orchards of northern Greece during the last years. The identification and evaluation of local natural beneficial species under field conditions should be of special interest, as part of an overall IPM program.

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

Alberto Grassi, Romano Maines 289-293

Abstract: The biology, behaviour and reciprocal relationships of *Tetranychus urticae*, *Neotetranychus rubi* and the phytoseiid mite *Amblyseius andersoni* were investigated from 1999 to 2007 on floricane red raspberry in Trentino, Northern Italy. From 2005 to 2007, in a plantation in Mocheni's Valley the efficiency against two-spotted spider mite of an *A. andersoni* local strain and the commercially available predators *Amblyseius californicus* and *Phytoseiulus persimilis* was also evaluated. Two introduction rates (26 and 52 individuals/m, equivalent to 10.4 and 20.8 individuals/m²) at different times of release were compared for these two last predators. *A. californicus* releases, applied before the middle of June, were more effective than late releases in every year, in comparison with check plots (no release). The best control result was recorded where the highest dose was introduced. However, *A. californicus* didn't perform as well as *A. andersoni* in the reintroduction plot. In our trials, *P. persimilis* established in the crop with very small populations, probably indicating important ecological requirements (prey density, release rate, climate under polyethylene rain covers, etc.) for its establishment. The information we collected was used to produce a two-spotted spider mite management recommendation scheme for Trentino's raspberry growers.

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

Edison Pasqualini, M. Melandri, G. Pradolesi, S. Civolani, V. De Luigi,

G. Burgio..... 294

Abstract: 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.

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

Hazem Dib, Yvan Capowiez, Sylvaine Simon, Benoît Sauphanor 295-299

Abstract: Rosy apple aphid, *Dysaphis plantaginea* (Passerini) (Hemiptera: Aphididae), is the most detrimental aphid species in European organic apple orchards. This study aimed to evaluate the natural regulation of *D. plantaginea* and the effect of installing hail nets on this regulation. The study was carried out during spring 2008 in one experimental apple orchard without pesticide and four organic commercial apple orchards located in southern France. The density and the diversity of natural enemies observed in the experimental orchard were higher than those in the organic orchards. The colonies of *D. plantaginea* were exploited by a multispecific guild of natural enemies. Hoverflies, lady beetles and earwigs were the most abundant groups. Hoverflies tended to arrive first, followed by lady beetles and earwigs. A high level of aphid infestation was observed in two organic orchards, presumably related to a low level of natural enemies and to a high level of ants. Regarding the effect of hail nets, the study revealed a positive influence of the hail nets on regulation by earwigs but a negative influence on the presence of other natural enemies especially lady beetles. To sum up, this field study indicated that the population dynamic of *D. plantaginea* was strongly affected by natural enemies, but not sufficiently to maintain it under the tolerance threshold. So, new management practices aiming at enhancing this natural regulation need to be found.

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

Lino Monteiro, C. Dor, P. Franck, C. Lavigne., B. Sauphanor 301-304

Abstract: 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. Diapausing larvae were observed to be parasitized in only 21.0% and 16.4% of orchards 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 than low densities of windbreak hedgerows and for low than for high 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 of egg and larval parasitism, the most 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 protection practices than egg predation.

The effect of rosy apple aphid and beneficial insect dynamics in an orchard

Karine Morel, Hubert Defrance, Alan Garnier, Emilie Durand, Maude Le Corre, Sylvaine Simon.....305-308

Abstract: The natural control of the rosy apple aphid *Dysaphis plantaginea*, a major pest in European apple orchards, was studied from 2006 to 2008 in three organic apple orchards planted with Smoothee 2832T[®], Ariane and Melrose cultivars. The development of *D. plantaginea* and the beneficial complex associated with aphid colonies were visually assessed in the spring, and the effect of the interaction within the orchard (edge, inner and intermediate areas) was studied. Infestation of orchard edge trees by *D. plantaginea* was higher. Beneficial numbers and the predator/prey ratio were also higher in edge trees in 2007, and 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.

Susceptibility of codling moth populations originated from Czech Republic to *Cydia*

pomonella granulovirus (CpGV)

Tereza Zichová, Vladan Falta, František Kocourek, Jiban Kumar, Jitka Stará.....309-312

Abstract: 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 codling moth for many years, registration of CpGV in the Czech Republic is still in progress. However, in the last six years, populations of the codling moth resistant to CpGV-M isolate were locally found in some European countries. With regard to this experience, the object of this research is to evaluate the susceptibility of various codling moth populations in the Czech Republic to CpGV-M and also to propose a suitable anti-resistance strategy for the Czech Republic. In 2008, the first monitoring of wild codling moth populations' susceptibility to CpGV-M was evaluated by laboratory bioassays. Three wild populations (Prague-Ruzyne, Bulhary and Velke Bilovice) and a reference (sensitive) laboratory strain were assessed. 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.

Poster Session 1: Biodiversity

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

Benoit Sauphanor, Camille Picard, Sylvaine Simon, Daniel Plénet.....315-318

Abstract: 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, produced 4 groups of growers relying on the protection strategy against *Cydia pomonella*: organic production, exclusive use of mating disruption (MD) against *C. pomonella*, intensive use of chemical insecticides (intensive), and a fourth group with both MD and chemicals (intermediate). The environmental impacts of these management strategies were assessed using two different indicators: i) the environmental impact quotient (EIQ) accumulating the impacts on farmers, consumers and non human biota, and ii) I-PHY_{ARBO}, 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-PHY_{ARBO} organic farming had the safest 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. Unlike I-PHY_{ARBO}, 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.

Poster Session 1: Pathology

Potential new storage rot problems in UK Cox apples

Angela Berrie, B. E. Ellerker, J. D. Robinson 320

Abstract: 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*.

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

Laurent Brun, Frédérique Didelot, Freddy Combe, Gilles Orain, Cécile Payen, Arnaud Lemarquand, Luciana Parisi 321-325

Abstract: 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/m³ of sampled air could be observed 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.

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 326

Abstract: *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.

Efficiency of association of scab control methods on resistance durability of apple:

the case study of cultivar Ariane

Valerie Caffier, Frédérique Didelot, Gilles Orain, Arnaud Lemarquand,

Luciana Parisi 327-330

Abstract: The major resistance gene *Vf* has been deployed in several commercial cultivars. This resulted in the emergence of virulent isolates of *Venturia inaequalis* in Europe. In France, isolates virulent to *Vf* developed since 1995, mainly in North-West region. To increase the durability of resistance of *Vf* cultivars in regions where virulent isolates are not yet present (or present at a low frequency), it was recommended that leaf litter be destroyed in winter and to apply fungicides at times of the highest scab risks. These recommendations, however, had not been evaluated experimentally previously. In 2004, we initiated a project to test these recommendations on cultivar ‘Ariane’, which has been deployed in France since 2002. 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. In untreated plots, scab increased quickly to 98% of scabbed trees and 35% of scabbed fruits in 2008, showing the high susceptibility of ‘Ariane’ in case of breakdown of its resistance. 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. For comparison, about twice the fungicide sprayings were applied in the same region on susceptible cultivars. In 2008 on the treated plots, 4% of the trees presented a very low severity of disease, and 0.2% of scabbed fruits were observed. This study shows the efficiency to associate sanitation and reduced number of fungicide sprayings to complement *Vf* resistance and delay its breakdown.

Control of Oriental Fruit Moth, *Cydia molesta* Busck, by Isomate OFM-Rosso

Dispensers in Peach Orchards of Bulgaria – Preliminary Results

Hristina Kutinkova, Jörg Samietz, Vasilij Dzhuvinov, Vittorio Veronelli,

Andrea Iodice 331-336

Abstract: Peach is the major fruit in South-East Bulgaria. Its main pest is the 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, recently their effectiveness decreased, apparently due to the resistance developed in many pests. Hence, alternative means of control are urgently needed. The most common environmentally friendly methods are those related to sex pheromones. Until recently, their use has been limited mainly to monitoring, aiming at precise timing and reduction of chemical treatments. Mating disruption (MD) presents a more promising solution, however. The trials on mating disruption in the present study were carried out with Isomate OFM rosso dispensers (Shin-Etsu, Japan) 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 the reference, i.e. conventionally treated orchard. The Isomate OFM rosso dispensers, installed before the first flight of OFM at the rate of 500 units per ha, efficiently reduced fruit damage – down to 0.1-0.2% at harvest. In the reference orchard, with 5-6 insecticide treatments against OFM, damage still reached 5-6%. 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.

An Integrated Approach for Reducing Fungicide Sprays Against Scab in Organic Apple Orchards

Imre J. Holb, Barbara Balla, Ferenc Abonyi 337-341

Abstract: 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 a 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 incidences 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 cv. Jonathan suggested that scab sprays could only be omitted before early tight cluster and after mid-August if leaf removal and pruning was applied.

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

Vincent Phillion, Arne Stensvand, Håvard Eikemo, David M. Gadoury 342

Abstract: 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.

The initiative: Monitoring of *Venturia inaequalis* virulences

Andrea Patocchi 343-344

No Abstract

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

Vittorio Rossi, Simona Giosuè, Riccardo Bugiani, Tito Caffi, Gian Franco Pradolesi, Massimiliano Melandri, Tullio Bevilacqua 345-349

Abstract: 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. Since the validation works

showed that the model produces 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. The disease incidence 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.

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

Regina Rancane, Maija Eihe 350

Abstract: 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.

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

Radek Vávra, Jana Kloutvorová, Stanislav Boček, Antonín Svoboda 351-356

Abstract: Occurrence of apple scab (*Venturia inaequalis*) on resistant cultivars was investigated in the Czech Republic however symptoms have never been 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 the 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* to strobilurine fungicides was tested in the orchards, where the chemical treatment against apple scab was ineffective. Leaf samples were collected from 22 commercial orchards, one sample was taken from apple tree solitary growing in natural conditions and one sample was taken in experimental orchard. A germination of spores in aqueous fungicide solutions was assessed. A decrease of strobilurine sensitivity of *V. inaequalis* was observed in several localities.

Apple Proliferation phytoplasma in South Tyrol – an Integrated Approach

Marcus Prantl, Robert Wiedmer, Josef Österreicher, Michael Unterthurner 357-360

Abstract: In 2000 and 2001 a severe occurrence of apple proliferation phytoplasma was noticed for the first time in apple orchards in South Tyrol (Italy). At the same time, 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, in some cases, rather heavy economic losses caused by these attacks 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 in combination with chemical control of the two vectors proved successful and resulted in a considerable reduction in infections in the past two years.

Poster Session 1: Pesticides & Resistance

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

Johannes Jehle, Stefanie Schulze 362

Abstract: 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.

Effect of a growth enhancer Carbon Kick Booster® on mites and natural mite enemies in apple

Tuomo Tuovinen 363-366

Abstract: The importance of mite pests is increasing in Finnish apple production due to lack of efficient pesticides and the effect of climate change. Integrated pest management has been successful to enhance natural control of mites by indigenous OP-resistant phytoseiid mites but rejection of OP-insecticides will cause increasing problems. Plant derived substances have been successful to restrain pest 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 conditions to evaluate its effect on apple rust mite (*Aculus schlechtendali*) and fruit tree red spider mite (*Panonychus ulmi*). In the laboratory 1-2% solution killed a majority of the pest mites in 1-4 days. In field tests the results were inconsistent but comparable to sulphur treatments. Mites of the families Tarsonemidae and Tydeidae were not affected and in field tests phytoseiid mites survived the enhancer sprayings better than the sulphur sprayings. Predatory cecidomyiid larvae were present in the trees and limited both red spider mite and apple rust mite population increases in all treatments.

Biological Efficacy of Botanical Insecticides in the Control of Green Apple Aphid

(*Aphis pomi* De Geer)

Slobodan Milenkovic, Snežana Tanasković 367-370

Abstract: The effects of the botanical insecticides pyrethrin (Pyros®), rotenone (Rotenone®) and pyrethrin + rotenone (ShowTop) were monitored in two apple orchards planted with cvs. Granny Smith and Kožara. The trial was set up according to the EPPO PP1/21(2) Protocol. The insecticides were applied in each of four rows. Four leaves from each tree were designated as samples for monitoring the population pressure of *Aphis pomi* De Geer. The insecticides were applied in June by spray drift and atomiser. The temperature was 23°C and relative air humidity 63%. The pest population pressure was checked immediately before the treatment and on the 1st, 2nd, 3rd and 7th day after treatment (DAT). The highest efficacious insecticide was Pyros® (83.2%) on 1 DAT followed by ShowTop (82.8%), whereas Rotenone® was the least effective

(67.1%) at controlling *A. pomi*. Rotenone[®] was most effective on 2 DAT (72.1%), with subsequent inspections showing a decrease in efficacy (67.3% and 44.7%). For Pyros[®], further inspection on 2 and 3 DAT registered a decline in efficacy to 72-73%, whereas on 7 DAT it reduced to 55.7%. The inspection on 2 DAT reported the highest efficacy of ShowTop (84%) and a further decline to 76.4% and 69.5% on 3 DAT and 7 DAT, respectively.

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

Nadia Lombarkia 371

Abstract: *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/cm²) 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.

Poster Session 1: Population Modelling

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

Isabelle Grechi, Françoise Lescourret, Benoît Sauphanor, Nadine Hilgert, Michel Génard, Rachid Senoussi, Marie-Hélène Sauge, Arnaud Chapelet, Jean-Philippe Lacroze 375-379

Abstract: Integrated Fruit Production (IFP) calls for an adaptation of production processes to improve crop quality and environmental safety. This approach gives priority to alternative methods of pest control. Our study investigates the potential of management scenarios that integrate chemical, biological (inundative release of *Harmonia axyridis* ladybirds) and cultural (nitrogen fertilization and winter pruning) pest control methods for the peach tree-aphid system. We used a modeling approach to address this question. We defined 108 management scenarios, which were based on theoretical pest control strategies combined with control variables relative to pest control and cultural practices. Then, we performed model simulations of these scenarios and studied the relationships between control variables and model outputs referring to agronomical, economical, sanitary (pest), and sustainability performance. Results showed that ‘agronomical performance’ was largely controlled by ‘agronomical practices’, while ‘pest performance’ was largely controlled by ‘pest control practices’.

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

Benoît Ricci, Olivier Martin, Pierre Franck, Jean-François Toubon, Rachid Senoussi, Claire Lavigne 381-384

Abstract: The codling moth (*Cydia pomonella*) is responsible for most insecticide treatments in pear and apple orchards. In a context of reduction in pesticide use, we aim at better understanding factors that affect codling moth damage intensity. We modelled the link between the proportion of

damaged fruits and both constant covariables (type of orchard: pear or apple, organic or not, with or without mating disruption) and time-varying covariables (weekly counts of adults and number of insecticide treatments). Observations were collected in 40 orchards in south-eastern France. We found that damage intensity increased with the number of adults trapped. An analysis of the random orchard effect indicated a certain temporal stability in the risk probability of orchards and a lower risk probability in orchards surrounded by numerous pomefruit orchards and windbreak hedgerows.

Poster Session 1: Semiochemicals

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. Olzem Altindisli, F. Ozsemerci, P. Hıncal, A. Derin, İ. Çınarlı, G. Pease, T. Ray, T. Wardley

387-388

Abstract: Turkey has more than 300 native grape varieties. Round Seedless (Sultana) is the most important variety. The Aegean Region is the first by possessing 28% of the vineyard surface in Turkey. The production area of Sultana seedless is mostly placed in Manisa Province. Bozcaada Island is in the Marmara Region, in the northwest part of Turkey. The island is very important because of its unique varieties cultivated such as Çavuş and Karasakız. It has 1000ha of viticulture. The two regions have different agro-ecosystems and ecological conditions. Up to now, synthetic pesticide application has been given priority against European grapevine moth (EGVM), (*Lobesia botrana* Den.-Schiff.) (Lepidoptera: Tortricidae), the key pest of grapes in Turkey. However, negative effects of chemical control on the environment and human health have led up to the necessity of biotechnical methods against the pest. Among them, the mating disruption technique has been tested against EGVM in Turkey. Isonet-L dispensers were proved to be as effective as chemical control against the pest. The objective of this study was to determine in different conditions of Bozcaada Island and Manisa whether the Exosex² GVM-LB auto-confusion system for EGVM, reduces mating and subsequent larval damage to the fruit by comparing with Isonet L, the registered material. By this study, auto-confusion was tested in Turkey for the first time. The auto-confusion (AC) technique by Exosex² dispensers (10 mg pheromone/dispenser) was applied in 17.3ha and 24.2ha in Manisa (Aegean Region) whereas it was applied in 12ha in Bozcaada Island (Marmara Region) in 2007 and 2008, respectively. Only in Manisa, classical mating disruption (MD) technique by Isonet L dispensers (172mg pheromone/dispenser) was used as a comparative technique in 15 and 6ha in 2007 and 2008, respectively. Chemical-treated vineyards were also included in the research as comparison (C) vineyard. At the beginning of first flight period, 180 Exosex² dispensers /ha and 600 Isonet L/ha were installed. Exosex² installation was repeated at sixty day-intervals. The need and time of chemical applications was decided by means of Forecasting System against *L. botrana* in C vineyards. In critical periods when the eggs and larvae of first, second, third and fourth generations were expected, and just before harvest; 100 bunches per hectare were controlled in the centre and borders of each AC and MD sampling vineyard, and 100 bunches in each C vineyard separately. Infestation rates were determined. Exosex² dispensers from both locations were analysed by GC. In 2007, the pheromone samples were taken from the first application tablets of both Regions on 31 May 2007. In 2008, the pheromone samples were taken from the second application tablets of Bozcaada on 13 August and third application tablets of Manisa on 09 October. The average infestation rate of all AC vineyards in Manisa was calculated as 6.3 % just before harvest in 2007. In the course of the experiment, 9.6ha-AC vineyards were treated against *L. botrana* once, whereas 6ha-AC vineyards were treated two times because of the infestation rate was higher than the threshold of 5%. Fortunately, a 1.7ha part of AC vineyards did not require any chemical treatment against the pest and auto-confusion has suppressed EGVM in alone. Moreover, the infestation rates were still higher than 5% in 30.6% of the entire AC surface (5,3ha-9 vineyards) at harvest time. In Manisa, 18.67% part of the entire MD surface had to be sprayed once at least, whereas 13.3% had to be applied twice in 2007. Average infestation rate of all MD vineyards was calculated as 8% at this time. However,

insecticide application has been avoided since the grapes are being harvested. In the last assessment in 2008, average infestation rate of all AC vineyards was calculated as 4.55% at harvest. In the course of the experiment, all AC vineyards in Manisa were totally treated against EGVM twice because of the infestation rates in 3rd generation were higher than the threshold of 5%. In 12% of the entire AC surface, the infestation rates were still higher than 5% at harvest time. They were only 3 vineyards having a surface of 3ha, totally. In Manisa, 16.67% part of the entire MD surface had to be sprayed once in 2008. Average infestation rate of all MD vineyards was calculated as 4.75% at this time. Only smaller MD vineyard had an infestation rate higher than the threshold at harvest. It can be concluded that small surface of MD caused higher infestation rate. However, insecticide application has been avoided since the grapes are being harvested. In comparison vineyard, broad-spectrum insecticides were applied against *L. botrana* five times. Infestation rates of the comparison vineyard were always lower than AC plots during the whole season owing to the sprayings of broad-spectrum insecticides. It is also usual to apply chemicals against EGVM in the centre of Manisa Province four or five times per season. No insecticide treatment has been used against any other pest in AC and MD vineyards. The best effectiveness from Auto-confusion has been obtained in Bozcaada against EGVM. No complementary treatment has been applied to suppress the pest. Auto-confusion by Exosex² dispensers was very effective. In comparison vineyard of Bozcaada broad-spectrum insecticides were applied against the pest three times. As occurred in the world, it is possible to have some years and some localities in Turkey, where biotechnical methods are not suitable or successful to control a pest in alone and require complementary insecticide treatment. Mating disruption technique is also registered in Turkey on condition that it should be supported by a biological insecticide treatment preferably to decrease the population density when the infestation rate exceeds 5-6% in the vineyard. By all means, when compared to chemically controlled vineyards, it can be assumed that Exosex² dispensers reduced the number of insecticide applications from 4-5 to 1-2 even in the Aegean Region where population density is higher, flight period is longer and temperatures are higher than Bozcaada Island. Temperature is one of the most efficient factors, which affect the efficacy and stability of pheromone in outer conditions. Average daily temperatures were lower in 2008 when compared with 2007 recorded in Manisa. Results of weekly Isonet-L weights also reflected this phenomenon by consuming their pheromone 3 weeks earlier in 2007 when compared to 2008. According to the results of GC analysis, it was determined that 97.3% of total pheromone amount from Exosex dispensers has been consumed in Bozcaada, whereas only 84% has been released in Manisa in 2007. Despite the higher temperatures in Manisa than Bozcaada in summertime, it can be assumed that the stronger winds might be more effective factor for the emission of pheromone from the dispensers because of lower leaf density in springtime. On the other hand, only 60% of total pheromone amount from Exosex dispensers has been consumed in Bozcaada, whereas 76% has been released in Manisa in summertime in 2008. Therefore, auto-confusion technique can be applied in the vineyards for the control of *Lobesia botrana* by installing 180 Exosex² dispensers/ha three times per season with 60 days interval. However, it must be combined in the Aegean Region of Turkey with a biological insecticide preferably, if the average infestation rate of the pest exceeds 5-6% once or twice per season.

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

Lakmali Amarawardana, David Hall, Jerry Cross, Michelle Fountain,

Gunnhild Jåstad 389-395

Abstract: The pear midge, *Contarinia pyrivora* (Riley), is a pest of pear fruitlets and the damage causes severe crop losses. Although it can be controlled by application of insecticide, the timing of application is crucial as *C. pyrivora* is present for only a short period in the year. Identification of the female-produced sex pheromone was undertaken so that it can be used in monitoring and control of the pest. Late larvae of *C. pyrivora* were removed from damaged fruitlets and reared in plastic tubes individually. After sexing, volatiles were collected from both males and females by air entrainment. Collections were analysed by gas chromatography (GC) coupled to electroantennographic (EAG) recording from a male antenna, and by GC coupled to mass spectrometry (MS). Male midges showed EAG responses to two components in collections of

volatiles from female. The major and the minor components were identified as 2,7-diacetoxyundecane and 7-acetoxy-2-undecanone respectively. Stereoisomers of the synthetic pheromones were separated by HPLC on a chiral phase and the racemates, individual stereoisomers and binary mixtures were evaluated in field trapping tests. Male *C. pyrivora* were attracted to stereoisomer A of 2,7-diacetoxyundecane and to the first eluting stereoisomer from HPLC fractionation of 7-acetoxy-2-undecanone and these are proposed to be components of the female sex pheromone. However, results were confused by the presence of at least one other midge species in the traps and the experiments will be repeated.

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

Catherine Baroffio, Charly Mittaz.....397-400

Abstract: 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 activity of the raspberry beetle has been monitored for the first time in the Swiss Alps with the semiochemical trap (floral attractant) and non-sticky funnel trap 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 of raspberry beetles decreased till end of July. A second important flight activity pattern was observed at the end of July and at the beginning of August. Fruit analysis showed that there was a gradient in the percentage of damaged fruits. Around the traps the damage was about 1% but the average of the whole plot was 5% in one plot and 9% in the second one with semiochemical traps. Neighbouring woods with wild *Rubus* sp. and other wild hosts near the plot could explain high raspberry beetle populations. This monitoring will continue for three years.

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

Paola Rioli, Roberto Bruni, Luigi Cappella, Franco Rama, Isidoro Nunzio.....401-404

Abstract: *Grapholita 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' is here 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 in two orchards located in the Ascoli Piceno Province of the Marche Region (central-eastern Italy). Specific, biodegradable, pheromone dispensers, known as Ecodian CFTM, were used for each application, with about 2,000/ha. During 2005, three dispenser applications were carried out, with two in 2006. The evaluation of this technique was through monitoring adult males by specific synthetic sex pheromone traps and visual inspections for fruit damage. *Anarsia lineatella* (peach twig borer), a secondary pest in plum orchards, was also monitored. The efficacy of Ecodian CFTM dispensers was compared with that achieved in commercial plum orchards sprayed with chemical insecticides or managed with mating disruption techniques. 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 check plots.

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

Cristina Carlos, Fernando Alves, Laura Torres.....405-409

Abstract: Since 2000 the mating disruption technique has been applied to control *Lobesia botrana* (Den. & Schiff.) in the Porto Wine Region. ISONET-L dispensers have been used in plots whose surface ranged from 3.0 to 25.0 ha. The average percentage of male disorientation for the 8-year experimental period ranged from 80.5 to 100%, being 100% in 55.5% of the 72 sampling periods studied. However, the rate of reduction obtained in larval infestation by the pest, even in favourable conditions (large areas and continuous application), was variable. 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 (high steepness). In this paper, the results are critically discussed and weak spots are analyzed, as a basis for identifying the real possibilities of the technique in the Porto Wine Region.

Cells responding to pheromone components and plant volatiles could affect

semiochemical based control strategies of insect pests in agriculture ecosystems

Antonio De Cristofaro, Gianfranco Anfora, Giacinto Salvatore Germinara, Claudio Ioriatti, Valerio Mazzoni, Giuseppe Rotundo 410

Abstract: 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.

Use of Sprayable Pheromone Formulations in Europe

Enzo Casagrande 411-413

Abstract: 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 assuring 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. The paper will review the technology, efficacy and use strategies of the Checkmate sprayable technology in Europe.

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, Starker E. Wright, Jaime C. Piñero, Ronald J. Prokopy 414

Abstract: 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 comprised of the synthetic host plant-derived volatile benzaldehyde and the synthetic male-produced aggregation pheromone grandisoic acid in order to aggregate adult activity in specific perimeter row trees. Then by applying insecticides to these select 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. Over the course of four years, comparisons of the trap-tree and perimeter-row treatment strategies have revealed

that these strategies prevented penetration by immigrating populations of plum curculio and resulted in economically acceptable levels of injury. The trap tree management strategy resulted in a reduction of ~70% total trees being treated with insecticide compared with perimeter row sprays and 93% compared with standard full block sprays. We currently are working to improve this strategy based on deploying even more powerful attractants within tree canopies to increase aggregation activity and reduce the number of required trap trees.

Integrating pear ester into direct management programs for codling moth

Alan Knight, Janet Haworth, Bill Lingren, Vince Hebert 415-418

Abstract: Several management approaches utilizing pear ester combined with codlemone have been developed in the first 10 years after the discovery of this ripe pear fruit volatile's kairomonal activity for larvae and both sexes of codling moth. These include a lure that consistently outperforms other high load pheromone lures within pheromone-treated orchards, and the use of a microencapsulated formulation that can improve both mating disruption and the effectiveness of insecticide sprays. Field studies demonstrating the effectiveness of combining pear ester with codlemone are presented.

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 419-422

Abstract: 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 have been applied. The trials carried out in the seasons 2006-2008 showed that this method is easy to apply for evaluating the effectiveness of MD in the field and gives a reliable feedback allowing fine-tuning of formulations.

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

Denis Pasquier, Patrik Kehrli 423-424

Abstract: 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*, especially in regions with low population density.

Effectiveness of mating disruption and granulovirus against codling moths in Central Bulgaria

Penka Peeva, Nyonka Velcheva, Olia Karadjova, Vittorio Veronelli, Denis Pasquier, Radoslav Andreev, Katia Radeva 425-429

Abstract: Due to economical changes, problems of resistance and the parceling of agricultural area, mating disruption (MD) was studied on its own or in combination with granulosus virus (CpGV) against the codling moth (CM), *Cydia pomonella* L., 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 an acceptable level of 5.1% in the 0.5ha 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 years old orchard of 1.3ha. Once again, fruit damage by CM was below the economical threshold until the beginning of July. Thereafter, five treatments with chlorpyrifos-ethyl and chlorpyrifos-methyl were made to avoid higher infestation levels. At pre-harvest, only 1.9% of apples had CM larvae, compared to 17.0% in the reference orchard that 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, only 1.5% of apples were infested with CM larvae at pre-harvest and we detected 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 granulosis viruses seems to be promising.

Mating disruption across the peach/apple interface

Peter Shearer, Kris Tollerup, Ann Rucker Rutgers 430

Abstract: 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.

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

Barbara Schildberger, Lothar Wurm, Eva Vogl, Manfred Kickenweiz 431-434

Abstract: Alongside standard systems of mating disruption, the activity of Exosex CM and Ecodian[®] under different application systems and on several varieties were tested in 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 similar to those 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 of integrating this technique with IPM programmes was tested. Ecodian[®] dispensers were distributed at a rate of 2000 dispensers/ha. The tube dispensers of pheromone (Exosex CM) were placed 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. Additionally, in 2008 different application systems were used. Ecodian[®] was tested on one hectare and compared with untreated areas. The assessments to quantify efficacy were made visually on windfall fruits, fruits on the tree and on all fruits at harvest and statistically evaluated. In 2007, among the fruits sprayed within the IPM system there was an infestation rate by the first generation on the variety Idared of 0.8%. The second generation treated with Exosex showed an infestation of 13%. In the biological trial, however, the infestation by the first generation was about 4% and the infestation by the second generation about 31%. The 2008 results were comparable to those of 2007.

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

Mitch Trimble, D. B. Marshall..... 435-438

Abstract: 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 1ha (100 x 100m) experimental plots, each separated by 100m, were established within each of three vineyards. Twenty-five synthetic sex pheromone-baited traps were deployed in each plot on a 20 x 20m 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 2.5m, respectively, along the periphery of the 1ha plots. The results provide impetus for additional research to determine if peripheral treatments with pheromone dispensers can be used to control *P. viteana*.

Control of codling moth, *Cydia pomonella* (L.) (Lepidoptera Tortricidae), with

EcoTape pheromone dispensers

Federica Trona, Mario Baldessari, Gianfranco Anfora, Valerio Mazzoni,

Enzo Casagrande, Claudio Ioriatti, Gino Angeli 439

Abstract: 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 3cm length dispensers at a separation of 0.6m, loaded with 2.5mg 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 synthetic 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.

Poster Session 2: Arthropod Pests

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

Bu-Keun Chung, Mitsuhiro Kawashima, Chuleui Jung 442

Abstract: 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 [mfl]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.

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

Marc Trapman, Matty Polfliet, Herman Helsen 443

Abstract: 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 cannot 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.

Practical results of a Stacked Control Strategy for Codling Moth (*Cydia pomonella* L.) management

Marc Trapman, Herman Helsen, Matty Polfliet..... 444

Abstract: 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.

Poster Session 2: Biocontrol Agents

Biological aspects and predatory capacity of *Chrysoperla externa* (Hagen, 1861) (Neuroptera: Chrysopidae) fed *Planococcus citri* (Risso, 1813) (Hemiptera: Pseudococcidae)

César Carvalho, Gerane C. D. Bezerra, Brígida Souza, Lenira V. C. Santa-Cecília 447-452

Abstract: In the citrus mealybug complex, *Planococcus citri* is one of the most important pests and its control is affected by insecticides. The green lacewing *Chrysoperla externa* is an insect often found in citrus orchards and is a natural predator of this pest. This work deals with studies on the predatory capacity and some biological aspects of larvae fed the three instars and adult female of *P. citri*. The experiments were conducted at 25±1°C, 70±10% of RH and 12-hour photophase with four treatments, represented by the development stages, and 30 replicates in a complete randomized design. It was found that the total predatory capacity of lacewing larvae was 231.2; 77.9; 32.6 and 21.2 for the three instars and adult females, respectively. The longevity of second and third instars of green lacewing larvae was lengthened when fed on adult mealybug females. The pupal stage was longer when it originated from larvae fed second and third instar larvae and adult females. The immature stage lasted from 19.8 to 22.9 days, and survivorship for this period was from 78.0 to 91.0%. A reduction in the number of consumed mealybugs was found in each instar, regardless the lacewing instar, however both nymphs and adult mealybug females were adequate prey for the larval development of *C. externa*.

The Effect of Floral Strips on the Abundance of Hymenopteran Parasitoids in Apple

and Olive Organic Orchards

Hazem Dib, Gilles Libourel, François Warlop.....453-457

Abstract: 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 organic low-input 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. Among the 26 studied flowering species in the apple orchard, 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 observed in *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, none of these species have been observed 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 in order to select flowering plant species attracting parasitic wasps specific to fruit pests.

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

Jitka Stará, Josef Havlík, Kamil Holý, František Kocourek.....459-462

Abstract: Side-effects of selected insecticides on model species of natural enemies, *Aphidius colemani*, *Aphidoletes aphidimyza* and *Neoseiulus cucumeris* were 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*. Propargite (Omite 570 EW) and Cyperkill 25 EC (cypermethrin) were also tested against adults of *N. cucumeris*. Mortality of tested species after 24 or 48 hours of exposure to residues of insecticides was evaluated. For insecticides with a low toxic effect, the effect on fecundity of *A. colemani* was tested. Methoxyfenozide had low toxic effect on all three insect species, causing mortality after 24 hours from 4.6% to 29.8%. Similarly, indoxacarb caused mortality after 24 hours from 11.1% to 25%. However, higher mortality of *A. colemani* was found after 48 hours of exposure to residues of methoxyfenozide and indoxacarb. Acetamiprid was highly toxic to *A. colemani* (100% mortality), medium toxic to *A. aphidimyza* (48.1% mortality) and no effect was found to *N. cucumeris* (2.3% mortality). Similar results were obtained with NeemAzal T/S. However, low toxicity to *A. colemani* was found when 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.

Poster Session 2: Biodiversity

Is the distribution of beneficial arthropods influenced by mixed hedgerows?

Jean-François Debras, Rachid Senoussi, René Rieux, Elise Buisson, Thierry Dutoit.....464

Abstract: 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.

Avian biodiversity: impacts of phytosanitary practices and landscape in South-Eastern French apple orchards

Jean-Charles Bouvier, Julia Agerberg, Benoît Ricci, Claire Lavigne 465-468

Abstract: In French apple orchards, the predominant conventional management strategy has resulted in 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 on the avifauna of three different management strategies (organic, conventional and integrated) were studied during three years in 15 commercial apple orchards. These orchards were situated around Avignon and had 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 is also affected, with a lesser proportion of insectivores in conventional orchards than in other orchards. Phytosanitary and environmental factors taken together explain 52% of the variability of the composition of bird communities. Phytosanitary treatments and local environment of the orchards had a similar explanatory power of 11% while environment at the landscape scale explained approximately 19% 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.

Changes of entomofauna in orchards under different pest management regimes

Vladan Falta, Jitka Stará, Fratišek Kocourek 469

Abstract: 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 (ca 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.

Arthropods and mycorrhizal fungi associated to the rhizosphere of grapevine in

Sicily

Alessandra Martorana, L. Torta, G. Lo Verde, E. Ragusa, S. Burruano, S. Ragusa Di Chiara..... 470

Abstract: 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.

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

Csaba Nagy, Jerry Cross, Martin Luton, Caroline Ashdown 471-477

Abstract: 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 4 year study began at East Malling Research in 2008 to develop conservation biocontrol methods to maximise anthocorid populations and other natural enemies of pear sucker in the 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 plant species compositions and structures adjacent to pear orchards in Kent, UK were identified and characterised. The aim was to identify species mixes that maximise anthocorid populations in the 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.

A large data base comprising more than 30,000 individuals, sampled and identified from 24 plant species, was constructed but not yet analysed. However, some trends in the data are obvious. 1) The largest numbers of anthocorids were found on hawthorn, goat willow and stinging nettle in the early season, while on downy birch, grey willow, stinging nettle, hazel, black alder, goat willow, field maple, blackthorn, rose and sycamore late in the growing season. 2) In the early growing season the highest numbers of anthocorids were found on the same plants that had the highest numbers of psyllids. 3) Later on, anthocorids were present mostly on plant species that had high numbers of aphids. 4) A large number of other predatory arthropods (mostly Miridae, Araneae, Dermaptera, Neuroptera, Cantharidae, Coccinellidae) also potential predators of pear psyllids were found on the hedge plants. 5) *Cacopsylla pyri* (L.) was discovered to be the most dominant psyllid species in the pear orchards, not *Cacopsylla pyricola* (Foerster), as previously reported for the UK.

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

Nyonka Velcheva..... 479-482

Abstract: The mating disruption technique is one of the most selective methods of controlling *Cydia funebrana* Tr. and is under development in Bulgaria. In this connection, a pre-study was carried out to follow the dynamics and density of the leaf-eating and fruit-surface damaging lepidopteran larvae in an abandoned plum orchard of mixed varieties in Sofia region. Species belonging to eleven families were found during the eight years of observations. Permanent inhabitants in the plum biocenose were larvae of Gelechiidae, Tortricidae and Geometridae with index of constancy $c=100$. The next by frequency of occurrence were species of Coleophoridae and Noctuidae ($c=87.50$), followed by Yponomeutidae ($c=75$), Lycaenidae ($c=50$), Lymantriidae

and Pieridae (c=25). The rarest were individuals of families Ypsolophidae, Chimabachidae and Lasiocampidae with c=12.50. In 1998 and 2002 the dominant species of all collected lepidopteran larvae was *Recurvaria nanella* (Denis & Schiffermüller, 1775) and *Anarsia lineatella* (Zeller, 1839) in 1999. *Operophtera brumata* (Linnaeus, 1758) dominated in complex of external lepidopteran larvae in 2000 and 2005, *Neusphaleroptera nubilana* (Hübner, 1799) in 2003, *Hedia nubiferana* (Haworth, 1811) in 2006 and *Argyresthia* spp. in 2007. Specimens belonging to 35 genera and 47 species were identified altogether. In spite of very rich biodiversity, the density of leaf-eating and fruit-surface damaging lepidopteran larvae was above economical threshold only during three of the eight years of investigation, so we consider it possible to develop plant protection programs for biological production of plum fruits in West Bulgaria.

Poster Session 2: IFP

Flash grazing of hogs in apple orchards for pest management

David Epstein, M. Grieshop..... 484

Abstract: 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.

Hazelnut quality and sensory evaluation in organic and conventional growing systems

Valerio Cristofori, B. Pancino, C. Bignami, E. Rugini, S. Gasbarra..... 485-488

Abstract: Consumer acceptance of organic products requires the association of the production system with directly perceivable quality attributes. Up to now, organically grown hazelnuts have been scarcely characterised for specific quality traits. Nuts of two Italian hazelnut cultivars, 'Tonda Gentile Romana' and 'Tonda di Giffoni', grown in conventional and organic systems, were evaluated for technological traits, kernel chemical composition and sensory profile. Organic nuts showed a slightly lower oil and starch content, a lower incidence of total saturated fatty acids and a higher content of oleic acid in comparison to conventional ones. Crude protein content in

the kernel was higher in organic nuts in ‘Tonda di Giffoni’. In both cultivars, the organic regime has positively influenced the content of polyphenols in the kernel. Sensory evaluation revealed differences associated with the growing system for the attributes of colour and oiliness of roasted kernels. The organic samples were the most appreciated for both cultivars.

Softpest: a website on the usage of pesticides & biocontrol agents in soft fruits

Christian Linder, Janet Allen, Catherine Baroffio, Agata Broniarek-Niemiec, Victoria Brookes, Jerry Cross, Cathy Eckert, Rudolf Faby, Bruno Gobin, Alberto Grassi, Adrian Harris, Barbara Łabanowska,, Emilie Lascaux, Carlo Malavolta, Vincent Michel, Slobodan Milenkovic, Thilda Nilsson,, Paivi Parikka, Klaus Paaske, Jean-Jacques Pommier, Daniele Prodorutti, Lene Sigsgaard, Arne Stensvand, Christer Torneus, Nina Trandem, Tuomo Tuovinen, Gábor Véték 489-491

Abstract: The usage of plant protection products and biocontrol agents in soft fruit production has always been an important subject for the IOBC/WPRS Working Group "Integrated Protection of Fruit Crops" Study Group "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 Study Group "Soft Fruit" initiated a survey on the availability and usage of active ingredients and biocontrol agents in the different European countries in 2007. First, the most important pests and diseases in strawberry and raspberry production were identified. 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>

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

Andrew Jessup, Marc Vreysen 492

Abstract: 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.

Organic Raspberry Production in Serbia

Slobodan Milenkovic, Snežana Tanasković, Dušica Sretenović 493-496

Abstract: 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/yr. This programme is promising, provided strict observance of regulations EC 2092/91, EC 834/2007 and EC 889/2008 is performed. Organic production plantings are established in well-drained, loose soils containing high quantity organic matter. The incorporation of 20t/ha of manure into the soil is a regular cultivation practice. Considering the control of diseases and pests, the following

control measures are applied: setting up plantings on suitable terrains, application of appropriate cultivation practices, healthy planting material, and application of sulphur and copper fungicides. The control and monitoring of pests was aided by the use of visual inspections (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 on raspberry have not yet been registered.

Is organic hazelnut cultivation profitable?

Barbara Pancino, Valerio Cristofori 497-500

Abstract: In order to analyze the economic results of hazelnut cultivation in an organic regime, the two methods of production commonly used in the Monti Cimino hazelnut district (central 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”. Costs and productive values were evaluated for the two techniques and, afterwards, a comparison with conventional management was carried out, referring to a standard method of production which allows average yields of 2.7t/ha to be achieved. The examination of the costs of production for these systems highlighted a substantial homogeneity in variable costs, although remarkable variations were observed in the different categories (raw materials, mechanization, work). On the contrary, the produce which can be sold varies greatly according to the different orchard management forms. A comparison of gross margins showed that the results achieved by conventional management are intermediate between those of the two organic techniques. 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.

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

Alessandro Roversi, Gian Luca Malvicini 501-507

Abstract: In some previous contributions, our Institute has pointed out some difficulties in the organic management of filbert orchards. A further two years of investigation showed that the main negative aspect of organic management is the high rate of nuts affected by bugs. Therefore another important problem is the reduction in productivity.

To validate 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 conventional and organic orchard management 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 3kg samples of nuts were taken from whole nut yielding. Each sample was studied through the standard marketing surveys. In particular fruit and kernel weight, *Curculio* holes, fruit empty and insect kernel damage percentage, has been considered. The results were statistically analyzed through conventional-organic comparisons, and tested with the "t" test.

Codling moth proof hail nets

Benoit Sauphanor, G. Severac, L. Romet, E. Esberard, J. F. Toubon, S. Maugin 508

Abstract: 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.

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

Sylvaine Simon, Benoît Sauphanor, Sophie Buléon, Johanny Guinaudeau, Laurent Brun.....

509-512

Abstract: 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 Smoothee 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 Smoothee plots within each system. Two-fold more treatments were applied in any SV plot and in Smoothee OG compared to Melrose LI. The LI system presented the lowest TFI and the lowest environmental impact of pesticides calculated by the I-phy_{ARBO} fuzzy expert system. Apart from Smoothee, I-phy_{ARBO} in the OG system scored between LI and SV. From the first four years of the experiment, the importance of the cultivar in the management of the orchard diseases (and to some extent pests) is outlined whatever the system, with a high variation in the number of treatments. 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.

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

Tuomo Tuovinen, Isa Lindqvist, Pirjo Kivijärvi

513

Abstract: 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.

Poster Session 2: Pathology

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

Boysen Bengt 516

Abstract: 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.

The OrganicA Project: Organic Disease Management in Orchards with 'Newer' Cultivars

Lorraine Berkett, M. Garcia, R. Moran, H. Darby, R. Parsons, J. Hayden, T. Bradshaw, S. Kingsley-Richards, M. Cromwell 517-520

Abstract: 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 'McIntosh', the predominant cultivar grown in the region. 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 the 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. The cultivars being studied in replicated plots in each orchard system are: '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 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 initial foliar disease assessments during the establishment years of the orchards, '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!'. 'Macoun' and 'Zestar!' exhibited a higher incidence of necrotic leaf spots than the other cultivars. 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.

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

Angela Berrie, B. E. Ellerker, K. Lower, G. Saunders 521-524

Abstract: The risk of pulverised excised canker prunings to apple trees was evaluated in two orchard trials. Cankers (*Nectria galligena*) on one year shoots were collected from apple trees cv. Gala in two orchards and distributed among sprout net bags. Cankers on two, three or older wood were similarly collected and pulverised with a tractor-trailed standard orchard pulveriser before placing in sprout net bags. Both sets of bags were pegged out in two orchard sites, either in the tree row or the grass alley way between trees in February 2005. The bags were sampled at monthly intervals and the state and viability of the cankers assessed. The pruned out cankers whether pulverised or unpulverised continued to produce perithecia for at least 16 months after removal from the trees. Conidia were only found in the first two samples. Perithecia were

produced more abundantly on pruned out cankered one year shoots. Pulverised prunings decayed more rapidly in the grass alley way than in the tree row. This study shows that pulverised canker prunings could be a source of inoculum of *N. galligena* and hence a risk to apple trees for more than a year after pulverising.

Integrating scab control methods with partial effects in apple orchards: the association of cultivar resistance, sanitation and reduced fungicide schedules
Frédérique Didelot, Valérie Caffier, Maël Baudin, Gilles Orain, Arnaud Lemarquand, Luciana Parisi525-528

Abstract: To preserve the environment, consumer health and reduce the economic impacts of apple scab, it is crucial to improve disease control while reducing the number of treatments and the impact of fungicide spraying. To reach this goal, the planting of cultivars with partial resistance to the disease, associated with an integrated control strategy, may be an attractive alternative. However, to decrease the risks for 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. The thresholds for chemical spraying must be defined and validated, taking into account the cultivar resistance level and the sanitation practices applied. Since 2006, we have studied within an experimental orchard the association of the cultivar 'Reine des Reinettes' (which presents good partial resistance) with:

- i) A sanitation practice: reduction of leaf litter.
- ii) A chemical schedule: fungicide spraying only if a medium or high Mill's risk is recorded or expected.

The results obtained in 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 efficient with less than 2% of scabbed fruits.

Application of thermo- and chemotherapy in vitro for elimination of some viruses infecting fruit trees and small fruits
Mirosława Cieslinska529-533

Abstract: *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 for thermotherapy. Chemotherapy was conducted using 10-100mg/l 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 concentration 25-100mg l⁻¹ 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. Combining thermotherapy and chemotherapy contributed to elimination of all studied viruses from most treated shoots.

In vivo antagonism of *Acremonium byssoides*, endophyte in *Vitis vinifera*, towards *Plasmopara viticola*
Gaetano Conigliaro, Valeria Ferraro, Alessandra Martorana, Santella Burruano...535-538

Abstract: 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 gamic structures of pathogen. The aim of our researches 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.

Preliminary investigation on the endophytic communities in *Olea europaea* L. in Sicily

Valeria Ferraro, Gaetano Conigliaro, Livio Torta, Santella Burruano, Giancarlo Moschetti539-543

Abstract: An investigation was carried out in order to study the composition of the endophytic community of olive (*Olea europaea* L.) in Sicily (Italy). One olive-yard in San Cipirello (Palermo) and another one in Racalmuto (Agrigento) were sampled, similar for plant age, cultivars and agricultural management. Isolation assays were carried out on samples collected from each locality in spring, summer and autumn during both 2007 and 2008.

Numbers of fungal and bacterial isolates differed between the sampled sites. Prevailing fungal genera in almost all samplings were *Alternaria*, *Cladosporium*, *Diplodia*, *Phoma*, *Septoria*, *Stemphylium* and its teleomorph *Pleospora*. Isolation frequencies were dependent on the sampling site. Our preliminary results show a constant composition of endophytic assemblage of *O. europaea* in Sicily, even if the degree of infection varies depending on both geographical and environmental factors. Further studies will be carried out in order to complete fungal and bacterial identification and to analyse the interactions between endophytes, host and environment.

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

Nick Harvey, Angela Berrie, Xiangming Xu545-553

Abstract: 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, Jürg E. Frey, Markus Kellerhals ..555-558

Abstract: A field survey throughout Switzerland established an inventory of fruit genetic resources. The decentralised collections network was subsequently completed and the characterization of the accessions is ongoing. Considering international standards, guidelines for the phenotypic description of the fruit genetic resources were developed and practically applied. Apple accessions from the Swiss pool of genetic resources were tested for fire blight (*Erwinia amylovora*) resistance in the greenhouse. Results of the fire blight screening confirm significant differences between accessions. Additionally, the accessions were analysed with SCAR markers surrounding a QTL for fire blight tolerance. Moreover, young trees of 600 accessions were planted to evaluate their scab (*Venturia inaequalis*) and powdery mildew (*Podosphaera leucotricha*) resistance in a field trial. The project aims at defining accessions useful for cultivation as standard trees for cider and juice production and that are an important landscaping and ecological factor. Promising accessions are being used for breeding.

Activity of Physpe (laminarin) in control of strawberry diseases

Beata Meszka, Anna Bielenin.....559-563

Abstract: Strawberry plants are susceptible to many pathogens, such as *Botrytis cinerea*, *Mycosphaerella fragariae* and *Sphaerotheca macularis*. Phytochemicals are intensively used to limit pathogen infections on strawberry plantations in Poland. Resistance problems, residues in fruits and protection of the environment require alternative strategies. In the present study the efficacy of Physpe (laminarin) in control of main strawberry diseases in field conditions was tested. Experiments were conducted in 2006 and 2008. Laminarin reduced *B. cinerea* infection by approximately 50 to 80%, depending on the experimental site. Its effectiveness in reduction of leaf spot symptoms was about 50% and almost 80% in reduction of powdery mildew. The use of Physpe in program with fungicides sprays could be acceptable for commercial use and gives possibilities to reduce the number of chemical treatments against main strawberry diseases.

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

Riccardo Bugiani, Vittorio Rossi, Simona Giosuè, Ceredi Gianni.....565-569

Abstract: *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; first seasonal symptoms become visible between 19 May and 12 July. These infections were always correctly predicted by the model, with an average incubation period of three weeks. Five 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 four of these years the model did not predict infection all season long, while in one year it wrongly predicted two possible infection periods. Sensitivity, specificity and accuracy of the model showed that one would have somewhat more confidence in predictions of non-infections than in predictions of infections. In a practical use of the model, this would lead to some unjustified alarms.

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

Marcel Wenneker, Peter Vink, Ilse Heurneman, Marcel van Raak, Anne Sophie van Bruggen.....570

Abstract: 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.

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

Lubos Talacko571-575

Abstract: Sanitation of apple cultivar ('Rubinstep') and pear cultivars ('Astra', 'Bohemica', 'David', 'Elektra', 'Erika') was carried out by *in vitro* thermotherapy 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. Twenty clones of apple cultivar 'Rubinstep', 20 clones of pear cv. 'Elektra', 19 clones of pear cv. 'Erika', 20 clones of pear cv. 'Astra', 20 clones of pear cv. 'Bohemica', and 12 clones of pear cv. 'David' were tested after chemotherapy in years 2007-2008. Fifteen clones of pear cv. 'Elektra', 6 clones of cv. 'Lada' and 10 clones of cv. 'Rubinstep' were tested after thermotherapy in 2008. The occurrence of viruses Apple chlorotic leaf spot virus (ACLSV), Apple stem grooving virus (ASGV), Apple stem pitting virus (ASPV), Apple mosaic virus (ApMV) and phytoplasmas *Candidatus 'Phytoplasma pyri'* (CPP) and *Candidatus 'Phytoplasma mali'* (CPM) were 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. The results presented here are preliminary.

Poster Session 2: Pesticides and Resistance

Chlorantraniliprole (DPX-E2Y45, Rynaxypyr®) (Coragen®20SC and Altacor®35WG) - a new diamide insecticide for control of codling moth (*Cydia pomonella*) and other top fruit Lepidoptera. Product features with regards to IFP criteria

Andrea Bassi, Axel Dinter, Kristin Brugger, Niels-Martin Frost, John Wiles, Jean

Luc Rison578

Abstract: 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.

Can delayed flight activity serve as an indicator for insecticide resistance?

Patrik Kehrl, Denis Pasquier, Pierre-Adrien Roux579-581

Abstract: Together with the codling moth, *Cydia pomonella*, the summer fruit tortrix moth, *Adoxophyes orana*, is a major pest insect in apple orchards of western Switzerland. Whereas codling moth developed simple, cross and multiple resistances to various classes of insecticides over the last decade, *A. orana* seemed to be still susceptible to these pesticides. However, since 2004, fruit growers indicate more and more failures of conventional control schemes against

summer fruit tortrix moths. Using laboratory bioassays we established that *A. orana* shows resistance to insect growth regulators and to insect growth inhibitors. This resistance becomes manifest in the slower development of *A. orana* larvae. Field observations showed that the flight of resistant moth populations is 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 the alternate use of insecticides with different modes of action.

No evidence in codling moth for cross-resistance between chemical insecticides and

Cydia pomonella granulovirus

Annegret Schmitt, Johannes Jehle, Isabella Bisutti, Benoît Sauphanor,,

Jürg Huber..... 582

Abstract: 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.

Cydia pomonella (Lep: Tortricidae) resistance and cross-resistance to various classes of insecticides in Central Europe

František Kocourek 583

Abstract: 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-instars 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.

Trials for the development of alternative control strategies against the codling moth (*Cydia pomonella*) in pome fruits in Austria in 2007

Christa Lethmayer, H. Hausdorf, J. Altenburger 584

Abstract: The development of future alternative control strategies against the codling moth, *Cydia pomonella* (Tortricidae, Lepidoptera), 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 including virus products, but also the expiration of the authorization 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 also suitable for integrated production 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, Methoxyfenozid, Chlorpyrifos and Indoxacarb as active ingredients were used in different numbers of applications 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.

Because the 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.

Efficacy of chlotianidyna (neonicotinoid group) in the control of the strawberry root weevil (*Otiorhynchus ovatus*) on strawberry

Barbara Labanowska 585-588

Abstract: The strawberry root weevil (*Otiorhynchus ovatus*) feeds on roots and, therefore, it is a very dangerous pest on older strawberry plantations. The efficacy of two clothianidine formulations (Apacz 50 WG (clothianidine 50%) and TI 435 1 GR (CAGR 8; Santana 1 GR) (clothianidine)) were tested against the strawberry root weevil on strawberry plantations. Both insecticides belong to neonicotinoid group. Granular formulation (TI 435 1GR) incorporated into soil at the rate of 10 and 15kg/ha in the spring, before strawberry blossom, reduced significantly the number of weevil larvae. In two trials TI 435 1 GR applied at the higher rate (15kg/ha) decreased the number of larvae by 72%. The efficacy of this insecticide used at the lower rate (10kg/ha) against weevil larvae was 61.3 and 78.7%. Results obtained with TI 435 1 GR were similar to those obtained with standard insecticide – Diazinon 10 GR (80kg/ha). Apacz 50 WG applied as a spray treatment at the rate of 0.15 and 0.20kg/ha before strawberry blossom reduced weevil larvae by 74.5-99.6%. Apacz 50 WG applied at the rate of 0.15 and 0.20kg/ha just after strawberry harvest reduced the pest abundance by 72.1-96.3%. Reduction of the pest at this time is very important because after harvest adults of the strawberry root weevil feed on leaves and females lay eggs. The results obtained with Apacz 50 WG were similar or better than those obtained with standard the insecticides; Diazinon 10 GR or Dursban 480 EC (chlorpyrifos).

Microencapsulation and PBO: a tool in resistance management of the green peach aphid

Emanuele Mazzoni, Carlotta Gobbi, Ferdinando Pavesi, Valerio Borzatta, Piero Cravedi 589-592

Abstract: 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 orchard. 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 sequestering. Recently, many authors have demonstrated that piperonylbutoxide (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 formulation are discussed in term of increased mortality, application rate as well as offsprings reduction.

According to the results, 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.

Susceptibility to abamectin of pear psylla, *Cacopsylla pyri* (L.) (Hemiptera: Psyllidae) in pear orchards of north-east Spain

Xavier Miarnau, Miquel Artigues, Maria José Sarasúa..... 593

Abstract: *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.

Plant infusions to limit the development of pests or diseases: results on *Aphis pomi*

Sophie-Joy Ondet..... 594

Abstract: 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.

- 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, René Causse 595

Abstract: 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.

- Preliminary resistance screening of abamectin on pear psylla (Hemiptera: Psyllidae) in Northern Italy
S. Civolani, Edison Pasqualini, R. Peretto, C. Chieco, M. Chicca, M. Leis 596

Abstract: 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.

- Strategies and timing of protection practices against *Cydia pomonella* (L.) in apple orchards
Daniel Plénet, Camille Picard, Jean-François Toubon, Olivier Martin, Rachid Senoussi, Benoît Sauphanor 597-601

Abstract: The understanding of actual farmer practices is essential to identify the constraints for the adoption of new integrated pest management strategies. From data collected in 2006 in 71 randomised pear and apple orchards in a small production area in south France, our objective was to comprehend the management practices against codling moth (*Cydia pomonella* L.). We first investigated the timing and frequencies of insecticide applications in relation with national and regional recommendations. The orchards were classified according to three management strategies: conventional with major use of chemical insecticides, MD associating mating disruption with chemical pesticides and organic orchards. For each plot and day, the probability of applying an insecticide was described by a logistic model taking into account the main variables that influence farmers' decisions to make the application. The protection strategies significantly affected the number of insecticides applied against *C. pomonella*, the application frequencies during the risk periods of each generation of the pest and the choice of active ingredients. Farmers followed the application guidelines more closely within MD protection strategy.

- Insecticide Resistance of *Cydia pomonella* (L.) (Lepidoptera: Tortricidae) Eggs and First Larval Instars in Spanish Field Populations
Marcela Rodriguez, Dolors Bosch, Tânia Marques, Jesús Avilla 602

Abstract: 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 (2µl/cm²). 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.

Molecular detection of pest resistance to insecticides

Myriam Siegwart, Juliette Goussopoulos, Jérôme Olivares 603-606

Abstract: Insecticide resistance occurs at three levels in insects: i) stopping penetration through barrier tissues ii) conjugation, storage, and metabolism in internal tissues iii) modification of the molecular target site. The detection of these biological adaptations is often realized by the use of bioassays. This technique allows characterizing the resistance level of a population to a given compound, but is not informative on the mechanism. Therefore, it limits the potential of investigation and resistance management becomes more difficult. Molecular detection can be useful, enabling the identification of target mutations, and the modifications in the expression or the structure of detoxifying enzymes. Acetylcholine esterase and the sodium channel are two important molecular targets of organo-phosphates (OPs), carbamates and pyrethroids, respectively. The study of gene sequences allows the development of molecular tools in order to screen field populations.

We have already developed some molecular tools to detect pyrethroid resistance in *Cydia pomonella*. We are now investigating the molecular structure of target sites in other pest species, including *Cydia molesta* aiming to define new molecular tools for resistance detection. The first results are presented and discussed.

New isolates of CpGV overcome virus resistance of codling moth

Daniel Zingg 607

Abstract: 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.

Poster Session 2: Plant-Pest Interactions

Peach breeding for multiple resistances to pests and diseases contributes to integrated fruit production

Thierry Pascal, P. Lambert, J. L. Poëssel, V. Decroocq, M. H. Sauge 610

Abstract: In spite of the worldwide decline in peach production, a constant stream of new varieties are being provided 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 developed for PPV resistance. Whole of first results and perspectives are discussed.

Evaluation of technical scenarios for the peach-brown rot system using a virtual fruit model simulating quality and storage potential

Caroline Gibert, Pierre Rouet, Claude Bruchou, Gilles Vercambre, Michel Génard, Daniel Plénet, Philippe Nicot, Joël Chadœuf, Françoise Lescourret..... 611-615

Abstract: Improving fruit quality while reducing pesticide and water use supports both consumers' requirements and environmental and health concerns. This objective promotes some alternative technical scenarios that use more cultural than chemical control for pest management. Our study focused on the peach-brown rot system (*Monilinia laxa*). It aims at determining sets of cultural options providing an optimal trade-off between revenue build-up, consumers' requirements and environmental impacts. We used a modelling approach to simulate technical scenarios by using a virtual fruit model describing the seasonal changes in peach fruit quality traits during final swelling under the influence of climatic, biotic and cultural factors. We defined 243 virtual scenarios based on agronomical and epidemiological inputs (time and intensity of thinning, irrigation, cultivar choice and disease control). Virtual scenarios were evaluated on a multi-criteria profile of performance integrating storage potential, organoleptic and environmental factors, according to different objectives of profitability, water saving and no pathogen entry (cuticular crack) on fruits. Scenarios including water stress during final swelling are promising while requiring an evolution of market standards.

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, Sylvie Derridj..... 617-620

Abstract: *Cydia pomonella* (*C. pomonella*) is the main pest of *Malus domestica* (*M. d.*). *Malus floribunda* (*M. f.*) which is used in orchards to cross pollinate trees, shows no *C. pomonella* damage. We observed on single trees without any alternative that 60% of females may lay eggs on *M. d.* (41 eggs) vs. 0% on *M. f.* After collecting and analyzing, by gas chromatography, leaf surface metabolites, we were able to test the known active metabolite pattern on females to confirm the tree observations. Acceptance and egg-laying was reduced by the *M. f.* metabolite pattern. The gravid female behavior was observed on trees in no-choice controlled conditions. On both *Malus* sp. females preferred to land on the upper side of corymb leaves and on the fruits. Then females generally remained on the site where they had landed. The behavioural difference to both *Malus* sp. was observed at the stage of ovipositor scanning, which was linked to egg-laying. Scanning was dramatically reduced on *M. f.* and the locomotion speed was lower. Host and non-host characters belonged to the egg-laying stage and non volatile metabolites.

Apple resistance to arthropod herbivores: genetic basis and modification by environmental factors

Karsten Mody, Sibylle Stoeckli, Cesare Gessler, Silvia Dorn..... 621-626

Abstract: 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 with 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. *devecta* 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 such as within-canopy variation in climate, and neighbourhood-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 studies revealed the genetic basis of apple resistance to different arthropod herbivores and the modifying influence of environmental parameters that may impede QTL detection.

Poster Session 2: Plant-Pest Interactions

MRV-Carpocapsa: a phenological model as decision support system for Codling

Moth (*Cydia pomonella* L.) in Emilia-Romagna (Italy)

Alda Butturini, Rocchina Tiso, Mauro Boselli, Simona Giosuè, Giovanni Burgio ... 627-631

Abstract: 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 fields surveys is used to develop warnings concerning the risk of pest/disease attack. For the control of *Cydia pomonella* is available a phenological time-distributed delay model. 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 cumulating 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 over 1992-1998 and therefore has been effectively used for ten years in Emilia-Romagna to optimize control strategies in IPM.

From the first application in 1998, it was executed steadily a quality control of simulated data by their comparison to that observed in orchards. As the pheromone traps do not always describe population dynamics properly, it has been chosen to assess the oviposition activity.

Weekly field observations were carried out over 1998-2008 in an untreated orchard near Bologna. The eggs were examined for the exact phase of embryonic development determination. Then the egg laying dates were estimated taking into account of specific degree-days for each embryonic phase.

Results from the comparison between the simulated data and those observed in field are reported. Altogether, actual and simulated oviposition curves agree fairly well over the last eleven years despite the different climatic condition recorded in this period.

GEP, a tool for helping decision making for pest control advisers in Lleida (Spain)

Manel Ribes-Dasi, Jesus Avilla, Ramon Torà..... 632

Abstract: 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.

Impact of flower strip establishment in apple orchards on natural enemy populations

Jennifer De Almeida, Daniel Cormier, Éric Lucas..... 633-636

Abstract: Composite flower strips were established in 2006 in three commercial apple orchards in Quebec. Strips were composed of the Canadian goldenrod (*Solidago canadensis*) and the common yarrow (*Achillea millefolium*), two native plants known to attract beneficial organisms. The aim of the project was to reduce pesticide application treatments directed against orchard pests, more specifically the European red mite (*Panonychus ulmi*), the two-spotted spider mite (*Tetranychus urticae*), the green apple aphid (*Aphis pomi*), the European apple sawfly (*Hoplocampa testudinea*), the tarnished plant bug (*Lygus lineolaris*) and the white apple

leafhopper (*Typhlocyba pomaria*). In the present trial, populations of potential natural enemies of these pests were monitored in 2008, using sticky white traps, in both control and managed areas. The most common predator species were Coccinellidae, Syrphidae, Neuroptera (Chrysopidae and Hemerobiidae) and Aranea. Results varied according to the species of natural enemy, the treatment (control versus floral strip) and the distance to the flower strip.

COSMOS, a spatially explicit model to simulate the epidemiology of *Cosmopolites sordidus* in banana fields
Fabrice Vinatier, Philippe Tixier, Christophe Le Page, Pierre-François Duyck, Claude Bruchou, Françoise Lescourret.....637-641

Abstract: A stochastic individual-based model called COSMOS was developed to simulate the epidemiology of *Cosmopolites sordidus* in banana fields, based on simple rules of local movement of adults, egg-laying of females, development and mortality, and infestation of larvae inside the banana plants. The biological parameters of the model were estimated from literature. The model was validated at the small-plot scale. Simulated and observed distributions of attacks were similar in twelve out of 18 plots (Kolmogorov-Smirnov test). An exhaustive sensitivity analysis using the Morris method, showed that dispersal and demographic parameters of adults were the most influent parameters.

Development of a dynamic population model as a decision support system for Codling Moth (*Cydia pomonella* L) management
Marc Trapman, Herman Helsen, Matty Polfliet.....642

Abstract: 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.

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
Ana Scomparin, Marc Saudreau, Hervé Sinoquet, Benoit Sauphanor, Marie Berling, Odair Fernandes, David G. Biron.....643-646

Abstract: The developmental rate of codling moth, *Cydia pomonella* (L.) (Lepidoptera: Tortricidae), is supposed to be directly proportional to air temperature between the lower and upper developmental thresholds. However, some review papers suggest that insect species have a higher developmental rate when reared in thermoperiodic conditions as compared with constant temperatures. Thus, in this study, the developmental rate and the zero temperature threshold of codling moth for the larval stage were determined in thermoperiodic conditions for strains resistant and non-resistant to chemical and viral (CpGV) insecticides. Two methods were used to determine the zero development temperature for the four *C. pomonella* strains: (i) the x-intercept method and (ii) the thermal unit test. Our study supports the “thermoperiod hypothesis” and suggests that the effect of thermoperiod on the developmental rate of *C. pomonella* larvae should be taken into account in the development of phenological models.

Poster Session 2: Semiochemicals

A field unit for automatic monitoring of insect behaviour

Federica Trona, Gianfranco Anfora, Roberto Oberti, Ezio Naldi, Claudio Ioriatti, Gino Angeli..... 648

Abstract: 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 80cm 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.

Raspberry cane midge *Resseliella theobaldi*: 3 years of flight monitoring in Swiss raspberry cultures

Catherine Baroffio, Charley Mittaz..... 649-651

Abstract: 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 generations were observed in the low altitude and three in the mountains. Based on these observations and in order to find a substitute to diazinon, the only registered insecticide, an efficacy trial was conducted in 2008. Besides diazinon, two insecticides were tested. Only thiacloprid and diazinon showed a significant difference compared to control. The trial will be repeated in 2009.

Management of Oriental Fruit Moth and Codling Moth with spray application of microencapsulated sex pheromone

Daniele Demaria, Manuela Cigolini, Graziano Vittone, Fabio Molinari..... 653-656

Abstract: Codling moth (*Cydia pomonella* L.) and oriental fruit moth (*Grapholita molesta* (Busck)) are the main pests of apples and peach, respectively. Various formulations of synthetic sex pheromones 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 achieve the same results as insecticides and hand-applied pheromone dispensers.

Isomate C Plus Dispensers as an Alternative Means for Control of Codling Moth, *Cydia pomonella* L., in Apple Orchards of Bulgaria

Hristina Kutinkova, Jörg Samietz, Vasilij Dzhuvinov, Vittorio Veronelli, Andrea Iodice..... 657-662

Abstract: In the years 2006-2008, trials on the control of codling moth (CM) by mating disruption (MD) using Isomate C plus dispensers were carried out in an isolated 1-ha apple orchard in South-East Bulgaria. Dispensers were hung in the upper third of tree canopies at a density of 1000 pieces per ha before CM flights started. Dynamics of CM flights was monitored by pheromone traps installed in the trial plot and in a conventionally treated reference orchard.

Fruit infestation was periodically assessed till harvest time. Hibernating population of CM was estimated in autumn by counting diapausing CM larvae in corrugated cardboard bands. In each of the years, Isomate C plus dispensers completely inhibited CM captures in pheromone traps in the trial plot. Fruit damage remained at low levels till late July and increased slightly only in August. At harvest the percentage of damaged fruits was below 1%. The hibernating population also stayed at low level. In the reference orchard, in spite of numerous chemical treatments, the final fruit damage was high (5.5-28.4%), apparently due to resistance of CM to insecticides. It has been concluded that 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, if isolated from external sources of infestation and if initial CM population is low.

Correlation between maturity of female *R. cerasi*, oviposition, larval development and ripeness of cherries

Kirsten Köppler, Barbara Féjóz, Heidrun Vogt..... 663-667

Abstract: The European cherry fruit fly *Rhagoletis cerasi* L. (Diptera: Tephritidae) is the most serious pest in European cherry production. The control of the pest is difficult, especially against the background of EU wide reduction programs for broad spectrum insecticides. To find alternative control measures, the biology and behaviour of the fly must be known in more detail. One option to control the pest might be bait sprays, which have to be applied repeatedly during the main infestation period. To achieve the optimal efficacy and with respect to the costs, timing and number of applications are important questions. For this reason we investigated the correlation between the maturity of female *R. cerasi* by analysing the ovary status of flies caught with yellow sticky traps, oviposition, larval development and ripeness of host fruits (varieties Sam, Van and Hedelfinger) by measuring colour, sugar content as well as solidity, recorded as pressure resistance.

The 1st fly was trapped on May 9, whereas the 1st ripe eggs after dissection of ovaries were found on May 13. According to the cherry variety, the first deposited eggs were detected between May 28 and June 2. During this time, the cherries turned their colour from green to yellow/orange, pressure resistance ranged between 4.0 and 6.3kg/cm² and sugar content between 8.4 and 13.8 Brix. Newly deposited eggs were found until mid of July, whereas 3rd instars occurred from mid of June until mid/end of July, depending on cherry harvest and variety.