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Invited Papers

Citrus IPM in Florida: chaos after Canker and Greening diseases invade [Abstract only]

M.A. Hoy 1

The current situation of citrus pests and their control methods in Turkey

N. Uygun, S. Satar..... 2-9

Abstract: Citrus production areas in Turkey have risen from 40.000 ha in 1970 to around 96.000 ha in 2005 with the rate of 2.45% increase annually. Paralleling to this significant increase, abundance of indigenous pest populations and introduction of exotic pests are also increasing dramatically. In the citrus groves in Turkey, 89 pests, 34 diseases, 16 nematodes and 155 weed species have been determined until 2007. Among these species, 17 pests, 8 diseases, 1 nematode and 10 weeds are economically important and control measures should be taken. In this presentation, how the IPM tactics used for suppressing the key pests, diseases and weeds, and how to prevent the potential species reach to economic levels will be explained and discussed.

Current situation of citrus pest and the control methods in use in Morocco

A. Mazih..... 10-16

Abstract: With 80 000 ha, Morocco produces annually 1.2 to 1.5 million metric tons of Citrus fruits, from which 55% are exported as fresh fruits. The main areas of production are the Souss, Gharb, Moulouya, Tadla, and Haouz covering more than 80% of the total plantations. Dominant varieties are Clementine mandarin, Valencia and Navel orange. More than thirty phytophagous arthropods and snail species are present. However only four are considered as key pests: Mediterranean fruit fly, *Ceratitis capitata* Wiedemann (Diptera, Tephritidae.), California red scale, *Aonidiella aurantii* Maskell (Homoptera, Diaspididae), mites mainly Citrus red mite, *Panonychus citri* McGregor (Acarina, Tetranychidae), and Citrus leafminer, *Phyllocnistis citrella* Stainton (Lepidoptera, Gracilariidae). Up to now, the pest management in Moroccan orchards still heavily relies on chemical control. However, the implementation of ecological methods is slowly taking place. Some have already been developed by research, and could be made ready for use in practice, in order to meet the new requirements of the market regarding fruit quality, environment, health, and the good agricultural practices (Eurepgap, Nature choice). Thus, biological control is in progress and alternative methods to chemical control such SIT are underway. *Phytophthora* is the most important fungal disease encountered in Moroccan citrus orchards. In general, foliar applications of potassium phosphonates are used, when necessary. Virus, bacteria, and nematodes do not have any significant economic importance. More than 200 weed species were recorded in citrus orchards; however, the most economically important are *Cynodon dactylon*, *Convolvulus* spp, *Cyperus rotundus*, *Chenopodium album*, and *Solanum* spp. Both cultural and chemical treatments are used to control these weeds.

California Red Scale

Population dynamics of *Aonidiella aurantii* on citrus nursery trees in northern and eastern Sicily in the period 1997-2006.

F. Conti, R. Fisicaro 19-24

Abstract: During the period 1997-2006, according to previous experiences carried out in Sicily on mature citrus groves, male catches of *Aonidiella aurantii* (Mask.) were recorded in nursery citrus trees located in North and East growing area of the island. Data were obtained in five representative sites where two-three years old *Citrus* spp trees were cultivated. Pheromone yellow sticky traps were hanged at the canopy level of young trees and were changed weekly. *A. aurantii* male captures were counted under stereomicroscope in laboratory. The pheromones were changed monthly. Climatic data were recorded with mechanical or electronic meteorological station located in each sites for determining Degree-Day (DD) accumulation, using the lower development threshold of 12 °C, defined as thermal constant (K). Male captures showed four flights per year. In several years a partial 5th male flight was observed as well. The 1st flight (over-wintered generation) showed frequently a well-defined progressive peak, but when the winter temperatures were not very cool a multi-cohorts 1st flight was recorded. The following flights (1st, 2nd and 3rd generation) showed two or, rarely, three cohorts not clearly attributable to a generation, due to overlapping stages. From data collected in all sites in ten different years the mean K for total development of four flights (over-wintered, 1st, 2nd and 3rd generation) was 609 DD (± 70), in coincidence with data obtained previously for mature citrus groves in Sicily. In nursery condition due to mild climate it was possible to calculate a mean K for total development of five flights, including a partial 4th generation, with a value of 556 DD (± 47). In the different years of the observation period, the peaks of the 1st flight were recorded in a range from April to mid-May; peaks of 2nd flight were recorded from mid-June to mid-July; peaks of 3rd flight were recorded from end of July to end of August; peaks of 4th flight were recorded from end of August to mid-October; when it occurred, a 5th flight was recorder from mid-October to mid-December. On these bases, male captures peaks and Degree-Day accumulation can help for determining the optimal spray timing for *A. aurantii* control in nursery cultivation.

Seasonal trend of California Red Scale (*Aonidiella aurantii*) populations in eastern Spain

2005-2007. [Abstract only]

A. Castaño, B. Escrig, M. Guillén, O. López, M. Llopis, A.B. Martínez, A. Moreira, L.

Peris, J.J. Pérez, J. Sepúlveda, M. Vicente, F. García-Marí, J.M. Guitián, M.P.

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Parasitism levels and species of natural enemies in field populations of California red scale

Aonidiella aurantii (Hemiptera: Diaspididae) in Eastern Spain

J. José Sorribas, F. García-Marí..... 26-33

Abstract: During 2004-2007 we sampled natural enemies of the citrus red scale (CRS) *Aonidiella aurantii* (Maskell) in 173 different citrus orchards distributed throughout the main Spanish citrus area (Valencia, east of Spain). Twigs and fruits containing CRS populations were observed in laboratory and parasitoids were reared to adults in climatic chambers. Twenty orchards were sampled periodically estimating parasitism levels in different instars stages and on different tree substrates. Pheromone and chromatics traps with periodical renovation were placed in 100 citrus orchards to identify captured parasitoids. Parasitism is present in all citrus groves with California red scale. From the 18,006 parasitoids identified 50% belong to *Aphytis chrysomphali* (Mercet) and 49% to *Aphytis melinus* DeBach. *Encarsia perniciosi* (Tower) (1%), not previously documented in Spain, has also been observed. The proportion of *A. chrysomphali* increases from South to North and in the colder months. Parasitism levels reach up to a maximum of 78% of susceptible instars, with average levels of 19% in all the sampled orchards. Higher levels of parasitism were found between August and November. The predatory complex is constituted by *Rhyzobius lophantae* Blaisdell, *Chilocorus bipustulatus* (L.), *Lestodiplosis aonidiellae* Harris, *Chrysoperla carnea* (Stephens), *Semidalis aleyrodiformis* (Stephens) and *Hemisarcoptes coccophagus* Meyer.

Host size availability for *Aphytis* parasitoids in field populations of California Red Scale

Aonidiella aurantii, in citrus groves in Eastern Spain

A. Pekas, A. Aguilar, F. García-Marí..... 34-40

Abstract: The availability of suitable for parasitism California red scale (CRS) *Aonidiella aurantii* (Maskell) sizes affects the activity and distribution of its ectoparasitoids *Aphytis melinus* (DeBach) and *A. chrysomphali* (Mercet). The seasonal trend and spatial variation in the body size of different development stages in field populations of *A. aurantii* in the Community of Valencia (eastern Spain) citrus groves have been studied trying to assess its influence on parasitism rates and species of *Aphytis* present. Different citrus orchards were periodically sampled along 2007. Body, cover and exuvia of healthy and parasitized scales from branches, leaves and fruits were measured in the laboratory. The sizes of the scale cover and of the scale body were closely correlated. The scale body size was influenced by the season of the year, plant substrate and location. *Aphytis melinus* preferred third instar scales in the size range of 0.38-0.82 mm² (in surface area of the scale body), whereas *A. chrysomphali* parasitized mostly 0.15-0.33 mm² second instar females and 0.10-0.32 mm² second instar males. The influence of the range of scale sizes found in the field on species of parasitoids attacking CRS is discussed.

Parasitoids survey of California red scale (*Aonidiella aurantii*) in Citrus groves in Andalucía

(South Spain). [Abstract only]

J.M. Vela, M.J. Verdú, A. Urbaneja, J.R. Boyero - 41

On the presence and diffusion of *Comperiella bifasciata* How. (Hymenoptera: Encyrtidae) in Sicily.

G. Siscaro, F. Di Franco, L. Zappalà..... 42-45

Abstract: The results of a field survey on the presence and diffusion of *Comperiella bifasciata* How. (Hymenoptera: Encyrtidae), endoparasitoid of *Aonidiella aurantii* (Maskell) (Hemiptera: Diaspididae), in Sicily and Calabria are presented. The aim of the survey, which started in 2003 and is still continuing, was to confirm the establishment of the encyrtid and to draw a map of its diffusion, 15 years after its first introduction. For this purpose, infested fruits (20) and twigs (4 meters, 1-2 years old) were collected in 10 groves in South Eastern Sicily (Siracusa province). Half of the sample was observed and the parasitized instars were isolated and reared until the adult parasitoids emerged. The remaining 50% was kept into emergence boxes and the obtained parasitoids were collected and identified. The presence of the parasitoid was also monitored using pheromone traps for the California Red Scale in different citrus groves. The data collected showed that the encyrtid is well adapted and has colonized a wide area, 50km, on average, far away from the first introduction site, as highlighted by the presence of the species in more than 70% of the monitored orchards. The survey will be continued and expanded in order to acquire quantitative data on the parasitic activity of the encyrtid.

A new *Aphytis* species on *Aonidiella aurantii*? [Abstract only]

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Predation of *Aonidiella aurantii* (Maskell) crawlers by phytoseiids. [Abstract only]

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A demonstrative program using augmentative releases of *Aphytis melinus* DeBach for the biological control of *Aonidiella aurantii* (Maskell) in Sicilian orchards. [Abstract only]

E. Raciti, A. Messina, G. Pasciuta, G. Perrotta, E. Sapienza, F. Saraceno, V. Sciacca, R. Finocchiaro, R. Maugeri, A. Strano 48

Augmentative releases of *Aphytis melinus* (Hymenoptera: Aphelinidae) to control *Aonidiella aurantii* (Homoptera: Diaspididae) in a Sicilian citrus grove

L. Zappalà, O. Campolo, F. Saraceno, S.B. Grande, E. Raciti, G. Siscaro, V. Palmeri..... 49-54

Abstract: Releases of *Aphytis melinus* DeBach were conducted to control the populations of the California red scale, *Aonidiella aurantii* (Maskell) in an orange orchard in Eastern Sicily. The trial was performed in 2004-2006 on 1-ha plots (3 replicates) releasing 120,000 adults/ha compared with untreated control. The releases started immediately after the first male captures on pheromone traps and were repeated on a biweekly basis releasing each time around 20% of the yearly per-hectare total, on ten release points per plot. To monitor the effect of wasp releases on scale densities, in coincidence with peak male flight activity, based on trap catches, and at fruit harvest, twigs (40cm 1 to 2 year-old from each cardinal direction, between 1.5 and 2m above the ground on 2 trees per plot) and fruits (1 fruit from each cardinal direction on 24 trees per plot) were sampled, observed under the binocular scope and all the California red scale stages recorded and identified as alive, dead and parasitized (by ecto- or endo-parasitoids).

The results showed that, at fruit harvest in 2006, the percentage of fruits having one or more second-instar or older California red scale in the released field was significantly lower than in the untreated control. Thus periodical augmentative releases of *A. melinus* appear to be a viable option for the California red scale control in an integrated pest management system.

Dispersal capacity of *Aphytis melinus* (Hymenoptera: Aphelinidae) after augmentative releases.

V. Palmeri, O. Campolo, S.B. Grande, F. Saraceno, G. Siscaro, L. Zappalà 55-58

Abstract: The authors report the results of a trial on the spatial dispersion of *Aphytis melinus* DeBach (Hymenoptera: Aphelinidae), ectoparasitoid of *Aonidiella aurantii* (Maskell) (Homoptera: Diaspididae), after augmentative releases. The experiment was conducted in May-June 2006 in a Sicilian integrated citrus orchard in a 1-ha plot divided in two halves: one where a single release of *A. melinus* (180,000 adults) was performed and the other left as untreated control. The flight range of the parasitoid was evaluated using yellow sticky traps activated with *A. aurantii* sexual pheromone. The total number of parasitoids trapped at the end of the trial was significantly different between the released plot and the control plot. The dispersal capacity of the parasitoid was assessed.

Petroleum spray oils and releases of *Aphytis melinus* to control *Aonidiella aurantii* (Maskell) in Spain. [Abstract only]

A. Urbaneja, P. Vanaclocha, A. García, M. Laurín, J.L. Porcuna, A. Marco, M.J.

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Control of California red scale in Citrus orchards, using mineral oil and biological control.

[Abstract only]

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Preliminary data on mating disruption of red scale in Portugal.

H. Sousa, C. Soares, N. Ramos, H. Laranjo, I. Gonçalves, M. Rosendo, M. Neves, J.C.

Franco..... 61-65

Abstract: The use of Red Scale Down™ for mating disruption (MD) and pest management of the red scale (CRS), *Aonidiella aurantii* (Maskell), was evaluated in a field experiment carried out in 2007, in the Southern region of Portugal (Algarve). A total of 250 dispensers of Red Scale Down™ per hectare were installed in four 1-2 ha sweet orange orchards, in two applications (March and ca. 3 months later). Each dispenser contains 0.4 mg of the active ingredients, i.e., (3S, 6R)-3-methyl-6-isopropenyl-9-decen-1-yl acetate (0.041%) and (3S, 6S)-3-methyl-6-isopropenyl-9-decen-1-yl acetate (0.025%). Three modalities of RS management were compared in each orchard: 1) MD; 2) MD + 1 insecticide application (chlorpyrifos) RS; 3) MD + 2 or 3 insecticide applications (chlorpyrifos, mineral oil). Male captures in pheromone traps were monitored every two weeks. The level of fruit infestation by CRS was

estimated before the experiment and in the end of season in order to evaluate the effectiveness of each management modality. The results suggest that mating disruption of CRS may be an effective tactic for pest management of CRS populations when infestation levels are low.

Mating disruption to control California Red Scale (*Aonidiella aurantii* Maskell). [Abstract only]
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Biological efficacy of two organophosphate insecticides against California red scale (*Aonidiella aurantii* Maskell) related to deposition parameters under laboratory conditions.
C. Garcerá, P. Chueca, S. Santiago, E. Moltó..... 67-74

Abstract: California red scale (*Aonidiella aurantii* Maskell) is a major economic pest of citrus in many countries. It is mostly controlled by organophosphate insecticides. The present work is aimed at adjusting an optimal dosage of two insecticides, in order to reduce the presence of residues on the fruit while assuring their efficacy. The paper establishes, under laboratory conditions, the relationship between the deposition characteristics of these insecticides and their efficacy. It takes into account the influence of the development stage of the scale to build curves of expected mortality against the amount of active ingredient deposition. The results demonstrate the importance of applying the insecticides in the early stages of the pest and shows that the amount of active ingredient has to be doubled or even quadruplicated when treating the adult phases (pre-pupae, young female, adult female) with respect to the amounts required for the young ones (L1 and L2).

A binomial sampling method for the California Red Scale (*A. aurantii*) in Citrus groves.
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J.R. Boyero, N. Rodríguez, J.M. Vela, R. Moreno, F. Pascual 75

Host preference of *Aonidiella orientalis* on citrus in South Baghdad (Homoptera: Coccidae).
[Abstract only]
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Other Scale Insects

Chrysomphalus aonidum (L.) (Hemiptera: Diaspididae) in Spain. Studies on its biology and population dynamics.

A. Soto, M. Borrás, R. Vercher, F. García-Marí 77-81

Abstract: The diaspidid scale *Chrysomphalus aonidum* was first detected in Valencia in 1999. In 2004, studies on its biology were initiated due to the importance of the damages caused by this insect in most citrus regions of the world. The objectives of this work were, first, to investigate the distribution and behaviour of *C. aonidum* in the area of appearance in order to control the pest and prevent its dispersion towards commercial citrus fields. Second, to detect its natural enemies and to determine their relative abundance. *C. aonidum* monitoring was carried out in 2004 and 2005, locating all the infested citrus trees, starting from the first point of infestation. In two selected groves, periodic samplings were made, consisting of fifteen leaves and some fruits. In the laboratory, individuals of different development stages in the population were counted. In addition, adult males were captured with sexual pheromone traps. Very high levels of this scale were detected. *C. aonidum* completes from three to four annual generations, with higher populations in summer. Sex related differences were observed in the distribution of *C. aonidum*, males showing preference for the upper side of the leaves whereas females were located preferently on the lower side. Several natural enemies were identified along the period of the study. *Aphytis chrysomphali* was the most frequent, but only parasitized *C. aonidum* males.

Parasitoid complex of black scale *Saissetia oleae* on Citrus: species composition and seasonal trend.

A. Tena, A. Soto, F. García-Marí..... 82-86

Abstract: The parasitoid complex of black scale *Saissetia oleae* (Olivier) (Hemiptera: Coccidae) was studied on citrus to determine their relative abundance, seasonal trend, geographical distribution, and their incidence on black scale populations. Branches and leaves of ten citrus groves infested with black scale were periodically collected over the period March 2003-December 2005 in eastern Spain, covering an area of 10,000 km². Adult parasitoids were also sampled with a portable engine-powered suction device. Black scale females were often attacked by *Scutellista caerulea* (Fonscolombe) (Hymenoptera: Pteromalidae), which was found beneath 35.4 ± 7.5% female scale's body. However, it attacked the scales when most of their eggs had already hatched. The parasitic mite *Pyemotes herfsi* (Oudemans) (Prostigmata: Pyemotidae) fed on all development stages of *S. caerulea*. The gregarious female's endoparasitoid *Metaphycus lounsburyi* (Howard) (Hymenoptera: Encyrtidae) was commonly found, but the parasitism rates it reached were low. Second and third instars of black scale were parasitized by the solitary endoparasitoid *Metaphycus flavus* (Howard), and secondarily by *Metaphycus helvolus* (Compere) which was much less abundant and limited in distribution. Thus, *M. helvolus*, introduced 30 years ago, has not displaced *M. flavus* as in other Mediterranean areas. According to their abundance, distribution and incidence, *M. flavus* and *S. caerulea* appeared as the main parasitoids of black scale in eastern Spain, whereas *M. helvolus* and *M. lounsburyi*, considered the main parasitoids in other citrus areas of the world, had a limited incidence.

Scale insects (Hemiptera Coccoidea) on citrus in Tunisia.

H. Jendoubi, K. Lebdi Grissa, P. Suma, A. Russo 87-93

Abstract: The authors report faunistic observations carried out on most infested citrus groves of Cap Bon region (Tunisia) during the year 2007. Eleven species of scale insects have been detected: *Icerya purchasi* Maskell (Margarodidae); *Planococcus citri* (Risso) (Pseudococcidae); *Ceroplastes rusci* (Linnaeus), *Coccus hesperidum* Linnaeus, *C. pseudomagnoliarum* (Kuwana), *Saissetia oleae* (Olivier) (Coccidae); *Aonidiella aurantii* (Maskell), *Chrysomphalus dictyospermi* (Morgan), *Lepidosaphes beckii* (Newman), *Parlatoria pergandei* Comstock and *P. ziziphi* (Lucas) (Diaspididae). *C. pseudomagnoliarum* is a new record for Tunisian fauna. For each species, brief data on distribution and density are given.

May vine mealybug sex pheromone improve the biological control of the citrus mealybug?

J.C. Franco, T. Fortuna, E. Borges da Silva, P. Suma, A. Russo, L. Campos, M.

Branco, A. Zada, Z. Mendel 94-98

Abstract: It was recently showed that (*S*)-lavandulyl senecioate, the sex pheromone of the vine mealybug *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae), attracts the females of the parasitoid *Anagyrus* spec. nov. near *pseudococci* (Hymenoptera: Encyrtidae). In a further study we examined whether this behaviour increases parasitization of this wasp in citrus mealybug *Planococcus citri* (Risso), in citrus orchards. As an experimental tool we exposed, in field trials, sentinel mealybugs (3rd instar nymphs and adult females) on sprouted potatoes (= potato traps), to allow the access of the parasitoids to the mealybug colony. Three modalities were compared: 1) potato traps baited with dispensers loaded with the sex pheromone of *P. ficus*, 2) potato traps baited with dispensers loaded with the sex pheromone of *P. citri*, and 3) same trap design without pheromone (control). A similar set-up was conducted in citrus orchards in Portugal, Italy and Israel. Based on the number of trapped and emerged parasitoids and the minimal number of days of first parasitoid emergence we concluded that the presence of (*S*)-lavandulyl senecioate significantly increases the parasitization rate of *P. citri* colonies by *Anagyrus* spec. nov. near *pseudococci*. The results and their possible applications in future management of *P. citri* are discussed.

Pesticide secondary effects on *Anagyrus pseudococci*, parasitoid of the citrus mealybug

Planococcus citri in laboratory

P. Suma, G. Mazzeo 99-103

Abstract: The encyrtid *Anagyrus pseudococci* (Girault) *s.l.* is an important parasitoid widely used for biological control of pseudococcids and in Sicilian citrus groves it is the main indigenous natural enemy of the citrus mealybug. Laboratory-reared females were exposed to insecticides both sprayed on the internal surfaces of a glass box and supplied as food in a mixture with honey (1:1). The toxicity by tarsal contact, by ingestion and the effects on fecundity under laboratory conditions were evaluated. The tested insecticides were mineral oil, spinosad, chlorpyrifos-methyl, pyriproxyfen and buprofezin applied at the highest recommended field rate marked on the label. Mineral oil, spinosad and chlorpyrifos-methyl were highly harmful in the contact toxicity tests (100% mortality), therefore they have been excluded for the ingestion toxicity evaluation. No significant differences in mortality and longevity were observed between buprofezin and the untreated control; pyriproxyfen caused more than 50% of adult's mortality and significantly reduced the longevity. The ingestion experiments showed that the two IGRs significantly affected the longevity of the parasitoid females. The tested insecticides showed a variable level of toxicity in relation to the way they came in contact with parasitoids, and due to this fact the use of different testing methods in evaluating the effects of pesticides on natural enemies is suggested.

Influence of ant-exclusion on *Planococcus citri* density in a citrus orchard.

P.M. Marras, F. Sanna, R.A. Pantaleoni 104-110

Abstract: Formicids have been observed to protect mealybugs by aggressive behaviour towards their natural enemies. In field studies carried out over five growing seasons (1996-2000) in an organic citrus orchard in Sardinia, Italy, the influence of ant-exclusion on the population density of *Planococcus citri* Risso was examined. In the last three years sticky trunk barriers were used to exclude ants from orange tree canopies for at least 7 months every year. The presence of isolated *P. citri* specimens (1-10) or mealybug colonies (>10) on orange fruits was recorded. Randomized intervention analysis (RIA) was used to detect a change in the ant-excluded plot relative to the undisturbed one. It was applied to paired time series of data from both plots before and after manipulation over five years. Four species of ants were found on fruits and *Lasius niger niger* (L.) was the most common species (> 80%). The percentage of *P. citri* infested fruits in ant-free trees was significantly lower than that in ant-present ones, besides less fruit damage, due to black sooty mould, has been observed in the ant-excluded plot.

Side-effect of seven pesticides residues on *Anagyrus pseudococci* (Girault) and *Leptomastix dactylopii* Howard (Hymenoptera, Encyrtidae), parasitoids of citrus mealybug

Planococcus citri (Risso) (Hemiptera: Pseudococcidae).

J.M. Campos Rivela, M.T. Martínez-Ferrer 111-116

Abstract: The toxic residual activity of 7 pesticides, abamectin, petroleum spray oil, buprofezin, carbosulfan, chlorpyrifos, hexitiazox and pyriproxifen, was tested against adults of *Leptomastix dactylopii* and *Anagyrus pseudococci*, natural enemies of the citrus mealybug *Planococcus citri*. Insects were exposed for 7 days in small containers to pesticide residues on leaves of sprayed citrus at intervals of 1, 3, 8, 21 and 30 days post-treatment to determine their susceptibility to the residues and the persistence of the residues. The effect on the longevity and progeny production of parasitoids was studied. Carbosulfan residues showed high toxicity to both beneficial insects, due to both initial toxicity and persistence. Chlorpyrifos caused a slight toxicity in the beginning, but its persistence was low. Abamectin caused a high initial toxicity in both parasitoids but also with a low persistence. Insect growth regulators buprofezin and pyriproxifen residues, along with petroleum oil, appeared to be the less toxic for the parasitoids. *A. pseudococci* was more sensitive than *L. dactylopii* to the more toxic pesticides, carbosulfan and abamectin. None of the pesticides altered the progeny production of *L. dactylopii*; however the *A. pseudococci* progeny was adversely affected by both buprofezin and abamectin.

Treatment thresholds for the Citrus Mealybug *Planococcus citri* (Hemiptera: Pseudococcidae) based on the relationship between male abundance and fruit infestation.

M.T. Martínez-Ferrer, J.L. Ripollés Moles, F. García-Marí..... 117-123

Abstract: Citrus Mealybug is a polyphagous pest that on citrus attacks mainly navel varieties. Cosmetic damage on fruit due to large citrus mealybug colonies and honeydew and sooty mold *Capnodium* spp., chlorotic spots, and rind hypertrophy, are commonly observed on fruits at harvest. This causes economic loss for the citriculture export industry in Spain. Treatment thresholds have been determined based on these injuries observed at harvest, and depending on looses the grower is ready to take up office. For instance, if 8 to 12% of fruits with symptoms were accepted, then treatment threshold would be 15 to 20% of attacked fruits. No injuries were observed when population on fruit during the season was under 5% of attacked fruits, so this would be the lower treatment threshold. A positive relationship was found between all the male flights and the population of *P. citri* on the fruits, so traps with pheromone detected the abundance of population, both for number of insects per fruit and percentage of attacked fruits. This relationship was delayed in time, and there were from one to two months of difference between the male flight considered and the population on fruit, depending on the season. First male flight (May) correlated with population under the calyxes of the fruits in July; second (June-July) and third (August) male flights were related to population on fruit in August, and third and forth (September) male flights were correlated with fruit population in September.

The adoption rate of biological control of *Icerya purchasi* Maskell in Mazandaran, Iran.

[Abstract only]

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Mediterranean Fruit Fly

Parasitism of *Diachasmimorpha tryoni* (Hymenoptera: Braconidae) on the host *Ceratitis capitata* (Diptera: Tephritidae) under Mediterranean temperatures

E. Garzon Luque, F. Beitia, J.V. Falcó..... 125-129

Abstract *Ceratitis capitata* (Wiedemann, 1824) is an endemic citrus pest since the 1930s in the East Coast of Spain, where biological control against the medfly was attempted in those first years without any success. In 2003 the Valencian Institute of Agricultural Research (IVIA) began a project to study new possibilities of use of Hymenoptera parasitoids in order to include them in Integrated Pest Management strategies against the Medfly in the Mediterranean Coast of Spain. With this aim the braconid wasp *Diachasmimorpha tryoni* (Cameron, 1911) was imported from Hawaii and a laboratory rearing of this species is in progress in the IVIA facilities. *D. tryoni* has a high parasitism and emergence rates at 25°C and at 21-25°C. The critical temperature of 30°C prevents the emergence of a new generation of parasitoids, but females are able to parasitize the host. When these high temperatures (25-30°C) are applied only for a few hours the parasitoid development is completed and adult emergence occurs. These results can explain the potential adaptability and survivorship of the parasitoid in the Mediterranean high temperatures when field releases are carried out to control the Medfly summer populations. Consequently, parasitism can be successful in the warmer months of the Mediterranean Spanish area.

Parasitism of *Spalangia cameroni* (Hymenoptera, Pteromalidae), an idiobiont parasitoid on pupae of *Ceratitis capitata* (Diptera, Tephritidae).

M. Pérez-Hinarejos, F. Beitia..... 130-133

Abstract: *Spalangia cameroni* Perkins, 1910 is a pteromalid hymenopteran, well known as a pupal parasitoid of flies belonging to different taxonomic families in the order Diptera, as Muscidae, Sarcophagidae and Anthomyiidae. This species is being used as a biological control agent against the housefly (*Musca domestica*) and the stable fly (*Stomoxys calcitrans*). In the family Tephritidae it was known as a parasitoid of *Anastrepha suspensa*, *Dacus cucurbitae* and

D. passiflorae, but recently it has been described as a parasitoid of the Mediterranean Fruit Fly, *Ceratitis capitata*, in the Valencian Community (Spain). Due to the importance of that fruit fly species as a serious pest on citrus and fruit trees, it has been started the rearing and the biological study of *S. cameroni* in laboratory conditions, in order to know its ability to be used in the biological control of the medfly. Biological and parasitic parameters of the insect, as adult longevity, female fecundity and fertility, influence of host age and temperature on parasitism and female ability in searching the host buried in the ground, are being analysed.

Importance of ground-dwelling predators on controlling *Ceratitis capitata* in Spanish citrus orchards. [Abstract only]
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Study of mass trapping devices to control *Ceratitis capitata* (Wiedemann). [Abstract only]
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Status of Mediterranean Fruit Fly, *Ceratitis capitata* Wied. (Diptera: Tephritidae), and its control in Turkey.
N.Z. Elekçioğlu, N. Uygun, R. Bozbuğa..... 136-141

Abstract: Turkey has a long history in biological and integrated control of citrus pests. Mediterranean fruit fly, *Ceratitis capitata* Wied. (Diptera: Tephritidae), is the only pest that causes significant damages in all citrus varieties (except lemon) when not chemically controlled. This pest is of main importance and increased its damage (population) over the last few years. The main reason for the increase of *C. capitata* damage is the alternative hosts of the pest, increasingly cultivated in or close to citrus orchards. The pest population increases on these fruit trees and moves to citrus in late summer or autumn.

The use of traps for monitoring the pest population and determining the proper time to spray and the attractants used during the spraying is important in the control of the pest. The only application recommended for this pest is bait spraying in Turkey. For the development of some more adequate control strategies, directed towards the integrated pest management, a better knowledge is necessary of the dynamics of the pest population. In this perspective, the determination of the population dynamics of *C. capitata* was done by pheromone traps in a Washington Navel orange orchard during 2005-2007. The traps were controlled weekly. The population was at its maximum level during June. We made comparison experiments of two attractants (Ziray and 94/5 coded attractant) by bait spraying method. The bait spray was applied on a 1-2m² area on south-east side of the tree and was a combination of attractants and an organic phosphate pesticide (Malathion) in 10-day intervals. Ziray gave better results than 94/5. In the presented paper, studies to determine the best attractant against the pest and the population dynamics of *C. capitata* in east Mediterranean region are reported.

Field experiments towards the development of a strategy for the control of the MedFly (*Ceratitis capitata*) using Match Medfly RB03 (Syngenta) in Citrus orchards.
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Evaluation of mass trapping using M3 bait-station to control Medfly in Citrus orchards.
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Improvement of *Ceratitis capitata* mass-trapping strategies on citrus in Northeastern Spain.
J.M. Campos Rivela, M.T. Martínez-Ferrer, J.M. Fibla Queralt 144-149
Abstract: In Spanish citrus orchards, *C. capitata* mass trapping strategies are based on 45-50 traps per hectare density, homogeneously placed across the fields. In order to protect early and mid season varieties from the *C. capitata* attack, traps are hung about 1.5 months before harvest.

Enhance of mass trapping methods in this study was focused on studying the moment of trap hanging on the trees and their spatial distribution in the field. In 2 ha groves, Tephri-trap traps baited with Tri-pack attractant were used for these trials. In two early citrus varieties groves (Marisol mandarin and Navelina orange) located in Tarragona and Valencia provinces (Spain), two different strategies were conducted in order to study the effect of advancing the trap placement, July instead of August. We attempted to reduce *C. capitata* populations during summer and to achieve a low pest presence when fruits are ripening.

The effect of trap distribution, perimeter and regular, across the orchards was tested in two early mandarin varieties groves (Loretina and Marisol) and one mid season variety (Clemenules) in Tarragona. No differences were found between setting traps dates. Percentage of attacked fruits ranged between 0.5 and 0.75% at harvest in early varieties (even chemical treatments had to be applied), and achieving a 0% fruit damage in the mid season variety. No significant differences in the percentage of attacked fruits between the regular and perimeter position of the traps were found. Further studies should be carried out in order to study those strategies in larger areas.

Integrated control of Mediterranean fruit fly *Ceratitidis capitata* (Wied.) with an enzymatic hydrolyzed protein by mass trapping

J.M. Llorens Climent, E.M. Valls, A.L. Espadas, C.M. Garrido, N. Sierras Serra..... 150-156

Abstract: Field trials were conducted on susceptible mandarin trees (*Citrus reticulata* cv. Beatriz and Oronules) and fig trees (*Ficus carica* cv. Colar) in Tarragona, Alicante and Murcia (Spain) to assess the effectiveness of a specifically developed enzymatic hydrolyzed protein (Cera Trap[®]) to control the Mediterranean fruit fly (medfly) *Ceratitidis capitata* (Wiedemann) (Diptera Tephritidae). The efficacy of Cera Trap (CT) was compared with standard farm control strategies (mass trapping or chemical treatments), assessing medfly captures and fruit damage (infested fruits on trees, at the ground and in the warehouse). The efficacy field trials showed that, 1) capture levels on CT plots were similar to those obtained by the standard farm control strategies, and, 2) fruit damage was lower on CT treated trees than under the farm standard control strategies. The CT hydrolyzed protein successfully controls the pest population, decreases medfly fruit damage and provides long-term control (from fruit ripening until harvest) reducing pesticide application to a minimum or even making it completely unnecessary.

The use of Biofeed devices in Israel's agriculture aimed for export [Abstract only]

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Preliminary evaluation of GF-120 to control of *Ceratitidis capitata* (Wiedemann) (Diptera, Tephritidae) in commercial citrus orchards. [Abstract only]

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New results with the ADRESS[®] bait station system based on lufenuron to control the Mediterranean Fruitfly, *Ceratitidis capitata* Wiedemann. [Abstract only]

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The importance of spread surveys on the behaviour knowledge of Medfly sterile males (*Ceratitidis capitata* Wiedemann) (Diptera: Tephritidae) released over Bicas and Biscoitos orchards, in Terceira Island, Azores

D.J. Horta Lopes, L. Pimentel, L. Dantas, A. Figueiredo, N. Macedo, J. Mumford, A.M.M. Mexia..... 161-169

Abstract: Biotechnical control could be a more practical and ecological means against pests compared to the alternative of using chemical products. With this point of view the sterile insect technique (SIT) using sterilized males of *Ceratitidis capitata* Wiedemann (Diptera: Tephritidae)

produced at the Madeira-Med programme facilities could be applied on Terceira Island. Therefore, in 2007 two dispersal tests were conducted to evaluate the sterile male dispersion over two areas on Terceira Island, one in an apple orchard (Biscoitos) and another in an urban area (backyards of Angra city). These tests were made in September 2007 with a release of 75 and 150 thousand flies at the Biscoitos and Angra areas, respectively. The dispersal test areas were first projected in computer images using ArcGIS 8 software and placed in using a Garmin GPS. In ArcGIS 8 the release points were projected in a line crossing an inner circle with 7 points spaced at 50 meter intervals and two concentric circles of 30 traps at 100 and 200 meters from the central release point that was plotted from the field after the *C. capitata* sterile adult male release. Adults (wild and sterile) captured in these traps were collected 24h, 72h and 8 days after the release. The major goal was to know the dispersal behaviour of the sterile males in the orchard and urban environments. In this test the wild males captured in the two concentric trap circles (at 100 and 200 meters) were analysed. In both tests the sterile adult males showed a distribution after release similar to the wild ones and covered all the area very quickly and stayed there for almost a week competing with wild *C. capitata* adult males. The results obtained showed a good dispersal capability of the sterile flies produced on Madeira Island in the Terceira Island climatic conditions and that the use of SIT can be a possibility to limit the Mediterranean fruit fly in Terceira and the Azores.

Effectiveness of clays and copper products in the control of *Ceratitidis capitata* (Wiedemann) in organic orange orchards

V. Caleca, G. Lo Verde, M. Palumbo Piccionello, R. Rizzo 170-175

Abstract: Medfly, *Ceratitidis capitata* (Wiedemann), is the key pest of early ripening citrus cultivars. Its control in organic groves is usually difficult, due to the almost complete lack of permitted effective insecticides. The research was carried out in 2005 and 2006, to evaluate in the field the repellent and antiovipositional action of clays and copper products to *C. capitata*. Tested products are known to limit another tephritid, *Bactrocera oleae* (Gmelin). Trials were carried out in an organic orange orchard located at Castelvetrano (Trapani Province, Sicily). Kaolin, copper hydroxide and copper oxychloride (in 2005), and kaolin, bentonite and copper hydroxide (in 2006) were tested and compared with an unsprayed plot. In both years, data on infested fruits were collected at the harvest, recording the presence of medfly punctures. Total infestation on kaolin treated fruits (29% in 2005, 62% in 2006) was significantly lower than copper hydroxide (50% in 2005, 82% in 2006) and control theses (73% in 2005 and 88% in 2006); no difference was found between the last two treatments. No statistically significant differences were found comparing white and blue copper oxychloride with control and kaolin. In 2006 the infestation level on fruits treated with bentonite was 74%, significantly lower than control, but higher than kaolin. In the same year no statistically significant differences among treatments were recorded in fruit drop.

Characterization of a *Bacillus thuringiensis* strain collection isolated from Spanish citrus agro-ecosystem and evaluation of insecticidal activity on *Ceratitidis capitata* (Diptera: Tephritidae). [Abstract only]

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Citrus Leaf Miner

Citrus leafminer *Phyllocnistis citrella* (Lepidoptera: Gracilariidae) and its parasitoids: Ten years after the implementation of Classical Biological Control in Spain. [Abstract only]

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Evolution of *Phyllocnistis citrella* Stainton (Lepidoptera, Gracillaridae) and its parasitoids in the last five years in citrus orchards of the western Sicily (Italy).

A. Lo Genco, C. Ciotta, M. Lo Pinto 178-182

Abstract: *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae), is native to India, China, and other Southeast Asian countries that has spread rapidly since 1993 to all citrus-growing areas of the world. In Italy, the pest was first discovered during the autumn of 1994, in some citrus groves of Sardinia and, subsequently, in Sicily in the summer of 1995 showing a very rapid range expansion in other citrus-growing regions of Italy. Currently, damage to mature trees under typical Mediterranean conditions is considered only esthetical, but *P. citrella* causes economic problems on young trees, nurseries, and overgraftings. Since the first occurrence of the citrus leafminer in Sicily, several indigenous natural enemies have been found attacking the pest, although only few parasitoid species were observed living on this phytophagous in the last years. The aims of this study were to monitor the population dynamics and mortality of *P. citrella*, and its natural enemies with parasitism levels, from 2002 to 2006, in some unsprayed citrus orchards in western Sicily, Italy. Results showed differences on dynamics of stages of *P. citrella* and of its parasitoid complex related to climate effects. Also, the monthly percentage mortality and parasitism are reported. The major percentage of parasitism was imputable to *Citrostichus phyllocnistoides* Narayanan and *Semiela cher petiolatus* (Girault).

Bio-ecological study of the parasitic complex of *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) in Western Algeria.

M. Boualem, A. Berkani, C. Villemant..... 183-188

Abstract: Samplings carried out in 2003-2005, from June to October, in a *Citrus sinensis* orchard of the Mostaganem wilaya (West Algeria) showed that *Phyllocnistis citrella* infestation was important, the percentage of attacked leaves always exceeding 95% in August. Maximum parasitism rates reached consistent values, from 45% in August 2003 to 78% in August 2005, while predation and other mortality factors remained less important. The 3rd larval instar appeared to be the most sensitive to parasitism and the two first ones the most affected by other mortality factors. Seven Hymenoptera Eulophidae parasitoids were recorded during the study period: *Semiela cher petiolatus*, *Cirrospilus pictus*, *Cirrospilus vittatus*, *Pnigalio pectinicornis*, *Citrostichus phyllocnistoides*, *Closterocerus formosus* and the hyperparasitoid *Pediobius* sp. Among primary parasitoids, the indigenous *C. pictus* and the introduced *S. petiolatus* are the most efficient enemies. In the frame of CLM integrated control in Algeria, it should be recommended to reinforce the populations of its natural enemies, notably the two last species, in favouring their indigenous hosts and host-plants.

On what scale native plants can enhance biological control? The case of the parasitoid complex of *Phyllonorycter delitella* (Duponchel) on *Quercus* trees and the citrus orchard. [Abstract only]

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Damages and control of *Phyllocnistis citrella* Stainton (Lepidoptera Gracillariidae) in Sicilian citrus nurseries after 13 years of its arrival. [Abstract only]

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The control of Citrus leaf miner *Phyllocnistis citrella* Stainton with bioinsecticides.

T. Perović, S. Hrnčić..... 191-194

Abstract: The aim of this paper was to evaluate the efficacy of some bioinsecticides for the control of Citrus Leaf Miner. The investigations were carried out in nursery of Centre of Subtropical Cultures in Bar (Montenegro), during 2006 and 2007. Four and six month old plants of the mandarin Unshiu cv. Cawano Wase were used. The foliar spraying was applied with two insecticides: SuccessTM and OikosTM. Efficacy of insecticides was evaluated 7, 14 and 21 days after application and assessment was according to the Abbott formula, based on the number of a live larvae and pupae per 100 leaves per sample. Results showed high efficiency of insecticides based on spinosad and azadirachtin in the control of *Phyllocnistis citrella* seven days after treatment. After that efficiency rapidly decreases.

Control trials of the Citrus Leaf Miner *Phyllocnistis citrella* Stainton (Lepidoptera, Gracillariidae, Phyllocnistinae) in nurseries.

T. Perović, S. Hrnčić..... 195-198

Abstract: Our research was orientated primarily towards to determinate the efficiency and duration of effects of insecticides from the neonicotinoid group for the control of citrus leaf miner *Phyllocnistis citrella*. The trials were conducted in nursery of Center of subtropical Cultures in Bar, on the three and four month old plants of mandarin Unshiu cv. Kawano Wase. After the miner attack had been identified in the nursery the following insecticides were applied as soil drench: Confidor 200 SL (a.i. imidacloprid), Calypso 480 SC (a.i. thialoprid), Mospilan 20 SP (a.i. acetamiprid) and Actara 25 WG (a.i. thiametoxam). The research demonstrated that these insecticides provide efficient control of the pest in the course of several weeks.

Field evaluation of the influence of different citrus rootstocks on *Phyllocnistis citrella* Stainton, *Aphis spiraeicola* Pacht and *A. gossypii* Glover incidence on 'Clementina de Nules' trees. [Abstract only]

S. Trapero Muñoz, Á. Hervalejo García, M. Jiménez Pérez, J.R. Boyero, J.M. Vela, E. Martínez-Ferri 199

Thrips, Whiteflies and Aphids

Field evaluation on citrus fruit scars in Italy

G. Siscaro, G. Perrotta, F. Conti, L. Zappalà..... 200-203

Abstract: The results of a field trial on the damage caused by *Pezothrips kellyanus* (Bagnall) on lemon fruits are reported. In order to carry out the trial, a rearing of *P. kellyanus* was started during spring 2006 and 2007. In the first year the trial was conducted in a twenty years organic lemon orchard. Six trees were selected and five fruits per tree, with a diameter of 1.5 cm, were chosen. All these fruits were caged with a fine polyester mesh bag; four of them were inoculated with five female thrips collected in the laboratory rearing, while the fifth was treated as control. The fruits were exposed to thrips activity for 1, 2, 3, and 4 weeks and then weekly checked in order to verify the surface conditions. In 2007, the trial was repeated in an integrated lemon orchard on older plants (30 years).

The trial conducted in 2006 inoculating *P. kellyanus* gave evidence of a presence of an epidermic alteration already after a week from fruit exposition to the thrips feeding activity. The damage became gradually more evident after 2, 3 and 4 weeks showing a presence of irregularly distributed scars that could interest large portions of the fruit surface. This kind of alteration was present on all fruits inoculated with *P. kellyanus* with high damage level. Differently, in 2007 the results were inconsistent, probably also due to extreme temperature conditions.

A threshold hypothesis for an integrated control of thrips infestation on citrus in South Eastern Sicily.

G. Perrotta, F. Conti..... 204-209

Abstract: Several species of Thysanoptera are able to cause characteristic scars on the peel around citrus fruit stem or on their contact surface. Since 1998 surveys on citrus thrips fauna composition have had a new impulse when the presence of *Pezothrips kellyanus* Bagnall was recorded on citrus first in Italy. This species has changed the interspecific relationship among citrus thrips fauna reducing the presence and the importance of *Heliothrips haemorrhoidalis* Bouché, once considered the most dangerous thrips species reported on citrus. At the moment the species reported on citrus flowers in south-eastern Sicily orchards largely belong to *P. kellyanus* and *Thrips flavus* Schrank, while *T. tabaci* Lindeman, *Frankliniella occidentalis* Pergande and *H. haemorrhoidalis* are less important.

The aim of the present work is to define a spraying threshold in order to support farmers with a good pest management technique. Monitoring activity has been carried out for four years (2003-2006) in two lemon orchards in Siracusa province. White chromo-attractive sticky traps were used to detect thrips population. Furthermore, a direct observation on flowers and fruitlets was

started to record adults and larvae presence. They were collected around the canopy circumference of five lemon trees. Flowers or young fruits were picked up after an evaluation of their average presence in ten canopy portions assessed with a 25 x 25 cm quadrat (Q). At harvest, damage on fruit caused by thrips feeding activity was evaluated. White sticky traps have always recorded a peak of adult thrips captures within the first half of June whereas fruitlets control did not show any significant thrips presence.

During the four years period, flowers and young fruits monitoring gave evidence of a different thrips population extent. In 2004 the highest larvae and adult thrips presence was recorded, exceeding the peaks of 12 and 10 specimens/Q respectively; furthermore, during the whole survey period, a mean of 3.28 larvae per Q and 2.53 adults per Q was recorded. At that population level the highest fruit damage occurred at the harvest period (24%). Traps were unable to express any significant relationship between thrips infestation and damage at harvest. On the contrary flowers and young fruits monitoring showed a relationship between the number of specimens per canopy quadrat and damage at harvest. In conclusion, these observations allowed us to define a spraying threshold to manage citrus thrips infestation that we suggest should be fixed in 10 larvae/quadrat.

Citrus whiteflies in Israel

D. Gerling, Y. Argov 210-213

Abstract: According to Evans (USDA: APHIS), there are about 105 species of whiteflies attacking citrus in the world. Their origin includes 59 neotropical species, 32 Asiatic species and a few which evolved in other parts of the world. Since the cultivated citrus plants have all been introduced into Israel, we are dealing with mostly an Asian flora whose whiteflies pests are introduced. Two of them *Aleurothrixus floccosus* and *Paraleyrodes minei* are from the Neotropics and two *Dialeurodes citri* and *Parabemisia myricae* are from East Asia. Less prominent pests are the Mediterranean *Acaudaleyrodes rachipora* and *Aleurolobus marlatti* whose origin is Asiatic. Citrus trees are also occasional hosts to generalist whiteflies such as *Bemisia tabaci*. All citrus whiteflies in Israel (and most of those in the world) are polyphagous tree pests. The main relevant damage-related features are the life cycles of the different species and their relationship to the tree's phenology. Some life cycles are closely tied to that of the citrus tree, thus *D. citri* oviposits on young, but fully developed foliage, and produces three generations/year. *P. myricae* on the other hand which apparently evolved in the citrus centers of the world has eight to ten generations per year which oviposit exclusively on very young foliage. The South American species evolved under different conditions and on different hosts, therefore, *P. minei*, and *A. floccosus* are less dependent upon new foliation and have as many as six yearly cycles. The former is also unique in its frequent appearance on mature leaves.

The variability of the life cycles is also reflected in the different parasitoids that have been acclimated in Israel: *Encarsia lahorensis* for *D. citri*, *Eretmocerus debachi* for *P. myricae* and *Cales noacki* for *A. floccosus* by. No effective parasitoids for *P. minei* are known. Altogether, citrus whiteflies form a complex of extremely varied life histories and host adaptations that we should recognize if we want to manage them properly.

First observations on the influence of *Bacillus subtilis* on the populations of *Dialeurodes citri* (ASH.) (Hom. Aleurodidae) in various citrus fruits orchards of Mitidja (Blidean Atlas, Algeria): is there an insecticidal effect? [Abstract only]
L. Allal-Benfekih, Z. Djazouli, F. Rezig, O. El Mokaïd, F. Hamaïdi 214

Field evaluation of the entomopathogenic fungi, *Beauveria bassiana* and *Verticillium lecanii* against jasmine whitefly *Aleuroclava jasmine* on citrus. [Abstract only]
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Life cycle of *Aphis spiraecola* Patch (Homoptera: Aphididae) in East Mediterranean region of Turkey and its development on some important host plants
S. Satar, N. Uygun..... 216-224

Abstract- Aphids are important pests on citrus in East Mediterranean Region of Turkey. Five different aphid species were determined in citrus of Mediterranean region of Turkey. These are; *Aphis spiraecola* Patch, *Aphis gossypii* Glover, *Aphis craccivora* Koch, *Myzus persicae* Sulzer and *Toxoptera aurantii* (Boyer de Fonscolombe) (Homoptera: Aphididae). *Aphis spiraecola* and *Aphis gossypii* are the most abundant and diverse species in the region.

In present study, host plants of *A. spiraecola* and its life cycles on these hosts were investigated in Eastern Mediterranean Region of Turkey. We also evaluated developmental periods, fecundity longevity and death ratios of the aphid on *Eriobotrya japonica*, *Pyracantha coccinea* and *Citrus sinensis* (Washington navel) at four constant temperatures (15, 17.5, 20 and 25 ± 1°C) under laboratory conditions.

According to the results, *A. spiraecola* has 11 host plants and overwinters on *E. japonica* as anholocyclic in Eastern Mediterranean Region of Turkey. *E. japonica*, *P. coccinea*, *Viburnum tinus* and all varieties from genus citrus were found as important hosts of *A. spiraecola*. The developmental time of *A. spiraecola* was ranged from 14.4 days for 15°C to 6.5 days for 25°C on *E. japonica*, ranged from 13.3 days for 15°C to 6.7 days for 25°C on *P. coccinea* and ranged from 12.1 days for 15°C to 5.8 days for 25°C on Washington navel. While no death ratio was observed at lower temperatures (15, 17.5 and 20°C) and 6.8% death ratio at 25°C on Washington navel, the death ratio on *E. japonica* was ranged from 9.1% at 15°C and to 15.7% at 25°C. The intrinsic rates of increase (r_m) at 15°C were 0.1029, 0.1078 and 0.1551 ♀♀/♀/day⁻¹ on *E. japonica*, *P. coccinea* and Washington navel respectively. On the other hand, the highest r_m was calculated at 25°C (0.2891 ♀♀/♀/day⁻¹) on Washington navel. The lower developmental thresholds of *A. spiraecola* were 7.4, 5.8 and 7.2°C and it required, 113.6, 131.6 and 107.5 degree-day for a first instar to become adult, on *E. japonica*, *P. coccinea* and Washington navel respectively.

Toxoptera citricida (Kirkaldy) [Hemiptera, Aphididae] and its natural enemies in Spain.

A. Hermoso de Mendoza, A. Álvarez, J.M. Michelena, P. González, M. Cambra..... 225-232

Abstract: The aphid *Toxoptera citricida* (Kirkaldy) is the most efficient vector of *Citrus tristeza virus* (CTV) in the world, and it can transmit the more aggressive isolates of CTV. *T. citricida* is present in most of the zones growing citrus in the world, but it was absent from the Mediterranean Basin and North America until middle 1990's. Nevertheless, it was detected on citrus trees in 1994 in Madeira, in 1995 in Florida, in 2002 in Asturias, Spain (in yellow water traps), in 2003 in northern mainland Portugal, and in 2004 in southern Galicia, Spain, even though the three last detections were not published till 2005. As a consequence of its detection in Spain, several surveys and studies were undertaken from 2005. The main results are listed below.

Currently, *T. citricida* is present on citrus along the Atlantic coast in the northwest quadrant of the Iberian Peninsula. In Asturias, it presents a minimum in winter and other one in summer, but the last one is shorter than the minimum which Mediterranean citrus aphids have too. *Chaenomeles speciosa* (Rosaceae) has been found as an occasional alternative host for *T. citricida*. No winter eggs of *T. citricida* have been seen. CTV spread has not been detected in northern Spain. *T. citricida* is attacked in the Atlantic area by several natural enemy species, most of them present in the Mediterranean zone.

Ants, Coleoptera and others

Survey of the ants (Hymenoptera: Formicidae) in citrus orchards with different types of crop management in Sicily.

A. La Pergola, A. Alicata, S. Longo..... 233-237

Abstract: In the framework of a research on the interactions between honeydew-producing insects and ants, a survey on the species of Formicidae in citrus orchards was conducted by means of pitfall-traps distributed on the soil and manual captures on the canopy. In order to find analogies and differences about abundance and identity of ants in different types of crop

management, captures were performed in three different citrus orchards in Catania plain, two under biological control and one under chemical control. During May-October 2006 and 2007 a total of 21,190 specimens of 25 species belonging to 17 different genera were collected and identified. *Linepithema humile* (Mayr, 1868), *Crematogaster scutellaris* (Olivier, 1791) and *Lasius alienus* (Förster, 1850), were found in a small number in the sprayed orchard. In the organic orchard a large number of *L. alienus* and *Formica cunicularia* Latreille 1798 was found; while *Tapinoma nigerrimum* (Nylander, 1856) and *Camponotus nylanderi* Emery 1921 are the most abundant species in the sprayed orchard. As regards the soil species *Pheidole pallidula* (Nylander, 1848) is not affected by chemical control while *Aphaenogaster semipolita* (Nylander, 1856) appears to be disturbed and was in fact found in lower number. A parallel trial on the symbiosis between ants and honeydew-producing insects disrupting natural biological control by predators and parasitoids is being carried out. *Aonidiella aurantii* (Maskell, 1879) and *Aphis gossypii* Glover, 1877 and the ant species connected with them are observed in this inquiry.

Potential natural enemies of the Citrus Longhorned Beetle, <i>Anoplophora chinensis</i> (Col.: Cerambycidae), an invasive Asian pest in Italy. [Abstract only] <i>F.M. Hérard, M. Ciampitti, M. Maspero, C. Cocquempot, G. Delvare, J. Lopez, N. Ramualde, C. Jucker, M. Colombo</i>	238
Present situation of <i>Anoplophora chinensis</i> (Forster) in Italy. [Abstract only] <i>C. Jucker, M. Maspero, M. Ciampitti, M. Colombo</i>	239
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infested leaves per plant were found. As in the previous years, *T. urticae* was found in the same nursery in 2006, as well. During the first week of September infested leaves were detected on 2%, out of 150 nursery lemon plants (variety *Meyer*). Infestations of several orange plants, and for the first time on mandarin (variety *Owari*), were detected in the next 3 weeks, the attacked lemons. At least three leaves per plant were infested. During all those years the symptoms of the *T. urticae* presence were not detected in any other citrus nurseries inspected along the Montenegrin seacoast, as well as in citrus producing orchards. In the first week of June 2007 infestations were detected for the first time in mandarin producing orchard, in Zoganje (Ulcinj citrus producing area). Out of approximately 500 mandarin trees in the orchard, symptoms of the attack were detected, on 5% of 100 examined plants.

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mineral oil showed a higher efficacy than the other products; it moreover determined the lowest rate of infested fruit at harvest. In relation to the activity of *Aphytis melinus* DeBach, parasitoid of the California red scale, no significant differences were recorded between spiroadiclofen and untreated plots.

Beneficials and Biological Control

Seasonal and spatial population trend of predatory insects in eastern-Spain citrus orchards

P. Bru, F. García-Marí..... 261-266

Abstract: The seasonal trend and spatial distribution of predatory species of arthropods found on Citrus trees in the main Spanish citrus area (País Valencià, east of Spain) was determined in 2005 and 2006. Seven different types of sticky traps were placed and periodically collected on 100 citrus orchards distributed throughout the 200,000 Ha of the Valencia citrus belt. In all, 39,016 specimens included in 31 taxons were identified. The most common families were Neuroptera Coniopterygidae (66% of all insects found) and Chrysopidae (15%), followed by Coleoptera Coccinellidae (13%), Diptera Syrphidae (4%), and Hemiptera Anthocoridae (1%) and Miridae (1%). The most common species among the Coniopterygidae were *Conwentzia psociformis* (Curtis) (51% of all specimens in the family), which increased in winter, and *Semidalis aleyrodiformis* (Stephens) (39%), more abundant in summer and at the southern areas. Most Chrysopidae were *Chrysoperla carnea* (Stephens), which showed its highest population in early summer and at the North. Coccinellidae included as most abundant species *Rodolia cardinalis* (Mulsant) (42%), *Scymnus* spp. (26%), *Propylea quatuordecimpunctata* (L.) (13%) and *Stethorus punctillum* (Weise) (13%). All species of coccinellids showed a similar population trend, with maximum population levels in the spring and early summer.

Ground-dwelling spiders (Araneae) in citrus orchards in Spain. [Abstract only]

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Studies on pest and beneficial insects of Citrus in Izmir province (Turkey)

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Abstract: This study was carried out in the town of Gümüldür and the Seferihisar district, which are the most important citrus, especially tangerine production and exportation areas of Izmir province (Turkey) between the years 2006-2007. Purpose of this study was to determine population fluctuations of some important pests on tangerine orchards and natural enemies of them, particularly aphids. Because aphid population increases remarkably year by year when compared to other pesticide-free tangerine orchards due to using broad-spectrum insecticides (4-5 times per year) to reduce the population of aphids without considering natural balance in tangerine agroecosystem by the producers. *Aphis gossypii* Glover, *A. spiraecola* Pagenstecher, *A. craccivora* Koch, *Toxoptera aurantii* (Boyer de Fons.), *Myzus persicae* (Sulzer), *Aleurothrixus floccosus* (Maskell), *Icerya purchasi* Maskell, *Ceroplastes rusci* L., *Saissetia oleae* (Oliv.), *Aonidiella* spp., *Coccus* spp., *Phyllocnistis citrella* Stainton, *Archips rosanus* L. and *Ceratitidis capitata* (Wiedemann) were determined as pests. Species of Coccinellidae (Coleoptera), Chrysopidae (Neuroptera), Cecidomyiidae and Syrphidae (Diptera) families as predators and species of Braconidae (Hymenoptera) family as parasitoids were found as natural enemies of aphids.

Biodiversity and distribution of beneficial arthropods within hedgerows in organic Citrus orchards in Valencia (Spain)

S. González, R. Vercher Aznar, A. Domínguez Gento, P. Maño, V. Borrás 275-279

Abstract: A study of natural enemies within hedgerows and on ground covers was carried out in two organic citrus orchards in two areas of Valencia (Spain) using two sampling methods, yellow sticky traps and a vacuum machine. Hedgerows had significantly higher levels of natural enemies, followed by citrus and ground covers. The species of natural enemies in hedgerows were similar to those found in citrus orchards, but different from those identified on ground cover. In hedgerows and citrus the predominant predators were Coniopterygidae (Neuroptera)

and Cecidomyiidae (Diptera), and the most abundant parasitoids were Aphelinidae (Hymenoptera).

Establishment of *Neodryinus typhlocybae* (Ashmead) (Hymenoptera: Dryinidae) in Sicilian lemon orchards.

L. Zappalà, G. Siscaro, S. Longo 280-283

Abstract: The results of a classical biocontrol program against *Metcalfa pruinosa* (Say) (Homoptera: Flatidae) introducing the specific parasitoid *Neodryinus typhlocybae* (Ashmead) (Hymenoptera: Dryinidae) are reported. The antagonist was released in a 15-ha lemon orchard in Eastern Sicily where the infestation levels and the population dynamics of *M. pruinosa* have been monitored, on a fortnightly basis, since March 2004. One hundred adults of *N. typhlocybae* were released in an area of the orchard with a high density of the pest and where a *Pittosporum* hedge was planted. The periodical sampling revealed the presence of the first pupae of the parasitoid only after January 2006 on trees close to the release point. The parasitoid was then found at a density of 1-10 pupae per tree, up to 100m far from the release point. The diffuse presence of *N. typhlocybae* on *Pittosporum* is of particular interest because of the potential use of these hedge plants as reproductive refuge of the antagonist. In the 3 years of the survey the infestation levels on lemon trees, expressed as mean percentage of new shoots bearing more than one *M. pruinosa* instar, were respectively 13.71%, 27.56% and 25.09%. Further observations are still being conducted in Sicily in order to find other areas of presence of the dryinid as well as to evaluate its activity and efficacy in controlling the citrus flatid.

Natural parasitism of chrysopid eggs by the parasitoid *Telenomus acrobates* Giard (Hymenoptera: Scelionidae). [Abstract only]

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IPM and Chemical Control

Current situation and new approaches to old challenges in citrus IPM in Israel. [Abstract only]

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Sicily IPM Demonstration Project.

R. Tumminelli, R. Finocchiaro, E. Raciti, C. Pedrotti, S. Calcaterra..... 286-289

Abstract: The purpose of the Sicily Integrated Pest Management (IPM) for Citrus Demonstration Project was to compare the costs and efficacy of various citrus pest management practices during 2003, 2004, 2005, and 2006 years. Within the project, some of the growers depended primarily on natural enemies (*Aphytis melinus* augmentative releases) and selective pesticides (narrow range mineral oil and sugar-feeding ant population rational management) to solve their pest problems while others depended primarily upon pesticides. In this program, the County Farm Advisor of Sicily Department of Agriculture staff and pest control advisors intensively monitored all of the pests and natural enemies in 10 commercial citrus orchards in the Catania County. The growers were generously allowing us to sample the blocks and evaluate the effectiveness and costs of their various control tactics. In conclusion, this program showed to result in reduced pesticide use (from 2,6 to 0,5 treatments per year) and similar fruit quality and economic returns compared.

Integrated Pest Management in two citrus varieties Navel and Maroc Late in Sidi Slimane Area, Western North of Morocco. [Abstract only]

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Side-effects of insecticides on *Leptomastix dactylopii* under semi-field conditions in Italy.

G. Mazzeo, P. Suma, S. Longo 291-294

Abstract: The side-effects of chlorpyrifos-methyl, spinosad and pyriproxyfen on *Leptomastix dactylopii* Howard, the most effective natural enemy of the citrus mealybug *Planococcus citri* (Risso), were investigated under semi-field conditions. The experiments have been conducted according to internationally approved guidelines, spraying young orange plants confined in test cage, with the insecticides at maximum field application rates. In each cage 20 *L. dactylopii* adults were released and the mortality after 24, 48 and 72 hours, the longevity, the progeny production of the survived parasitoid females and sex ratio of the progeny were assessed. Despite the fact that the tested insecticides were harmless to the parasitoid and none of them influenced the progeny production of the survived females, the longevity was negatively affected suggesting a multiple testing methods should be used when evaluating pesticide effects on beneficial arthropods.

Response of larval *Ephestia kuehniella* (Lepidoptera: Pyralidae) to individual *Bacillus thuringiensis kurstaki* toxins and toxin mixtures and effect of delta-endotoxin ratio in *Bacillus thuringiensis* crystals. [Abstract only]
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Diseases

Seasonal variation in the population level of *Fusarium* spp. in citrus nurseries in Southern Italy. [Abstract only]
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Seasonal variation in *Phytophthora* spp. in citrus nurseries in Southern Italy: preliminary results. [Abstract only]
A. Salama Eid, G. Cirvilleri, T. Yaseen, A.M. D'Onghia, A. Ippolito 299

Application of *Metschnikowia fructicola* for the integrated control of postharvest diseases of citrus in commercial packinghouses. [Abstract only]
P. Di Primo, M. Coniglione, M. Lazare, M. Keren-Zur, A. Bercovitz, D. Blachinsky, A. Husid, V. Bonaccorso 300

New or re-emerging fungal citrus diseases in the Mediterranean.
F.M. Grasso, P. Bella, S. Grasso A. Catara 301-304

Abstract: In recent years, the spread to new Mediterranean areas of citriculture with its new cultural practices, new citrus varieties and a changing climate, has led to the need to cope with new or re-emerging fungal plant diseases. The most notable are 'greasy spot' and 'alternaria spot'. A few papers have been published on this topic, but little attention has been given to them. For the last five years, many Italian orchards have been conspicuously dropping mature leaves affected with greasy spot to their undersides, which may develop groups of perithecia carrying asci which are morphologically similar to the *Mycosphaerella* genus. Potato agar cultures of the symptomatic mesophyll slowly grow greenish-brown colonies, bearing erratically multiseptate conidia, similar to the genus *Cercospora*. Some citrus species are more susceptible and may require appropriate spraying once the biological cycle of the fungus is defined. Only one out of four *Alternaria* diseases occurs frequently – the mandarin *Alternaria* brown spot, which is becoming more and more diffuse in many cultivars in Italy and Spain,

damaging the leaves and fruit of mandarin hybrids despite frequent chemical spraying. Septoria spot is less common in Sicily and Calabria, where symptoms occur on the fruit and leaves of lemon and bergamot. Anthracnose is an old disease affecting citrus twigs, leaves and fruit and is caused by a primary fungus coloniser of injured and senescent tissue in the field and usually does not require spraying.

Effectiveness of acetic and peracetic acid to control *Penicillia* agents of postharvest decay of citrus. [Abstract only]
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Host-pathogen interaction phenotype in citrus seedlings inoculated with *Phoma tracheiphila*. [Abstract only]
M. Russo, F.M. Grasso, G. Licciardello, V. Catara 306

Colonization of *Fusarium solani* isolate in Troyer citrange seedlings.
S. Spina, V. Coco, A. Gentile, A. Catara, G. Cirvilleri 307-316

Abstract: A research was carried out to investigate whether the association with the *rolABC* genes of *A. rhizogenes* could modify the susceptibility of Troyer citrange to *Fusarium solani*, the causal agent of dry root rot. *F. solani* strain 1A was inoculated in cuttings and leaves of Troyer citrange seedlings modified by *rolABC* genes and wild type (WT). Interveinal chlorosis of leaf, wilt and defoliation, observed both on *rolABC* and WT were more severe on transgenic line. Two months after root inoculation with the pathogen, root weight was significantly reduced in *rolABC* seedlings, but no root rot was recorded. *F. solani* was always reisolated from artificially inoculated cuttings, midribs and roots without differences between wild types and transgenic lines. The pathogen was never recovered from not inoculated plant tissues. Cell-free fungal culture filtrates induced leaf wilt and defoliation within 10 days from inoculation, without any significant difference between *rolABC* and WT shoots. Scanning electron microscopy (SEM) of infected roots, carried out at 3 and 6 days after inoculation, showed the penetration and colonization of the hyphae. Evidence is presented that *F. solani* infects Troyer citrange tissues without differences between wild type and transgenic lines in the early phase of colonization and in absence of visible specific disease symptoms. The tests here described could be used to evaluate rootstocks sensitivity to the pathogen.

New phytosanitary scenarios for Mediterranean citriculture as a result of the diffusion of the Citrus tristeza virus?
A. Catara, S. Rizza, M. Tessitori 317-324

Abstract: Being the most popular rootstock in the Mediterranean, the substitution of sour orange with other rootstocks would seem inevitable to circumvent the devastating effects of *Citrus tristeza virus* (CTV). This will temporarily solve the problem, but the emergence and/or introduction of more virulent CTV strains or more efficient vectors than current ones should also be considered. Moreover, the risk of introducing *Candidatus Liberibacter* species and its relative vectors should not be underrated as should not the risk from *Citrus tatter leaf virus* which is particularly harmful to plants grafted on trifoliate orange and citrange. From South America the risky diseases are 'blight', 'variegated chlorosis', 'sudden death' and 'leprosis'. Yet to be clarified is the emergence of other virus strains already present in some Mediterranean countries such as 'yellow vein clearing' and 'chlorotic dwarf' in Turkey, assumed to be associated to vectors, or 'leaf blotch', seed transmitted. Problems related to viroids, often masked by the use of sour orange, have to be reconsidered in the case of susceptible rootstocks and because of the recent discovery of new pathogenic viroids. Overall, the introduction of trifoliate and citrange as well as alemow and rough lemon has generated new problems which are frequently underestimated. More notable in loam soils is the "dry root rot" disease associated to *Fusarium* spp., affecting severely the citranges. This new condition strengthens the need to enforce international cooperation among entomologists and plant pathologists to plan

valuable strategies to avoid new entries of virus strains and the displacement of pests and diseases, and to define integrated programs of control.

- Incidence, distribution and diversity of citrus tristeza virus in two different areas of Sicily.
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S. Davino, G. Sorrentino, M. Guardo, A. Caruso, M. Davino 325
- Monitoring and eradication of citrus tristeza virus in Apulia region, Southern-Eastern Italy.
[Abstract only]
A. Percoco, F. Valentini, K. Djelouah, D. Frasheri, T. Colapietro, A. Guarino, A.M. D'Onglia..... 326
- Indicator cuttings instead of seedlings for a rapid biological indexing of the main citrus viruses and viroids. [Abstract only]
A.M. D'Onglia, M. Meziane, R. Brandonisio, K. Djelouah..... 327
- Transmission of turkish citrus tristeza virus isolates by *Aphis gossypii* Glover (Homoptera: Aphididae) in the laboratory.
S. Satar, U. Kersting, N. Uygun..... 328-335
Abstract: Tristeza is one of the most destructive diseases of world citrus. Although Mediterranean basin have not had effective vector until two years ago, in Spain, Italy and Israel, where tristeza is transmitted by *Aphis gossypii* Glover (Homoptera: Aphididae), it now devastates thousands of citrus trees. Although the citrus production areas of East Mediterranean Region of Turkey have been infected less than 1% with tristeza and also *A. gossypii* is one of the important aphid species in citrus, no natural spread of tristeza has been determined in East Mediterranean Region of Turkey in the last two decades. In this study eight isolates from Iğdır (I-3, I-4, I-7, I-9, I-10, I-12, I-13, I-14), two isolates from Serdengeçti (S-1, S-3), two isolates from Cyprus (K-1, K-5), and five isolate from USA (SY-560, T-510, T511, T515, T519) were transmitted by *Aphis gossypii* from Madam Vinous sweet orange to Mexican lime in laboratory conditions. The Turkish CTV-isolate “Iğdır” displayed variable transmission rates from 0% to 21.5%. No successful transmission was obtained using the second isolate collected in Serdengeçti. CTV-isolates from Cyprus were transmitted by *Aphis gossypii* in a rate of 18.2%, while only one of the five American isolates was transmitted about 4.5%, which is relatively low. The transmission rate depended on the number of aphids used in the experiments, ranging from 7.7% for five individuals to 38.5 % for 50 individuals and 28.6 % for 100 individuals.
- High density citrus orchard sustainability through a non-pathogenic viroid. [Abstract only]
S. Rizza, G. Nobile, M. Tessitori, R. La Rosa, A. Catara..... 336
- Use of lux-marked genes to monitor antagonistic *Pseudomonas syringae* on citrus fruits.
A. Bonaccorsi, G. Cirvilleri 337-344
Abstract: *Pseudomonas syringae* strain 48SR2, effective as biological control agent, was genetically tagged with the promoterless *lux* operon *Tn4431* to monitor the population dynamic in *in vivo* assay. Four hundred thirteen mutants were obtained and diverse bioluminescent activities were observed according to the insertion of *Tn4431* into a wide variety of regions of the chromosome. A selected strongly bioluminescent mutant (*lux* 176) and the wild-type strain were tested for their antagonistic properties to control the post-harvest pathogen *Penicillium digitatum*. Both the wild type and the *lux*-marked strain equally reduced the growth of *P. digitatum in vitro* and the severity and incidence of citrus decay *in vivo* when the biocontrol agents were applied in wounds 24 h before challenging *P. digitatum*. The persistence of the genetically engineered bacteria on citrus wounds was monitored over the time with bioluminescence detection systems as well as by dilution plating techniques. Population sizes of both wild-type and *lux*-mutant strain were comparable. These results indicate that *P. syringae* strain 48SR2 could be considered a biological control agent for citrus green mould and that

bioluminescence can be a sensitive detection method to study population dynamics and antagonistic behaviour during fruit storage.

Microbial antagonists of the citrus nematode, *Tylenchulus semipenetrans*, in Southern Italy and host-parasite rhizosphere interactions. [Abstract only]
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