



IOBC Working Group
Integrated Plant Protection in Fruit Crops
Subgroup "Soft Fruits"

**7th Workshop on
Integrated
Soft Fruit Production**

20–23 September 2010
Budapest, Hungary

**Programme, Abstracts &
Delegates List**

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Programme Monday 20 September

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19:00-	Free evening in the city

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7th Workshop on Integrated Soft Fruit Production

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Abstracts

Investigation of attraction of raspberry cane midge, *Resseliella theobaldi*, to volatiles from wounded raspberry primocanes

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Abstract: Mated raspberry cane midge (*Resseliella theobaldi*) (Cecidomyiidae) females are known to be strongly attracted to odours from recently split raspberry primocanes. Fresh splits are preferred over old ones. Using SPME microfibres to sample the volatiles *in situ* followed by GC-EAG (gas chromatography coupled to an electro-antennogram), a number of volatile substances produced in larger amounts from wounded canes were identified. Most of these are produced by other plants when damaged, but two compounds are more unusual and might be responsible for the specific attraction of female midges to raspberry canes. Experiments with several raspberry cultivars showed consistency in the patterns of volatile emission from cane splits, indicating that development of an attractant lure should be feasible based on a few, consistent compounds now identified.

The composition of the sap produced when raspberry canes are damaged has also been determined. This was largely as expected from the studies of volatiles emitted from intact and unsplit stems with the lower volatility compounds present at relatively higher proportions in the sap. However, two ketones were absent in the extracts although major components in volatiles from both intact and split stems. It is possible these are converted to the corresponding alcohols by enzymes released on damaging the stems by splitting. This could be of significance in attracting female midges to split stems rather than intact ones.

Synthetic lures containing a mixture of 13 of the main compounds were developed that emulate the bouquet from cane splits and testing of their attractiveness to *R. theobaldi* was undertaken in Kent, UK and Hungary in 2009 and 2010. The field trapping tests have given variable results. In 2009, very few female *R. theobaldi* were trapped in any of 5 experiments. However, delta traps baited with the synthetic cane volatile lures caught significantly more males than unbaited traps in 3 of 5 experiments. In 2010, a more complex range of blends has been evaluated. In 2 UK experiments, again very few female midges were captured but several of the host volatile lures attracted significant numbers of males. In contrast in one experiment in Hungary in 2010, significant attraction of the host volatile lures to females appeared to occur. The reasons for the inconsistent results are unclear. It may be that one or more essential components is missing from the synthetic lures, that the release rate or blend is critical and incorrect, or that additional visual or tactile components are needed for attraction. Further work to explore varying the composition and blend ratio of the volatile components and their effects on attractiveness to females and males is planned.

On overview of the work including results of recent field tests will be presented.

Key words: Semiochemical, *Rubus*, host volatiles, female attractant, primocane, pest monitoring

Semiochemicals in the integrated management of soft fruits: overview of research results of our team

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Abstract: Semiochemicals of important insect pests of soft fruits have been studied in our labs already in the past decades. Among successful past projects on Lepidoptera let us mention here for example pheromone studies on the currant borer *Synanthedon tipuliformis* (Sesiidae), a pest of red and black currant (Szöcs G. et al., Ent. exp. appl. 39:131-133, 1985, J. Chem. Ecol. 16:1289-1305, 1990, Ent. exp. appl. 60:283-288, 1991), or on the common magpie *Abraxas grossulariata* (Geometridae), a pest of gooseberries (Tóth M. et al., J. Chem. Ecol. 18:13-25, 1992).

In the present paper we would like to give an overview of more recent results on cetoniin scarab beetles (Coleoptera, Scarabaeidae, Cetoniinae), which occasionally can cause significant damages in different soft fruit cultures. Differing from Lepidoptera, where damage is caused by the caterpillars, in case of these scarabs the adults feeding on flowers and ripening fruits are the damaging developmental phase. Decreasing the population density of adult beetles by mass trapping may decrease damages also to an economically acceptable level. Our research concentrated on floral attractants, as – in contrast to more conventional pheromones – these lures attract both male and female beetles, thus exerting a more significant impact on the population.

A synthetic floral attractant consisting of (*E*)-anethol + (*E*)-cinnamic alcohol has been developed for the scarab *Epicometis (Tropinota) hirta*, which, besides attacking many other orchard cultures, in some years may devastate strawberry plantations, and occasionally blackberries or raspberries in southern Hungary and the former Yugoslavia. A non-sticky, high capacity funnel trap combining this attractant and the optimal visual cue, light blue colour, was developed and put in use in these countries. Later testing revealed that this trap is also efficiently catches the scarab *Tropinota squalida*, which is present more to the south in Europe, in North Africa and the Middle East. Another floral attractant containing 2-phenylethanol, \pm lavandulol and (*E*)-anethol has been optimized for the related scarab *Oxythyrea funesta*. In this case fluorescent yellow traps baited with this lure proved to be most efficient. More recent preliminary results indicate that the same trap catches also *Oxythyrea cinctella*, an important pest in the Middle East. Two larger cetoniins, *Cetonia aurata aurata* and *Potosia cuprea* are strongly attracted to 4-component baits consisting of 1-phenethyl alcohol, 3-methyl eugenol, (*E*)-anethol and \pm lavandulol. These scarabs, in contrast to *Tropinota* or *Oxythyrea*, do not respond to colour cues *per se*, but in the presence of the chemical lure highest catches were observed in light blue traps.

Key words: *Epicometis (Tropinota) hirta*, *Tropinota squalida*, *Oxythyrea funesta*, *Oxythyrea cinctella*, *Cetonia aurata aurata*, *Potosia cuprea*, cetoniin scarabs, pest monitoring, mass trapping, floral attractant

Blackberry and raspberry, new hosts of the yellow legged clearwing moth, *Synanthedon vespiformis*: What can the recently developed sex attractant offer in monitoring and beyond?

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Abstract: The yellow-legged clearwing moth, *Synanthedon vespiformis* L. (Lepidoptera, Sesiidae), a native species to central and South Europe, had been reported to occur on maron (*Castanea sativa*), as well as rarely on almond (*Amygdalus communis*) and peach (*Prunus persica*), while in silviculture on beech (*Fagus sylvatica*), oak (*Quercus* spp.) and occasionally also on poplar (*Populus* spp.), willow (*Salix* spp.) and on some other woody species. Strikingly and unexpectedly, it heavily attacked thornless blackberry (*Rubus fruticosus*) in 2006 at Nógrád county, Hungary, and since that time it may cause up to 30% death of bushes of some plantations. It was detected *en mass* also on raspberry (*Rubus idaeus*) plantations in 2009 in that region, by means of the newly developed sex attractant traps.

The objectives of this study were (1) to check whether the same sex attractant is a useful tool for monitoring the flight of various populations of this pest, living on different host plants / habitats (oak, blackberry and raspberry), (2) to follow seasonal flight pattern of the pest in various cultivars of blackberry, (3) to determine the circadian rhythm of trap captures and (4) to map the distribution of the pest in Nógrád county.

Sticky (RAG) as well as of large capacity, funnel type of pheromone traps (VARL+) (Csalomon[®], produced by the Plant Protection Institute, Hungarian Academy of Sciences, Budapest, Hungary) were used in course of the season of 2009 (objectives 1 and 4), and further trials have been running in 2010 (objectives 2 and 3). Trapping sites were chosen so that an isolation distance of at least 500 m were kept between various hosts.

Results show that the same sex attractant is a useful bait for monitoring for all populations of *S. vespiformis*, living either in oak forest, or in blackberry plantation, or in raspberry plantation. Significant captures were recorded in plantations of both the 'Loch Ness' and 'Thornfree' cultivars of blackberry, showing a more-or-less similarly continuous flight in course of the season. Male moth entered the traps predominantly in the afternoon (15:00-19:00). The pest was abundant in all of the checked black- and raspberry plantations in Nógrád county (Hungary).

Effective control measures are needed not just for achieving good yield of berries at harvest, but in blackberries also for preventing die out of bushes. Recently used methods are costly for farmers and requires heavy application of pesticides, therefore new, environmentally-sound methods would be needed.

Key words: host plant extension, pheromone traps, *Synanthedon vespiformis*, Sesiidae, blackberry, raspberry

Monitoring *Byturus tomentosus* with semiochemical traps in raspberry fields

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Abstract: The raspberry beetle, *Byturus tomentosus*, is a major pest of Swiss raspberry cultures, in particular at higher altitudes. Whereas adults attack flower buds, larvae damage berries. Damaged fruits have an abnormal coloration and dry up regularly. Since the economic threshold is very low (e.g. 1% flowers attacked), preventive insecticides treatments are commonly applied. However, today there is a large demand for residue-free fruits. With the final aim of developing an alternative control strategy against the raspberry beetle, adults' flight was monitored in a first step using the semiochemical trap developed by the Scottish Crop Research Institute. This trap lures beetles by emitting volatiles of the raspberry flower. In the beginning of June 2008 (2 weeks before flower buds), traps were installed at a density of 50 units per hectare in a raspberry field close to a natural forest sheltering wild *Rubus* species and other wild host plants of *B. tomentosus*. Beetles were captured immediately after the set-up of traps with a mean of 80 adults per trap. Towards the flowering period in the end of July, the number of captured beetles decreased significantly. A second important flight could be observed between the end of July and the beginning of August. Traps were installed two weeks earlier in 2009, nearly 2000 adults were caught per trap over the first week. Otherwise, the flight pattern was similar to 2008. The cartography of fruit damage showed that there were significantly less deformed raspberries close to traps. Whereas in both years only about 1% of fruits were damaged around traps, on average 14% and 5% of fruits were damaged in 2008 and 2009, respectively, on the plot level. This result is very encouraging. It seems that traps are very attractive and have a potential for mass-trapping. Thus, our study will continue in 2010 to confirm traps potential for controlling raspberry beetle and consequently decreasing the proportion of damaged fruits.

Key words: *Byturus tomentosus*, pest monitoring, semiochemical traps

Effective trapping of the strawberry blossom weevil, *Anthonomus rubi*

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Abstract: One of the major pests on cultivated strawberry in northern part of Europe is the strawberry blossom weevil, *Anthonomus rubi*. The weevils deposit eggs in the flower buds before it sever the buds from their stalks. This may lead to a direct loss of crop of more than 50%. To develop effective plant protection method against *A. rubi* funnel traps baited with the sex aggregation pheromone and plant volatiles were used for trapping weevils in the fields.

The sex pheromone blend used in the study was a mixture of Grandlure I, Grandlure II and Lavendulol (ratio 1:4:1). Plant volatiles emitted by the strawberry plants were collected using SPME and identified by GC/MS. These chemical analyses identified several compounds present in different quantities. The sex pheromone blend and selected plant volatiles were tested in fields either separately or in different mixtures. The field trials were carried out during a three year period where the last year aimed to optimise the mixture used in the previous years by adding more test compounds and testing the most potent compound at different concentrations. To improve insect catch rates modified traps were also tested. The study sites were in Norway, Denmark and in the UK.

General high catch rates were achieved at three different study sites in Norway due to high weevil density. The results from these fields, supported by the results from the fields with lower catch rates, were in accordance with each other. The main finding was that traps baited with some identified plant volatile compounds and the sex pheromone blend increased the catch rates compared to traps baited with single a plant compound or the sex pheromone blend alone. The results show also that the concentration of the plant volatiles relative to the pheromone concentration is important for attracting weevils to the traps.

This study has shown that it is important to bait insect traps with both sex aggregation pheromones and plant volatiles at the correct level to achieve significant catch rates of *A. rubi*. Hopefully, the results will generate knowledge important for developing new plant protection method for strawberry without using insecticides.

Key words: *Anthonomus rubi*, Strawberry blossom weevil, plant volatiles, sex aggregations pheromones, insect traps

Inconsistency in the plants to powdery mildew over time and over clonal propagation

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Abstract: Experiments were conducted to determine whether responses of individual strawberry plants to powdery mildew follow a similar trend over time and over clonal propagation, using both commercial cultivars and progeny plants from a few crosses. The same plants (including daughter plants) were inoculated over a period of several (up to eight) months either in a glasshouse compartment or controlled environment cabinet. Results suggested that correlation in the response of the same plants to mildew over time and over clonal propagation is weak, only accounting for < 9% of the total observed variability. Seedlings were most susceptible to mildew; however, new leaves on many of these plants were free of mildew despite of artificial inoculation a few months later. The ability to differentiate susceptibility of individual genotypes to mildew was greatly enhanced if screening was based on even just two daughter (clonal) plants of the same age. Selection for mildew resistance based on single plant in the early stages of breeding is thus not likely to be either reliable or efficient.

Keywords: *Podosphaera aphanis*, clonal propagation, resistance, consistency, breeding

Host origin important for infectivity and aggressiveness of *Colletotrichum acutatum* on strawberry

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Abstract: *Colletotrichum acutatum* causes black spot in strawberry (*Fragaria × ananassa*), but it has also been isolated from 30 other cultivated and non-cultivated plant species in Norway, including almost all fruit and berry crops. Bitter rot, which is caused by *C. acutatum*, is a severe disease in sweet and sour cherry and apple. We have studied the possibility of cross infection of isolates from other hosts and the potential aggressiveness of these isolates on strawberry. Molecular analyses (AFLP) have shown that isolates collected in Norway could be separated into three major phylogenetic groups in which isolates collected from either *Prunus* spp., *Malus domestica* or *Fragaria × ananassa* predominated. Experiments were carried out under laboratory, greenhouse and field conditions, and strawberry fruits, leaves and stolons were inoculated. All experiments showed that isolates originating from the *Fragaria* group was much more aggressive than those from the other two groups. If detached strawberry fruits were wounded at time of inoculation, isolates from all groups developed black spot, but disease development went much slower for isolates from the *Prunus* or *Malus* groups. If not wounded, there was no or hardly any disease development caused by isolates from the latter two groups. On whole plants inoculated in the greenhouse, isolates in the *Fragaria* group developed an incidence of 27 to 28 % flower and fruit infections compared to 0 to 4 % for isolates from the other two groups. Under field conditions, *Fragaria* group isolates developed 50 to 70 % more infected fruit than the others at harvest. On stolons, we inoculated by wounding, and differences in aggressiveness between isolates were only minor. On strawberry leaf laminae, we observed that the ability to colonize the leaf surface was much larger for isolates from the *Fragaria* group compared to those from the other two groups. However, planting healthy strawberry transplants adjacent to infected sweet cherry trees resulted in latent infections of *C. acutatum* on strawberry leaves (but no visible infections on fruits), indicating that cross infection between host species may occur under field conditions.

Key words: aggressiveness, bitter rot, black spot, *Colletotrichum acutatum*, *Fragaria*, *Malus*, *Prunus*, strawberry

Integrated management of *Botrytis cinerea* in protected raspberries to minimise fungicide residues in the fruit

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Abstract: *Botrytis* is the major cause of post-harvest fruit rotting and can cause significant reduction in yield. Generally fungicides are applied during flowering and early fruit to control botrytis. This results in fungicide residues in the fruit and retail surveillance has shown that more than 50% of UK produced fruit contains fungicide residues. This is no longer acceptable to the market and so alternative approaches to disease control must be explored to enable raspberry producers to significantly reduce this incidence of residues. Raspberries suffer from rain damage and, to meet the quality requirements of major multiple retailers, much of the crop is now grown under protection. This new growing environment provides opportunities to reduce reliance on pesticides.

In 2006 a 5-year HortLINK project was initiated to develop sustainable methods of integrated management of pests and diseases of protected raspberry to produce quality fruit with minimal risk of detectable pesticide residues at harvest. Here only the results with control of *Botrytis* are presented.

In the first three years fungicides and alternative products were evaluated for control of botrytis fruit rot in replicated field trials. However, none of the fungicides or alternative products was effective in reducing the incidence of botrytis fruit rot. The greatest reduction in *Botrytis* was achieved by improved cool chain management of the fruit post-harvest i.e. rapid removal of field heat at 1-2°C followed by increased cooling at 2-3°C in the two days prior to marketing. This resulted in a significant reduction in fruit botrytis assessed 6 and 8 days after harvest compared to the standard post harvest management at 4-5°C.

In the fourth year of the project a management system for botrytis based on good crop hygiene and cane management together with early season (pre-flowering) and post-harvest use of fungicides, rapid fruit cooling after harvest and high quality cool chain marketing of the fruit was compared for control of *Botrytis* with the growers conventional programme in two large scale trials on commercial farms. A combined analysis of the data from both sites indicated there were no significant differences in % marketable fruit or % with botrytis rot between the integrated management system and grower standard system. The management system will be further evaluated in 2010.

Key words: *Botrytis cinerea*, raspberry, integrated control, cool chain management, fungicide

Monitoring *Resseliella theobaldi* with pheromone traps in raspberry fields

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Abstract: The raspberry cane midge *Resseliella theobaldi* is one of the most important pests of Swiss Raspberries. The population dynamics has been studied in Switzerland for 5 years, with pheromone traps. These pheromones were identified and synthesised by East Malling Research (EMR) and Natural Resources Institute (NRI). The aims were to investigate the seasonal temporal pattern of the midge flight. In order to replace diazinon, the only registered insecticide, an efficacy trial was conducted.

Key words: Soft fruits, raspberry, monitoring, *Resseliella theobaldi*

Monitoring the flight dynamics of raspberry cane midge *Resseliella theobaldi* Barnes by pheromone traps in Western Serbia

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Abstract: The flight phenology of raspberry cane midge *Resseliella (Thomasiniana) theobaldi* Barnes (Diptera, Cecidomyiidae) was monitored over two successive years (2006-2007) in a raspberry plantings (open field) at two sites, Arilje (Zlatibor district – area 6142 km²) and Djeradj (Moravica district - area 3016 km²). This was the first time that large white delta traps baited with the raspberry cane midge sex pheromone were used in these provinces. No insecticides were used during the monitoring period in the experimental plots. The traps were set up on 11 April 2006, 4 May 2007 (Arilje) and 26 and 23 April in 2006 and 2007 (Djeradj).

Throughout the investigated period the midge presence was detected from April-May to September-October. During the two years, there were variations in numbers of midges caught per trap, as well as those in the total numbers of midges trapped across years and peak numbers per trap. The highest total number (4,876) of midges during the season, the highest average number of midges per trap in a sample (395,5 occurred on 20 July) and the earliest maximum catch per trap (309,5 occurred on 4 May) were recorded in 2006 on the locality Djeradj.

Key words: *Resseliella (Thomasiniana) theobaldi*, pheromone trap, midge number, western Serbia

Susceptibility of some gooseberry cultivars to fungal diseases and their suitability for IP and organic farming

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Abstract: American powdery mildew (*Sphaerotheca mors-uvae* (Schwein.) Berk. et Curt.) and leaf spot (*Drepanopeziza ribis* (Kleb.) Petrak) are the most important diseases in commercial gooseberry plantations in Poland. The old and very popular gooseberry cultivar – ‘White Smith’ is very susceptible to these diseases. Introduction of new gooseberry cultivars resistant to American powdery mildew could reduce the number of sprayings with fungicides in the growing season. The aim of this work was to determine the susceptibility of 18 gooseberry cultivars to main fungal diseases under field conditions. The observations were conducted in the years 2006, 2008 and 2009 in the “working” collection at the Experimental Orchards Dąbrowice, near Skierniewice. The experiment was conducted in the random complete blocks design, in 3 replications and 3 plants on the plot. Planting density was 3,5 x 0,75 m with the break of 1,25 m between plots. The evaluation was done using a 5-point ranking scale (1 – no symptoms, 5 - very strong symptoms of diseases). No chemical protection of plants was applied against the main fungal gooseberry diseases. The tested cultivars differed in the field resistance to American powdery mildew and leaf spot. Among tested cultivars – 8 (‘Invicta’, ‘Kamieniar’, ‘Laskovij’, ‘Misorskij’, ‘Pax’, ‘Pixwell’, ‘Rochus’, ‘Rolonda’) showed high resistance to powdery mildew and 8 cultivars (‘Captivator’, ‘Hinnomaki Gelb’, ‘Hinnomaki Rot’, ‘Macurines’, ‘Niesłuchowski’, ‘Puszkinskij’, ‘Ruskos’, ‘Spine Free’) were little susceptible to this disease, whereas ‘White Smith’ and ‘Krsnoslawianskij’ were very susceptible to powdery mildew. Unfortunately, none cultivar showed genetic resistance to leaf spot. The severity of this disease depended on genotype and year of studies and it ranged from 1,54 to 3,75 in a five-degree scale.

Key words: gooseberry, resistance, *Sphaerotheca mors-uvae*, *Drepanopeziza ribis*, American powdery mildew, leaf spot

Soft fruit pathogen testing for the UK certification scheme

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Abstract: SCRI is the sole UK source of *Rubus* and *Ribes* nuclear stock plant material for entry into the UK Plant Health Certification Scheme, which operates to ensure that the Scottish and UK soft fruit industry has access to clean planting material for sustainable cropping.

The nuclear stock mother plants are tested for a wide range of pathogens, with all tests adhering to both UK schemes and the European and Mediterranean Plant Protection Organisation (EPPO) guidelines. Such tests involve visual assessments for virus symptoms on foliage and fruit; enzyme-linked immunosorbent assay (ELISA) for raspberry bushy dwarf virus (RBDV), molecular diagnostic techniques for *Phytophthora rubi* and *Phytophthora idaei*, the oomycetes associated with raspberry root rot disease, bioassays which use herbaceous virus-indicator test plants and graft inoculation to *Rubus* or *Ribes* virus indicators.

To provide an effective certification scheme which adapts to changing disease pressures a new PCR diagnostic for the detection of Blackcurrant Reversion Virus (BRV) and an improved diagnostic method for the detection of raspberry root rot are being investigated at SCRI.

Key words: Certification scheme, Blackcurrant Reversion Virus, *Phytophthora rubi*, PCR diagnostic detection

Gooseberry – a new host of *Phytophthora cactorum*

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Abstract: *Phytophthora* spp. are common, widely distributed, soilborne pathogens with a very wide host range. In Poland *P. cactorum* is well known as apple and strawberries pathogen. Also other species like *P. citricola*, *P. cinnamomi* and *P. cryptogea* were occasionally isolated from some fruit plants. Collar rot of gooseberry, caused by *P. cactorum* (Leb. &Cohn) Schroet., was first time recorded in Poland in 2008 on ‘Pax’ cultivar. ‘Pax’ is a relatively new English cultivar, which has virtually spineless bushes, high yielding and some resistance to powdery mildew. It produces flavorful red berries for fresh use. In spring, on one year old gooseberries, grown on own roots, wilting and dying of some bushes was observed. Such symptoms were not observed on gooseberry plants of ‘Pax’ cv. grafted on *Ribes aureum* rootstock planted on the same plantation. The affected plants showed brown, water-soaked lesions appear mostly at the base of stem, typical for collar rot. Rotted lesions develop also down under and up to 10-20 cm above soil level. Pathogen isolated from symptomatic plants was identified as *P. cactorum*. On LBA (Difco) medium it produces culture, homothallic mycelium with dominantly paragynous antheridia and markedly papillate, caducous sporangia, typical for this species. This pathogen could be distributed in a new plantation with infected plants or it existed on the site before and infected a very susceptible tissue of ‘Pax’ cv. gooseberries. Resistant *Ribes aureum* rootstock seems to be a good solution because it keeps susceptible tissue away from infected soil. Good results in disease control were obtained after use of metalaxyl and fosetyl-aluminium several times during the season. These products drastically reduce new infections of gooseberries.

Key words: collar rot, *Phytophthora cactorum*, gooseberry, symptoms, control

Blueberry scorch virus: a new disease for highbush blueberry in Trentino

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Abstract: Blueberry scorch virus (BIScV) is a dangerous disease for blueberry orchards, causing damages and yield losses in North America. In 2004 it has been found in open fields in Europe (in Piedmont, north-west of Italy). Symptoms vary according to the blueberry cultivar and the virus strain. Susceptible varieties usually show a rapid flower and twig blight (scorch) therefore the best time to check symptoms is during or at the end of the bloom. Blueberry scorch virus is transmitted by aphids in a non-persistent mode.

During the summer 2009, some highbush blueberry (*Vaccinium corymbosum*) plants grown in Trentino Province (North-eastern Italy) showed symptoms usually associated to BIScV. A number of these samples tested positive in specific DAS-ELISA for BIScV. In 2010 the presence of the virus was confirmed on *V. corymbosum* and it was also identified on *V. ashei*. Sequence analysis of the coat protein coding region demonstrated that the strain isolated in Trentino was distinct from the strain previously identified in Piedmont and most similar to strains from British Columbia listed in the databases. Control and prophylactic measures are being carried out.

Key words: Blueberry scorch virus, *Vaccinium corymbosum*, *Vaccinium ashei*, Italy

Viruses and phytoplasmas of small fruit plants maintained in collection of the Reserach Institute of Pomology and Floriculture in Skierniewice, Poland

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Abstract: Fruit and ornamental plants infected by different isolates of viruses and phytoplasmas are collected and maintained in the Virology Laboratory of the Research Institute of Pomology and Floriculture in Skierniewice, Poland. One of the parts of this collection includes infected small fruit plants. Biological indexing, ELISA, PCR/RFLP and sequence analysis of the genome fragments of the pathogens confirmed the presence of the following viruses and phytoplasmas:

strawberry: *Strawberry mottle virus*, *Strawberry crinkle virus*, ‘*Candidatus Phytoplasma asteris*’; raspberry: *Raspberry vein chlorosis virus*, *Raspberry bushy dwarf virus*, *Raspberry leaf spot virus*, ‘*Candidatus Phytoplasma ulmi*’, X diseases phytoplasma; blackberry: *Raspberry bushy dwarf virus*, *Raspberry leaf spot virus*, ‘*Candidatus Phytoplasma ulmi*’; black currant: *Black currant reversion virus*; red currant: *Gooseberry vein banding virus*, *Cucumber mosaic virus*; gooseberry: *Gooseberry vein banding virus*; blueberry: blueberry mosaic, ‘*Candidatus Phytoplasma asteris*’

Key words: virus, phytoplasma, biological indexing, ELISA, PCR/RFLP, sequencing

Development of Molecular diagnostics for characterization of *Verticillium* spp. infestation in strawberry production systems

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Abstract: Many *Verticillium* species are soil-borne fungal pathogens which cause each year worldwide crop losses in the range of billions of dollars. Rapid and reliable diagnostic methods are needed to detect and differentiate *Verticillium* species in soil. Existing cultivation-dependant diagnostic methods for *Verticillium* spp. do not clearly discriminate among *V. dahliae*, *V. longisporum*, and *V. tricorpus* while detection of *V. albo-atrum* is not possible. However, only *V. dahliae* and *V. albo-atrum* are pathogenic to strawberries. Therefore, reliable methods for specific detection and differentiation of these two *Verticillium* species in soil are needed. As a first step in the development of a specific PCR-based diagnostic tool the molecular genetic phylogeny of *Verticillium* spp. was studied using a multi gene approach. Gene sequences were all retrieved from GenBank and included sequences for the ribosomal operon, i.e. the small subunit RNA, the internal transcribed spacer (ITS) and the intergenic spacer (IGS), as well as sequences for the DNA-dependant RNA polymerase II and the cytochrome oxidase. Cluster analyses revealed species-dependant clustering for the IGS gene sequences. Therefore, the complete IGS region was isolated from 55 *Verticillium* spp. strains and DNA sequences were determined. Species-dependent clustering will be verified with an independent proteome analysis of the same strains. Based on this data set, species-specific DNA sequence signatures will be identified and primers specifically targeting the IGS of the different species will be designed. Specificity of the primers will be tested on the strain collection and on environmental samples before application as a diagnostic tool for detection and quantification of *Verticillium* wilt infestation in the field.

Key words: *Verticillium* wilt, strawberry, molecular diagnostic, phylogeny, ribosomal intergenic spacer

Green manures to control *Verticillium* wilt of strawberry

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Abstract: The efficacy of different types of green manure plants to reduce the soil inoculum of *Verticillium dahliae*, causal agent of *Verticillium* wilt, was tested in two different soils. A brown mustard (*Brassica juncea*) cultivar with a high content of glucosinolates (GSL) was used to test the effect of biofumigation on the survival of *V. dahliae* microsclerotia in soil. The principle of biofumigation is based on the transformation of glucosinolates in isothio- and thiocyanates (ITC), which are biocidal volatile molecules. A brown mustard cultivar with a low glucosinolate served to estimate the non-biofumigation effect of a *Brassica* green manure. Rye (*Secale cereale*) was included to know the efficacy on *V. dahliae* of a non-cruciferous species. In a loamy soil, the strongest reduction of *V. dahliae* microsclerotia was achieved with the high-GSL brown mustard and the lowest with rye. In contrast, in a sandy soil, rye was the most and high-GSL brown mustard the least successful plant to reduce microsclerotia of *V. dahliae*.

Key words: biofumigation, brown mustard, rye, soil type, *Verticillium dahliae*

The big bud mite – *Cecidophyopsis ribis* (Westw.) as a pest of black currant and the possibility of its control in Poland

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Abstract: The big bud mite, *Cecidophyopsis ribis*, is a very dangerous pest of black currant in whole Europe, especially in Poland, where black currant is one of the most important crops. The big bud mite may infest nearly all growing cultivars and cause damage to numerous buds on plants. On some plantations even more than 50 % of buds are inhabited.

During the last few years, two efficient acaricides to control the big bud mite: endosulfan and amitraz were withdrawn and cannot be used anymore in the black currant protection programme. This is the main reason why new acaricides useful in controlling this pest have to be found. In the last two years we estimated the usefulness of sulphur and acaricides registered to control the twospotted spider mite on black currants – fenpiroximate as Ortus 05 SC and propargite as Omite 570 EW. In the field-laboratory test (affected buds treated in the field were brought to the laboratory, where a number of big bud mite leaving buds were noted) the sulphur and fenpiroximate reduced the number of mites. The efficacy of sulphur was higher. The observations in the field showed that sulphur used once before blooming of currants reduced the number of affected buds to the level of 40-50%. The experiments are going on. We are also looking for some new chemicals to control the big bud mite.

Key words: *Cecidophyopsis ribis*, big bud mite, black currant, chemical control

Occurrence and distribution of *Cecidophyopsis* mites on different currant cultivars and species in Latvia

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Abstract: Red and black currants are the second most important berry crops in Latvia and black currants are the most important. From all currant cultivars used in Latvia, 5 red currant and 10 black currant cultivars are widely cultivated. *Ribes aureum* is not a traditional crop plant in Latvia but in wild three native currant species (*Ribes alpinum*, *R. nigrum* and *R. spicatum*) are distributed, and in surroundings of populated areas red and black currant plants of an alien origin are observed also in wild habitats as aliens. One part of cultivated red and black currant cultivars is originated as in-between species hybrids and can not be related to fixed currant species. Several currant species and cultivars are host plants of different *Cecidophyopsis* mites. During the second part of 20th century the distribution of *Cecidophyopsis* mites in Latvia is increased.

Faunal and distribution studies of *Cecidophyopsis* mites in Latvia were started in 2008 and samples from *Ribes* plants (in cultivation and in wild) are collected from all parts of the territory of Latvia. During research the occurrence of *Cecidophyopsis* mites were observed on *Ribes* plants from all kinds of inspect areas. Red and black currant cultivars are the commercially important group from all investigated plants. In red currants from 21 cultivar *Cecidophyopsis* mites were observed on 14 cultivars. Native *R. spicatum* (red currant group) in wild conditions (Valley of Gauja River) were also infested and on some plants infestation with mites was in high density. In black currants from all investigated 44 cultivar mites were observed on 34 cultivars and on *R. nigrum* (black currant group) in some wild habitats. *Cecidophyopsis* mites were observed also on native *Ribes alpinum* (in wild habitats and some ornamental plantations). On other species and cultivars of *Ribes* plants in plant collections (*Ribes ×nidigrolaria* ‘Josta’, *R. aureum* (different cultivars), *R. fasciculatum*, *R. fragrans*, *R. komarovii*, *R. latifolium*, *R. laxiflorum*, *R. sanguineum*, *R. sinanense* and *R. uva-crispa*) mites were not observed.

Key words: *Cecidophyopsis*, *Ribes*, distribution, Latvia

The occurrence of two pest mites and three groups of biocontrol agents in organic and conventional strawberry fields

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Abstract: Organic fields are often assumed to have less pests and more beneficials than conventionally managed fields. We monitored 12 Norwegian strawberry fields, 6 organic and 6 conventional fields, by sampling leaves two times per year in 2002-2003. Young folded leaflets were visually inspected for eggs and adult females of strawberry mite (*Phytonemus pallidus fragariae*), and mature leaves were used for extraction of mobile stages of two-spotted spider mite (*Tetranychus urticae*). The spider mites were examined for infection of the mite-pathogenic fungus *Neozygites floridana*. Predatory mites (Phytoseiidae) were recorded on both leaf types, and the females mounted and identified. We also sampled leaves from selected plants in the boundary vegetation of most fields to look for sources of *T. urticae*, phytoseiids and *N. floridana*. Soil was sampled from each field, to study the natural occurrence of entomopathogenic nematodes. All samples were taken 0-13 metres from the border vegetation. Both pest mites tended to be more abundant in conventional than in organic fields, while the number of phytoseiid mites was very low in both growing systems. Nevertheless, three phytoseiid species are recorded for the first time in Norway: *Amblyseius rademacheri* Dosse, *Neoseiulus kodryensis* (Kolodochka) and *Neoseiulus reductus* (Wainstein). *N. floridana* infection found in *T. urticae* females varied from 0-19%, and was higher in 2002 than in 2003. The fungus was recorded at least once in all 12 fields, and there was no consistent difference between the two growing systems. In 2002 there was a significant negative correlation between % *T. urticae* with *N. floridana* hyphal bodies found in the first sampling and the number of *T. urticae* present in the second sampling about 4 weeks later. Beneficial nematodes (mostly *Steinernema*), tended to occur in more of the organic than in the conventional soil samples. To sum up, both pests (*T. urticae* and *P. pallidus*) and one of the beneficial groups (entomopathogenic nematodes) seemed to conform to the expected difference between organic and conventional fields. There are many possible mechanisms related to the differences in pesticide and fertilization regimes that could lead to such a pattern. For the two remaining beneficials (*N. floridana* and Phytoseiidae) we could not find a consistent correlation between abundance and growing system.

Key words: *Neozygites*, nematodes, *Phytonemus pallidus*, Phytoseiidae, *Tetranychus urticae*

Strategies for release of *Neoseiulus (Amblyseius) cucumeris* to control western flower thrips, *Frankliniella occidentalis*, in tunnel grown everbearer strawberries

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Abstract: Western flower thrips (WFT), *Frankliniella occidentalis* is a serious pest of everbearer strawberries in the UK. This pest has developed resistance to many insecticides and within the last two years, resistance has been confirmed in some populations to spinosad, the only remaining effective compound used for its control. In other crops successful biological control of WFT has been achieved with releases of *Neoseiulus (Amblyseius) cucumeris*. However, on everbearer strawberries, control is often not effective enough to reduce fruit damage in plantings with high populations of WFT. This may be because insufficient mites are released or because the mites are released too late in the season, when WFT populations have already built up. This experiment was done to assess the effectiveness of early releases together with different release strategies for *N. cucumeris*. Mites were released while populations of WFT were very low on the plants, in early May. Releases were made from *Amblyseius* breeder system (abs) sachets (Certis BCP) or as loose product, with single releases or two releases, four weeks apart. WFT adults and larvae in strawberry flowers were significantly lower compared with the control seven weeks after the first release in all release treatments, but by nine weeks numbers of adults were similar in all treatments; larvae were still significantly lower than in the untreated control. A second release of predators did not appear to enhance WFT control.

Key words: Western flower thrips, *Frankliniella occidentalis*, *Amblyseius cucumeris*, biocontrol, release strategies

Effect of powdery mildew on the interaction between two-spotted spider mite and a predatory mite in strawberry

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Abstract: Powdery mildew (*Podosphaera aphanis*) and two-spotted spider mite (*Tetranychus urticae*) are major pests of strawberry (*Fragaria × ananassa*). Strawberry production in high plastic tunnels is increasing, and this creates conducive conditions for powdery mildew and spider mites. In other host-pathosystems, it has been shown that incidence, densities and reproduction of spider mites are greater on leaves infected with powdery mildew than on healthy leaves. Therefore, it has been suggested that fungal structures may serve as oviposition sites and hiding places for spider mites and that spider mites have a higher preference for mildewed than healthy leaves. However, this has not been studied in detail in strawberry. Preliminary laboratory experiments were therefore conducted to study: (1) the impact of powdery mildew on *T. urticae* egg production and predation of the predatory mite *Phytoseiulus persimilis* (2) the preference of *T. urticae* to mildew infected vs. healthy strawberry leaves. To study the effect of powdery mildew on egg production of *T. urticae* and predation by *P. persimilis*, leaflets of the same age from cv. Korona were inoculated with powdery mildew. Non-inoculated leaflets were placed in separate Petri dishes and incubated together with mildew inoculated leaflets for five days at 20 °C, 80% RH and 16 h day length. Six adult female *T. urticae* and one predatory mite were released onto each leaf disk (inoculated and non-inoculated) and incubated at 25 °C, 70% RH and 16 h day length. In the preference study, the experiment was set up in a way that mites could choose between mildew infected and healthy leaf disks of strawberry. Six female *T. urticae* were released and their movement and settlement were recorded. Five days after the mite release, the total number of *T. urticae* eggs and nymphs found on healthy leaf disks were 2 times higher compared to leaf disks containing powdery mildew, predatory mites or both. There was no significant difference in the predation by predatory mites between spider mites released on mildew infected or healthy leaf disks. As expected, the highest mortality of spider mites was recorded where predator mites were present. In the preference experiment, a significantly higher number of *T. urticae* moved to and settled on healthy strawberry leaf disks than on mildewed strawberry leaf disks. These preliminary studies indicate that *T. urticae* did not thrive on powdery mildew infected strawberry leaves, and that powdery mildew did not seem to affect the predation efficiency of *P. persimilis*.

Key Words: *Podosphaera aphanis*, *Tetranychus urticae*, *Phytoseiulus persimilis*, interaction, Strawberry

Impact of two-spotted spider mite *Tetranychus urticae* Koch on protected soil less raspberry crops

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Abstract: The two-spotted spider mite *Tetranychus urticae* Koch (TSSM) is a major pest in protected soil less florican-fruited raspberry crops of Switzerland. Under plastic tunnels very favourable climatic conditions can lead to big TSSM outbreaks. Due to pesticide residue issues, treatments are applied before flowering and are based on an empirical threshold of 10% of occupation of terminal leaflets by at least one TSSM mobile form. This value is judged to be too high by many unsatisfied growers who asked for new studies. In a first experiment conducted in 2010, we studied the impact of various TSSM densities on the yield and fruit quality of the variety Tulameen grown under plastic tunnel in pots containing blond turf and compost. Results should help to define a better threshold value and bring some new information about raspberry compensation abilities toward TSSM outbreaks.

Key words: *Tetranychidae*, population dynamics, *Rubus idaeus*, yield, quality, thresholds

Autumn treatment with sulphur or rapeseed oil as part of a management strategy for the raspberry leaf and bud mite *Phyllocoptes gracilis* in ‘Glen Ample’

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Abstract: Glen Ample is the main raspberry cultivar in Norway. This cultivar is very susceptible to the raspberry leaf and bud mite *Phyllocoptes gracilis*, and serious damage on both leaves and fruits are common. The only documented control measure available has been fenpyroximate (Ortus/Danitron), a substance that can only be used once per growing season, which is not sufficient to keep *P. gracilis* below damaging population levels. Nor can it be used by organic growers. In a search for alternative control measures we have conducted 4 trials with rapeseed oil (emulsified with soft soap) and sulphur (Thiovit Jet) in heavily infested fields in Western Norway since 2005. Sulphur and oil were never mixed or applied on the same plants. The effect was measured by counting mites overwintering in the buds and assessing leaf damage. In the poster we will sum up the results and discuss the best way of using sulphur or rapeseed oil as part of a control strategy in integrated and organic raspberry production. Since sulphur (and to a certain degree rapeseed oil + soap) applied during the growing season entail a risk of serious phytotoxic damage, we will focus on the best timing and dosage for post harvest sprays.

Key words: acaricides, integrated pest management, Norway, organic agriculture, raspberry

***Drosophila (Sophophora) suzukii* (Matsumura), new pest for soft fruits in Trentino and in Europe**

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Abstract: In September 2009, Spotted Wing *Drosophila* (SWD), *Drosophila (Sophophora) suzukii*, has been detected on raspberry (*Rubus idaeus* L.), highbush blueberry (*Vaccinium corymbosum* L.) and strawberry (*Fragaria x ananassa* Duch.) fruits in several fields in Trentino, North of Italy. This is a major soft fruits production area in Italy and the pest seems to impact heavily the crops, especially raspberry and blueberry in the fruit maturity stage.

SWD is native from Southeast Asia. It is present in China, India, Japan, Korea Republic, Myanmar, Russia (Primor'e region-Far East), Thailand. Only recently, it has been found also in USA (California, Oregon, Florida, Washington), Canada (British Columbia) and in Europe (Italy, Spain and France) where heavy damages have been reported on different *Rosaceae* species, blackberry, and also on grape, blueberry, kiwis, persimmon and tomato (www.eppo.org/QUARANTINE/Alert_List/drosophila_suzukii.htm).

Since infested fruits have been collected from different production areas of our region, we suppose the pest was already present in Trentino before 2009, but it has not been probably detected at that time because it occurred later in the season, damaging just the last ripening fruits. During the autumn in Trentino, the availability of many susceptible ripening fruits and, particularly in the last years, a good climate represent an optimal condition for SWD development and damage.

This is the first report of *Drosophila suzukii* in Italy on soft fruits and represents a potential serious pest for this fresh fruit production chain. A more accurate species identification work is in progress to describe the species-specific morphological characters at different life stages. Additional field surveys and trials are planned for 2010 season; it is necessary to better understand the distribution of the infestation on our territory, to determine the hosts range (cultivated and spontaneous), to deepen the biology and behaviour, and to set up a well-reasoned management plan.

Key words: Spotted Wing *Drosophila*, *Drosophila (Sophophora) suzukii* Matsumura, soft fruits, Trentino

Insecticide management of the spotted wing drosophila on small fruits in Pacific Northwest small fruits

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Abstract: *Drosophila suzukii* (Matsumura) (SWD) is a direct pest of maturing small fruits in the Pacific Northwest. The presence of SWD larvae in the fruit accelerates softening and promotes premature fruit rot, rendering machine harvesting impossible for fragile fruits. Processors will reject maggot infested juice grapes, caneberries and blueberries. Consumer appeal towards other fruits including caneberries, blueberries, and cherries will be reduced if fruit is maggot infested. Wine grape quality may suffer from infestation and wine makers will react negatively. Chemical controls for SWD in Washington state cropping systems are in development due to the recent invasion of the pest in late season 2009. It was detected in strawberry and red raspberry in mid-August at the WSU Puyallup REC and since that time, found infesting blueberry, raspberry, blackberry, strawberry and blackberry in northwestern Washington. With a rapid generation time, a lengthy list of alternative host fruits, and the fruiting season falling well within the anticipated active period of *D. suzukii*. The \$100 million dollar small fruit industry in the Pacific Northwest could suffer devastating losses in the coming 2010 season without early intervention. How well SWD will persist in the hotter drier climates of eastern Washington is as of yet undetermined. At risk are the \$300 million cherry, \$50 million juice grape, and \$150 million wine grape crops. A list of effective chemicals, including new chemistries and rotation partners addressing insect resistance management and pollinator conservation, is necessary for the upcoming 2010 season in order to prevent economic losses by these industries.

Key words: *Drosophila suzukii*, spotted wing drosophila, small fruits, field efficacy

Efficacy and residue field trials of different copper rates on soft fruits

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Abstract: In consequence of the European harmonization, the maximum residue level (MRL) of copper has been reduced from 20 to 5 mg/kg for small fruits and strawberries. This restriction could cause some problems in the control of the main diseases, especially in blackberries and currants. Starting from 2009, efficacy and residue field trials using different copper rates and formulations were carried out in Trentino region (north-eastern Italy).

In a blackberry and a red currant orchard, the following treatments were applied: three copper rates (100, 62 and 37 g/hl of metallic copper) of a commercial product containing copper sulphate, one formulation based on copper oxychloride (75 g/hl of metallic copper) and a foliar fertilizer containing copper (15 g/hl of metallic copper). Untreated plots were used as control. Copper residues on ripe fruits were analysed. Incidence and severity of downy mildew (*Peronospora sparsa*) and anthracnose (*Drepanopeziza ribis*) were evaluated for blackberry and red currant, respectively.

Five applications of the different copper treatments were made on red currant during the growing season. Analysis of copper residues on berries showed the overcoming of the MRL for the treatments with the higher copper concentration (100, 75, 62 g/hl of metallic copper) while only the treatments with 37 g/hl and 15 g/hl remained below the limit of 5 mg/kg. On blackberry, 7 applications were sprayed and the copper residues resulted below the MRL of 5 mg/kg in all the treatments. After fruit-set, blackberries received less copper applications compared to red currants; this aspect could explain the different results obtained for fruit residues in the two crops.

In 2009 both anthracnose and downy mildew showed generally a low rate of incidence and severity, nevertheless all the copper treatments significantly reduced the disease development compared to the untreated plots. No clear differences resulted between treatments with high and low copper rates and even strategies with reduced copper doses were effective to control the target pathogens.

Key words: copper, MRL, blackberry, red currant

A possibility of automated prediction of pests

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Abstract: The integrated protection of pests is based on a precise prediction. The automated trap developed and used by us makes it possible to observe the emergence of insects whose sex pheromones are known.

The automated trap is a sex pheromone trap with a built-in meteorological meter, combined with a computer system and a camera. The camera of the equipment takes photographs of the insects on the sticky sheets at intervals depending on the setting, and the information is saved in its memory. The equipment can send the photos and the measured meteorological data to a central server through internet connection. The automated meteorological equipment is supplied with an internal and external temperature meter, a humidity meter, an air pressure meter, an anemometer and a rain-gauge. The system is fixed on a frame sinkable into the soil, the solar cell is on the top of the frame, and the anemometer and rain-gauge are placed on the cross-bar 50 cm away from the vertical axis in both directions.

On the vertical axis is the insect trap opened on two sides, where the pheromone dispenser as odour source, the sticky sheet and the camera with the lighting equipment for night-time exposure unit are placed. The computer unit is placed in a water-proof box. The energy necessary for the operation is provided by a solar cell.

The trap has been used for the monitoring of raspberry cane midge (*Resseliella theobaldi*) males in the last years. By developing the trap we aimed to make possible the continuous monitoring of the emergence of the pest, as well as the automatization of its prediction.

Our experience shows that in the observed species – presumably due to the high abundance of catches – the exchange of sticky inserts is required every three or four days, being independent of saturation. After the exchange of the sticky insert the males flew in a large number to the sex pheromone for two-three days, and then their flight stopped. The phenomenon was also observed when the surface of the sticky insert didn't become saturated with specimens. The prediction of the start of emergence of the pest can be solved with this trap. The equipment should be placed in the plantation in mid-April (depending on temperature) and the appearance of the first males can be observed by checking the photos sent by the trap daily.

Key words: automated trap, pest monitoring, pheromone trap, prediction, *Resseliella theobaldi*

Can plant breeding be a tool to control the rosehip flies (*Rhagoletis alternata* Fallen) in organic production?

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Abstract: Rose hip fly is the major pest in cultivated rose hips as well as in wild-growing plants. During three seasons adult rose hip flies, *Rhagoletis alternata*, were captured on traps placed among different *Rosa* genotypes in an unmanaged field. Two of the nine traps captured more flies in all years, which indicated differences in susceptibility between the genotypes. The question if plant breeding can be a tool to control rosehip flies in organic production will be discussed.

Key words: *Rhagoletis alternata*, traps, *Rosa*

The effect of pollinating insects on blackcurrant fruitset, yield and quality

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Abstract: Bees are the primary pollinator of most fruit crops. Pollination by insects improves not only crop yield, but also crop quality, e.g. fruit size in blackcurrant. Blackcurrant is susceptible to poor pollination because it is an early-flowering crop and, therefore, often subject to lower temperatures when pollinating insects are less active. The extent to which blackcurrant is self compatible and/or wind pollinated is not clear. It is possible that enhancing the provision of pollinating insects will increase crop yield and quality and reduce infection by *Botrytis cinerea*, particularly in seasons when blackcurrant flowering occurs over an extended period. Premature fruit drop occurs in more self-pollinated compared to honeybee-pollinated blackcurrant. Not only are honeybees in decline across Europe, but it is reported that they are less effective at pollinating early season crops as the colonies are not up to full size and the temperatures are generally too low for foraging. Alternative, more effective pollinating bee species are practically available, but have not been fully tested in UK blackcurrant plantations. Bees of the genus *Osmia* Panzer (Hymenoptera: Megachilidae) are among the contenders to supplement honey bees as fruit pollinators. *Osmia rufa* (species endemic to Europe) is, potentially, a commercial pollinator of spring-flowering fruit crops. Their foraging distance is ~400 m, hence, they are easier to confine to a plantation. They are active for 10-12 weeks of the year (bumblebees and honeybee 8-9 months), but their peak of activity is in the spring, when native bumblebee and honey bee colonies have not built up to full size. *Osmia* is also able to forage at lower temperatures than honey bees and can be active under strong wind or light rain.

Preliminary results of a field experiment in 2010 in which bees were contained in 12 x 1.5 m insect mesh tunnels over cultivated blackcurrant bushes (Ben Hope and Ben Gairn) are reported. Four treatments were evaluated: provision of 1) *Bombus terrestris dalmatinus* or 2) *Osmia rufa*, 3) no pollinating insects and 4) open pollinated plots (no mesh tunnel). Measurements of fruit set, new shoot growth, yield, BRIX and botrytis infection will be reported. In addition, preliminary information on the native pollinating insect fauna within the plots will be presented.

Key words: blackcurrant, *Bombus terrestris dalmatinus*, *Osmia rufa*, pollination

Open field surveys to evaluate the susceptibility of red raspberry genotypes to raspberry gall midge, *Lasioptera rubi* Schrank (Diptera, Cecidomyiidae)

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Abstract: Earlier investigations (Milenković and Tanasković, 2007; Milenković and Tanasković, 2008) of raspberry gall midge, *Lasioptera rubi* Schrank (Diptera, Cecidomyiidae) in untreated raspberry planting pinpointed on the different harmfulness, extended flight period and appearance of different stages. Assessments were continued during 2008 and 2009.

Raspberry cane samples were collected on 15 and 22 July 2008 and 2009 from five raspberry genotypes (Willamette, Tulameen, Latham, Meeker and the hybrid K 81-6) in abandoned raspberry planting, site Zdravljak. Collected canes were brought to laboratory where the diameter of canes was measured, and diameter, length and width of galls and the number of larvae in galls were recorded.

During 2008 and 2009 growing period we registered different number of infested canes, galls/canes, larvae/gall on the genotypes.

No galls have been evidenced in Meeker during 2008, in Latham and Tulameen during the 2009-research period. During the both research years, the galls were found at a height not exceeding 70 cm of primocanes, being sporadically observed on fruiting canes and petioles. The most vigorous canes were observed in hybrid K 81-6.

Galls are of the biggest size in Tulameen during 2008. The highest number of larvae per cabin was registered in Tulameen in season 2008 and K81-6 in season 2009 (40 and 43, respectively). The presence of eggs was registered in Tulameen, Willamette and hybrid K 81-6. The highest larval pressure was found in Latham (24.5 larvae per gall) and the smallest in Willamette (4.5 larvae per gall).

Key words: *Lasioptera rubi*, crop damage, raspberry, cultivars

Biology and management of spotted wing drosophila, *Drosophila suzukii* (Matsumura) in small fruits in the Pacific Northwest

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Abstract: *Drosophila suzukii* (Matsumura), SWD, the spotted wing drosophila, was first reported from day neutral strawberries in Washington state on 10 August 2009. It went on to infest late variety blueberries, ‘Elliott’ and late-season caneberries. Raspberries first became susceptible to SWD oviposition when 0-25% of the surface showed color. The ovipositor of SWD females differs from most drosophilids because it is highly sclerotized with prominent spines allowing the female to cut through the ripening fruit surface and insert the egg. Bioassays have shown that at least 4 classes of insecticides are effective in controlling SWD. Successful management requires proper timing of sprays to coordinate with pollinators and protect fruit through harvest. Sustainable berry production is more challenging with only 2 effective insecticides for SWD control, Pyganic® and Entrust®. Preliminary testing of diatomaceous earth and Perma-Guard® D-21, a diatomaceous earth impregnated with pyrethrum and piperonyl butoxide, applied as a wettable powder to blueberries, was not effective on the adults and did not deter oviposition. Field barriers are being tested to determine efficacy in blueberry.

Key words: *Drosophila suzukii* (Matsumura), spotted wing drosophila, SWD

Overwintering of the strawberry blossom weevil *Anthonomus rubi* in Norway

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Abstract: Strawberry blossom weevil (*Anthonomus rubi*) is a small weevil using the flower buds of several species of Rosaceae as habitat for its offspring. The damage made by the weevil in Norwegian strawberry fields is increasing as chemical control is proving difficult and large numbers of weevils are observed in yet more districts. To develop new strategies to control the weevil, a better understanding of its biology is needed. Most studies of *A. rubi* focus on the period when bud damage is done, while less is known about the ecology and behaviour in other parts of its life cycle. The literature on overwintering habits indicates that in the UK *A. rubi* leaves the strawberry field to overwinter, while elsewhere in Europe they may stay in the field. We will present data showing that the Norwegian blossom weevils to a large extent stay in the strawberry plants, and discuss the implications for control strategies.

Key words: integrated pest management, overwintering habitat, strawberry

Monitoring *Anthonomus rubi* damages in raspberry fields

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Abstract: The strawberry blossom weevil *Anthonomus rubi* Herbst is an important pest in open field raspberry crops of Switzerland. In certain fields more than 30% of flowers are attacked by the weevil and damaged flower buds do subsequently not bear fruits. Today growers tend to apply systematically insecticides against this pest, although several provisional economic thresholds for intervention are proposed, e.g. 1 female per linear row metre or 1 to 5% clipped flower buds per inflorescence. However, many part-time growers do not monitor adult populations with the beating method, because its implementation is judged to be too complicated. The visual assessment of the number of flower buds damaged is an alternative, but it is time consuming. In order to simplify the process, we used the Nachman function to study the relationship between the number of clipped flower buds per inflorescence and the percentage of inflorescences damaged. Using data collected on different floricanes-fruiting cultivars over several years, we obtained an excellent correlation (r^2 : 0.91) between these two parameters. Thus, the current threshold of 1 to 5% of clipped flower buds corresponds to 10 to 35% of inflorescences having at least one damaged bud. With this method the time for assessing damage is significantly reduced, thus offering a valuable alternative to the systematic application of insecticides.

Key words: Curculionidae, *Rubus idaeus*, pest monitoring, thresholds

Management of European tarnished plant bug in late season strawberries

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Abstract: Strawberries are susceptible to many pests but European tarnished plant bug, *Lygus rugulipennis*, is one of the most important that cannot be controlled by non-pesticidal means currently. In late season strawberry crops *L. rugulipennis* feeding in flowers and on green fruits can cause up to 80% crop loss, rendering production uneconomic. The pest is highly polyphagous feeding on a wide range of annual and perennial weeds and abundant in the environment. Crop invasion by the pest is sporadic and unpredictable, and, in the absence of effective control measures, severe economic losses are caused at low population densities which are difficult to detect in normal crop inspections. Application of broad-spectrum pesticides to control *L. rugulipennis* is an important barrier to the implementation of biocontrol systems in strawberries.

Ongoing research at East Malling Research and Natural Resources Institute to develop approaches for monitoring and non-pesticidal controls for the pest will be overviewed including the development of an effective sex pheromone trap for pest monitoring and use of trap crops, tractor-mounted vacuuming and repellants for control.

Previous work by us showed that three specific compounds – hexyl butyrate, (*E*)-2-hexenyl butyrate and (*E*)-4-oxo-2-hexenal – are produced by females. However, it had proved extremely difficult to demonstrate attraction of male bugs to blends of the synthetic chemicals, at least in part because these chemicals are also known as defence compounds released upon disturbance. The volatile secretions, present in the metathoracic scent gland, are produced frequently and abundantly and may play an important role in minimising intra-specific competition between females. We reported attraction of males of *L. pratensis* to a mixture of all three chemicals and attraction of *L. rugulipennis* to a blend of hexyl butyrate and (*E*)-4-oxo-2-hexenal dispensed from glass microcapillary tubes. However, the blends were not well-defined and the dispensers extremely short-lived. Further observations showed that these compounds are produced only during a well-defined period immediately after dawn, coinciding with the time virgin females were most attractive to males in field tests. Detailed studies have been carried out to determine the exact compositions of the blends produced and then to devise dispensing systems for the synthetic chemicals that mimic these. We have been able to trap males of *L. rugulipennis* and *L. pratensis* with species-specific blends in novel, practical dispensers. Modifying trap design has also been crucial.

Trap crops of alfalfa (*Medicago sativa*) coupled with tractor-mounted crop vacuuming are successfully used in the USA for control of the congener species *L. hesperus* and *L. lineolaris* on strawberries on a commercial scale. Work exploring the same approach for *L. rugulipennis* is in progress in the UK and will be described. The attractiveness of different plant species and their suitability for use as trap crops for *L. rugulipennis* and practical means of deploying and managing the trap crop are being investigated. The use of hexyl butyrate, a defence compound, as a repellent is also being investigated. The overall aim is to develop an integrated management system for *L. rugulipennis* with suitable monitoring and control methods including pheromone trap pest monitoring, the best trap crop species and method of management, crop vacuuming and selective chemical and biopesticide controls.

Key words: *Lygus rugulipennis*, sex pheromone, monitoring trap, crop vacuuming, bug vac, trap crop, alyssum, lucerne

Implementing Integrated Pest Management programmes in protected strawberry crops across Europe

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Abstract: An overview of recent BCP Certis trial results in protected strawberry crops in the UK, France and Spain is given. The combined use of *Neoseiulus* species with *Orius* sp., successfully controlled *Frankliniella occidentalis* in French and Spanish trials. The timing of *Orius* releases to correspond with flowering, and the selection of *Neoseiulus* species according to temperature conditions, were critical to success. Strategies used to control *Tetranychus urticae* in Northern Europe were tested in Spain, where three releases of *Phytoseiulus persimilis* from mid January established and controlled spider mites, reducing the numbers of pesticide applications required. In replicated plots, it was observed that releases of *N. cucumeris*, applied to control thrips, reduced peak numbers of spider mites. With thrips and spider mites well controlled using Integrated Pest Management (IPM), aphid control results were variable. Challenges included the range of different aphid species that attack strawberries as well as the lack of effective pesticides that can be integrated with biological control agents. Initial trials using a mix of six different parasitoid species achieved good control against *Acyrtosiphon malvae* and *Macrosipum euphorbiae* in a UK trial but not in a French trial. The reasons for this are discussed. In Spain, *Aphis gossypii* was well controlled by *Aphidius colemani*, but *Chaetosiphon fragaefolii* required pesticide applications. The drivers for changing to IPM and feasibility of implementing cost effective programmes are discussed.

Key words: Thrips, spider mites, aphids, *Orius*, *Neoseiulus*, *Phytoseiulus*, *Aphidius*, biological control, protected strawberry crops

The potential use of flowering alyssum as a ‘banker’ plant to support the establishment of *Orius laevigatus* in everbearer strawberry for biological control of western flower thrips

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

Key words: Everbearer strawberry, western flower thrips, *Frankliniella occidentalis*, biological control, *Orius laevigatus*, banker plants, alyssum, *Lobularia maritima*

Thrips control in strawberries – comparison of IPM strategies

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Abstract: Trials were conducted over two years (2008 & 2009) to assess the feasibility of IPM strategies used in the UK in South West of France tunnel grown strawberries, focusing on thrips control, a pest which can lead to major crop losses and has become resistant to most chemicals. Two strategies including *Orius laevigatus* and *Amblyseius cucumeris* or *Amblyseius swirskii* were experienced. Moreover the *A. cucumeris* block was equipped with a misting system in 2008 only. Both strategies gave high quality fruits in 2008 and 2009 and kept thrips levels under the commercial threshold during the whole cropping period. In 2009 (no misting system in both tunnels), *Amblyseius swirskii*, established quicker and in higher numbers than *A. cucumeris* and helped reducing the thrips larvae numbers per flower, until *Orius laevigatus* population was high enough to ensure a good thrips control. Adjusted numbers of species introduced, timing and rates of applications showed that it was possible to reduce the cost of thrips control from 0.66 €/m² for the strategy including *Amblyseius cucumeris* and 0.77 €/m² for the programme with *Amblyseius swirskii* in 2008 down to respectively 0.14 €/m² and 0.17 €/m² in 2009, making it possible to develop cost efficient IPM strategies for strawberry growers.

Key words: *Thrips control (Frankliniella occidentalis), Amblyseius cucumeris, Amblyseius swirskii, Orius laevigatus*, cost efficient IPM strategies

The effect of cultural practices on severity of strawberry root rot and petiole blight

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Abstract: The strawberry root rot and petiole blight caused by *Gnomonia fragariae* Kleb. is a widespread and serious disease in perennial strawberry cultivation in Latvia. However, the epidemiology and control measures of the disease are poorly studied. The effect of different combinations of cultivars, soil mulching, cover and type of the planting material on severity of strawberry root rot and petiole blight has been investigated in two separate experiments. Plants were evaluated by scoring disease severity and formation of fruiting bodies of the pathogen for two growing seasons during 2009 to 2010. The results of the first year have shown significant influence of the cover and cultivar on the disease severity and formation of pathogen fruiting bodies. The obtained results suggest that managing of cultural practices could give the possibility to control the disease.

Key words: *Gnomonia fragariae*, disease management, fungal diseases, cultivation practices

Comparison of pests and diseases in everbearing strawberry in tunnel and open field

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Abstract: Three everbearing strawberry cultivars were grown in 2008-2009 in tunnel and open field to compare the occurrence and injuries of pests and diseases. Biological control of mites and thrips was practised in both areas, and no chemical control of insects or diseases was used. *Tetranychus urticae* was successfully controlled by releases of *Phytoseiulus persimilis*, and thrips were controlled by *Neoseiulus cucumeris* and *Neoseiulus barkeri*. Populations of *Anthonomus rubi* and *Lygus* spp. were moderate. Sawfly larvae occurred commonly both in the tunnel and open field. Grey mould was almost absent in the tunnel whereas in open field it caused significant injuries. Powdery mildew was not observed at all in berries. Marketable berries covered 72% and 49% of the total yield in the tunnel and open field in 2008, and 84% and 58% in 2009, respectively. A big part of the injuries in berries was due to abiotic factors or technical injuries, which represented 9.4% and 22.8% (2008) and 5.9 and 18.2% of the total yield in the tunnel and open field, respectively. Malformed berries counted for 5.6% and 9.2% (2008), and 2.1% and 5.3% (2009), other insect and slug injuries 7.3% and 6.3% (2008) and 6.0% and 10.1% (2009), and grey mould 2.4% and 9.9% (2008) and 0.8% and 9.4% (2009) of the yield losses in the tunnel and open field, respectively.

Key words: strawberry, injury assessment, protected cultivation, biological control, *Tetranychus urticae*, *Phytoseiulus persimilis*, thrips

Use of *Cryptococcus albidus* in decay protection and storage ability of organic strawberries fruits in Poland

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Abstract: The registration and commercialization of biological fungicides for postharvest is during development. Biological control of postharvest diseases has become a potentially effective and commercially viable technology. The product YieldPlus[®] used in our experiments is registered only in South Africa. No postharvest biocontrol products are registered in Europe, at present. The yeast *Cryptococcus albidus* included in this commercial product was used during the growing season of strawberries in organic system under field conditions. One millilitre of suspension contained 1×10^6 cells of yeast. During the growing season the product was applied three times. The foliar spraying was made at the beginning of blooming; next one was performed during full blooming (one week after the first) and the last treatment before harvest. For treated and untreated plants four replicates were performed, each one included 80 plants. In this paper, results of recorded fresh fruits towards their ability to storage will be presented. The sampled fruits were collected from treated and untreated fields. At the end of the storage period (21 days, at 4°C and 98% RH), *C. albidus* reduced the incidence of gray and blue mold of treated fruits compared to the water-treated control. Any wounds and symptoms of decay disqualified fruits. In the second experiment the ability of fresh fruits to storage after their dipping in three different suspensions of *C. albidus* was assessed. The suspensions of *C. albidus* were adjusted to concentrations of 1×10^6 ; 1×10^3 and 1×10^2 cell/ml with distilled water. Obtained results are very promising.

Key words: organic production, strawberries fruits, *Cryptococcus albidus*, storage ability, biocontrol

Integrated pest management for strawberry production in Sweden

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Abstract: Studies to evaluate the prerequisites and component parts for formulating an IPM program for strawberry production were carried out in 2010 as on farm research at three locations (one in eastern-middle and two in southern Sweden). The IPM strategy was composed of field scouting, utilization of a warning system for management of *Botrytis cinerea* and implementation of biological control agents *Bacillus thuringiensis* and *Neoseiulus (Amblyseius) cucumeris* into an overall management system.

Comparisons with the farmers' practice based on the use of chemical pesticides as well as untreated control serve as a basis for the assessment. Each treatment was replicated three times following the randomised block design. Project results will assist in the continuous improvement and development of better and safer management strategies.

Key words: biological control, field scouting, Integrated Pest Management, strawberries, warning

Integrated Pest Management against aphids in strawberry crops

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Abstract: Since 2005, strawberry crops have been investigated by Koppert in collaboration with research stations and growers, as the demand for developing IPM strategies in strawberry crops has been growing. After developing an IPM strategy against thrips which was the main pest in strawberry crops, very quickly aphids become the major problem for French growers. On the one hand, the reduction of registered pesticides and the demands of the legislation (residues, re-entry times...) lead to a lack of efficient aphicides. On the other hand, the huge variety of species found in strawberry crops lead to difficulties in management of aphid populations during the whole season but especially in early crops. As a consequence, the aims of the studies carried out since 2008 were, first: to identify and make an inventory of the species, to know more about the behavior of aphids on plants, and to find a damage threshold for each species. Then, to find an adapted strategy with the use of *Chrysoperla* spp., which is one of the predators that is efficient at low temperatures. The predator was tested at two different dosages: 1 larva/plant and 5 larvae/plant and in a preventive way, with releases according to the vegetation stage. The results were unsettled and different according the aphid species but lead to establish a global decisional program of intervention with *Chrysoperla* spp. Some parasitoids like *Ephedrus cerasicola* started to be evaluated. In 2009, new parasitoids were tested (*Aphidius ervi*, *A. colemani*, *Aphelinus abdominalis* and *Praon volucre*) and integrated into the strategy with *Chrysoperla* spp. The aim was to finalize an economically acceptable strategy with *Chrysoperla* spp. by testing lower doses and different release frequencies. One of the subjects was also to test a new tool (Mini-Bug) to release this predator to make the strategy workable in a farm and to see if this way of spreading could improve the efficiency of the predator. In 2010, a new mix of parasitoids is tested: *Aphidius ervi*, *A. colemani*, *A. matricariae*, *Aphelinus abdominalis*, *Ephedrus cerasicola* and *Praon volucre*. The aim is to see if we can adapt the parasitoids to low temperature and to know if there are better candidates than the others tested so far to control aphids, especially *Rhodobium porosum* and *Acyrtosiphon malvae rogersii* which remain the most problematic in the South-West of France, one of the biggest production areas. This presentation gives an overview on three years of work on aphids.

Key words: aphids, *Chrysoperla* spp., IPM strategy, parasitoids, strawberry crops

FresaProtect: the use of a cocktail of parasitoids against aphids in strawberries - a case study

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Abstract: A cocktail of six species of parasitoids has been used to control aphids on strawberry in biological and integrated pest management cultures. As the aphid populations are different from one year to another and from one place to another, a mix of different species of parasitoids covering all the aphid species possibly occurring on that plant is the easiest way to work and have good result. The design of the releasing points has been studied and optimized in order to simplify the manipulations necessary to deploy them. After three years of R&D in the lab and in the field and two years of large scale field trials in Belgium and Europe, FresaProtect has been proven to be an efficient treatment for aphid control.

Key words: Strawberry, aphids, parasitoids, IPM, FresaProtect

Open forum: How to improve Softpest, working group's website on available pesticides and biocontrol agents in soft fruits?

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Abstract: Softpest is a website initiated by the IOBC Working group “Soft Fruits” after the workshop in East Malling (UK) in 2007. It lists the availability of pesticides and biocontrol agents in 15 countries against the 14 most important pests and diseases of strawberries and raspberries. The platform relies on more than 20 contributors and data are updated once a year. Although calls were made to integrate more countries, crops, pests and diseases in the database, no real progress was made. Ways to improve website's design, database structure, content, administrator rights and update frequencies will be proposed for stimulating the debate between WG members. Results of this open discussion will be used to build a better website with more useful and accurate information.

Key words: strawberry, raspberry, registration, integrated pest and disease management, biological control

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