

IOBC / WPRS

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Discovery in Continental Portugal and Spain of the aphid *Toxoptera citricidus*, a potential threat to citrus trees in the Mediterranean Basin

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The recent discovery in Continental Portugal and Spain of *Toxoptera citricidus*, the aphid vector of the most severe strains of citrus tristeza virus, is reported. The areas where the aphid has been collected in Continental Portugal up to the end of April/2005 are indicated. Attention is drawn to the interest of knowing very well the distribution of *Toxoptera citricidus* in Portugal and its biology, as well as the identification of citrus trees infested with tristeza virus, for possible elimination.

Citrus tristeza epidemiology in the Mediterranean basin: a changing scenario?

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Decline of citrus plants grafted on sour orange rootstock is the commonest aspect that people associate to *citrus tristeza virus* (CTV). Manifestation of decline may range from being barely noticeable, extending over a period of years, to quick decline in which the tree dies in a matter of months. Slow decline is very frequent on the Mediterranean Basin. Quick decline (QD) episodes have been occasional (e.g. Spain, Israel, Italy). In citrus producing areas outside the Mediterranean region, where sour orange is not extensively used as a rootstock, it is common to find plants exhibiting stem-pitting (SP) symptoms on the branches; these symptoms which do not lead to death of the tree are associated to a reduction in the size and quality of the fruits. Although less spectacular than QD, the SP syndrome is economically damaging and can not be avoided by changing to tolerant rootstocks. The existence of virus strains is one cause for this wide range of symptoms. It has been generally believed that in the Mediterranean basin only mild CTV strains which produce slow decline exist and that severe ones, when found (e.g., Spain), have been immediately eradicated.

CTV has one of the biggest monopartite RNA genome harbouring 12 genes. In recent years we conducted a worldwide molecular characterization of diverse of these genes, which lead us to recognize the existence of 7 CTV strains. No geographic speciation could be found. Examples of all these strains were found scattered in the Mediterranean basin, frequently in mixed infections. In mainland Portugal, 6 out of the 7 strains have already been detected. Biological characterization of isolates which were determined as "pure" strains enabled to establish a relationship between molecular factors and symptoms. Existence of strains considered as severe (QD or SP) was recognized hiding in mixed infections in diverse parts of the Mediterranean basin. Nevertheless, in some places, the severe syndromes were showing in the field (e.g. SP in Croatia; QD in Italy).

In most citrus producing areas of the world where *Toxoptera citricidus* appeared the CTV incidence has increased. A well documented example refers to Florida (Halbert et al.

2004); the existence of SP strains passed unnoticed until recent years, resembling the Mediterranean situation. According to those authors, two years were sufficient after the establishment of *T. citricidus* for a marked increase in the appearance of severe forms of tristeza (SP and QD). In view of the proved existence of all the CTV strains in the Mediterranean basin (and almost all in Portugal), the introduction of *T. citricidus* in the Iberia peninsula appears to provide the missing ingredient to change the epidemics scenario in the area unless very efficient measures are taken.

New Developments in the San Joaquin Valley California Citrus IPM Program

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Abstract: The majority of citrus, primarily navels and Valencias for fresh market, is now grown in the central San Joaquin Valley of California. Beginning in the late 1990s a number of new insecticides (pyrethroids, insect growth regulators, neonicotinoids, and fermentation products) were registered for control of citrus pests. These insecticides have improved worker safety, reduced environmental effects, and improved the survival of some natural enemies by greatly reducing organophosphate and carbamate usage. There are, however, some problems with integrating these new insecticides into the California citrus pest management program. First, the two most commonly used insecticides, pyriproxyfen for California red scale *Aonidiella aurantii* control and spinosad for citrus thrips *Scirtothrips citri* control are highly selective for these two pests. Their use and the lack of broad spectrum pesticides, releases from control secondary pests such as forktailed bush katydid *Scuddaria furcata* and citricola scale *Coccus pseudomagnoliarum*. This necessitates additional insecticide treatments for the secondary pests. Secondly, many of the new insecticides are toxic to the predatory vedalia beetle *Rodolia cardinalis*. Thus, cottony cushion scale *Icerya purchasi* problems have increased. Finally, exotic pests continue to invade the region, for example, glassy-winged sharpshooter *Homalodisca coagulata*, citrus peelminer *Marmara gulosa* and citrus leafminer *Phyllocnistis citrella*. These pests require the development of management tactics that must be integrated into the existing IPM program. The use of more selective insecticides, the toxicity of new insecticides to coccinellids, and the invasion of new pests has increased the complexity of the integrated pest management program for San Joaquin Valley citrus.

Evolution of integrated pest management and integrated production in citrus, in Portugal

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Since the end of the 1950s integrated pest management (IPM) has evolved slowly in Europe. However, since the beginning of the 1980s significant development was achieved in countries like Germany, Switzerland, and certain regions of Italy. In Portugal, although the initiatives to develop the practice of IPM have been initiated in the 1980s and continued in the following decade the practise of this technology was almost incipient until the 1990s. In Portugal, since the implementation of the agro-environmental measures in 1994, an intensification of the IPM practice was observed.

Citrus is one of the crops addressed in the agro-environmental measures, together with pomefruits, vineyard, cereals, vegetable crops, olives, stone fruits and nut crops. Since 1997, DGPC has carried out the recognition of farmers' associations in the scope of IPM and integrated production. The present paper describes some data, namely in relation with recognised farmers' associations, involved areas, farmers and technicians.

The Phytosanitary problems that affect orange groves on Terceira Island, Azores

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Abstract: In orange orchards several pests (insects and mites) trips) damage the trees, reducing production and contributing to low quality fruits. The INTERFFRUTA project has as one of its goals a better understanding of the phytosanitary problems (pests and diseases) that appear in the orange orchards in the three most productive areas of Terceira Island (Biscoitos, Angra do Heroísmo and São Sebastião). Mites, thrips, aphids, whiteflies and the citrus leaf miner are the most important pests in orange orchards and they mainly concentrate their action in the upper part of the citrus trees. The methodology used to estimate damage was direct observation with a biweekly registration of all data collected from the orange orchards (such as occupation percentage, for almost all the pests found, and the number of mobile forms and eggs for the mites), and for thrips monitoring captures on yellow traps coated with glue. Two collecting methods were used to identify both harmful and beneficial insects: the Battage and the Mailaise trap, in a seasonal strategy with three periods of sampling (Spring, Summer and Autumn). In this study we have analyzed the seasonal evolution and occupation percentage for each pest registered in the orange orchards, at each of the three most important production areas of Terceira Island. The disease and virus survey was made in six orange orchards using direct sampling by observation of symptoms, at different times according to the development of the orange trees, searching for symptoms in 10% of all the trees present in each orchard. Eight species of fungi were found, but tests showed that the CTV virus was not present in all the orange orchards studied.

Ecological infrastructures and conservation biological control in citrus orchards

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The IOBC/WPRS edited recently a book (Boller et al. 2004b) on ecological infrastructures, i.e., any infrastructure at the farm or within a radius of about 150 m that has an ecological value to the farm, such as hedges, grasslands, wildflower strips, ruderal areas, conservation headlands, stone heaps, whose judicious use increases the functional diversity of the farm. One important aspect of functional biodiversity for pest management is the preventive and sustainable regulation of pests by their natural enemies. In this way ecological infrastructures can contribute for conservation biological control by increasing the density of the natural enemies and enhancing their impact on the pest. A minimum surface of 5% of farmland is required by IOBCwprs to be designated as ecological infrastructures (Boller et al. 2004a, b). A synthesis on the results of a project (nº 29 PO AGRO-Medida 8.1-DE&D 2002-2005) aiming at study the influence of ground cover management and hedges in the diversity and abundance of natural enemies in citrus orchards will be presented and discussed.

Abundance and population dynamics of ground-dwelling predators in Spanish citrus orchards

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There is little information on the abundance-activity of predaceous ground arthropods in citrus crops in Spain. In this work a large number of ground predatory species have been identified in citrus groves in Valencia (Spain) for the first time. We monitored ground-dwelling predators in four citrus orchards, during one year (April 2004 to April 2005), by pitfall trapping across the diagonal in each orchard. Ants (Hymenoptera) were the most abundant-active group, followed by spiders (Araneae), rove beetles (Col.: Staphylinidae), ground beetles (Col.: Carabidae), earwigs (Dermaptera) and tiger beetles (Col.: Cicindelidae). Ants were captured in very low numbers during the winter months but they were very active during the rest of the year. Spiders, rove beetles and earwigs were active throughout the year, fluctuating without a clear pattern. Carabids were especially active in spring and at the end of the summer and tiger beetles were only collected during the spring period.

Parasitism disruption by ants of *Anagyrus pseudococci* (Girault) and *Leptomastix dactylopii* Howard (Hymenoptera: Encyrtidae), two parasitoids of the citrus mealybug *Planococcus citri* (Risso) (Homoptera: Pseudococcidae)

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Abstract: Numerous ant species are known to disrupt parasitism of citrus pests by natural enemies. *Lasius niger* (Latreille) is the most abundant specie in citrus groves in this area, so the effect of this ant on *P. citri* parasitization by *A. pseudococci* and *L. dactylopii* was studied. *L. niger* significantly reduced parasitism by about 35%, while sex ratio of the progeny remained unaffected in both parasitoid species. Nevertheless, when both parasitoids were tested altogether, ants reduced parasitism by about 50%. Field observation showed that ants rarely left the calyx area where mealybugs were located, and both parasitoids were able to attack *P. citri* in presence of attending ants. Host inspection by *L. dactylopii* was detected by ants in 59% of the events, compared to *A. pseudococci*, which was only detected in 32%. Nevertheless, disturbance by ants led *A. pseudococci* to leave the host, or the fruit itself, more frequently than *L. dactylopii*.

Natural enemies of the black scale *Saissetia oleae* (Homoptera: Coccidae) in Valencia (Spain)

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Abstract: A survey of the black scale [*Saissetia oleae* (Olivier)] present in citrus orchards in Valencia (Spain) was conducted between March 2003 and March 2004 in order to determine the main species of natural enemies and to study their seasonal abundance, distribution and incidence on *S. oleae* populations. Four orchards were sampled fortnightly, and occasional samples were collected in 13 more orchards. Each sample consisted of 16 branches (15 cm long) and 64 leaves. Adult natural enemies were also sampled with an engine-powered vacuum-machine. Six species of parasitoids of *S. oleae* were identified, being the most abundant *Metaphycus flavus* (Howard), *Metaphycus lounsburyi* (Howard) (Hymenoptera: Encyrtidae) and *Coccophagus lycimnia* (Walker) (Hymenoptera: Aphelinidae). Among three species of egg predators, *Scutellista caerulea* (Fonscolombe) (Hymenoptera: Pteromalidae) was the most abundant. *S. caerulea* was often parasitized by the mite *Pyemotes herfsi* (Oudemans) (Prostigmata: Pyemotidae). The entomopathogenic fungus *Verticillium lecanii* (Zimmermann) reached high incidence in one sampling point in autumn. According to their abundance, distribution and impact on *S. oleae* populations, *M. flavus* and *S. caerulea* appeared as the main natural enemies of *S. oleae* in citrus orchards in Valencia (Spain).

Side-effects of insecticides on natural enemies of citrus scale pests in Italy*§

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Abstract: Laboratory trials were conducted to test the side-effects of 5 insecticides, Etifos[®] M (chlorpyrifos-methyl), Applaud[®] (buprofezin), Admiral[®] (pyriproxyfen), Laser[®] (spinosad) and Biolid[®] E. (narrow range mineral oil) on 4 parasitoids of Citrus scales: *Aphytis melinus* DeBach, *Coccophagus semicircularis* (Förster), *Coccophagus lycimnia* Walker (Hymenoptera: Aphelinidae) and *Leptomastix dactylopii* Howard (Hymenoptera: Encyrtidae). The tests were conducted using a spray Potter Tower following the standard principles accepted by the IOBC/wprs Working group “Pesticides and Beneficial Organisms”. Contact toxicity on adults after 24, 48 and 72h, the effects on their fertility as well as the sex-ratio and the fecundity of the progeny were observed. A test was carried out also spraying Citrus mealybug mummies parasitized by *L. dactylopii*. Total mortality (100%) of all tested parasitoids due to contact toxicity was observed 24h after the treatment with chlorpyrifos-methyl and spinosad. The mean levels of mortality obtained after 72h on *C. semicircularis* and *L. dactylopii* were 76% and 58% respectively after treatments with mineral oil. Buprofezin after 72h caused 95% mortality on *C. semicircularis*, 100% on *C. lycimnia*, 42% on *L. dactylopii* and 76% on *A. melinus*. The other IGR (pyriproxyfen) caused lower mortality rates (88% on *C. lycimnia*, 48% on *L. dactylopii* and 62% on *A. melinus*). The average number of progeny per single *L. dactylopii* surviving female was 13.45±4.10 (buprofezin), 13.67±9.61 (mineral oil), 10.83±5.67 (pyriproxyfen) and 15.09±10.35 (untreated control) with no statistically significant differences. The sex ratio of the progeny (M:F) was 0.8:1 (buprofezin), 2.6:1 (mineral oil), 1:1 (pyriproxyfen) and 0.8:1 (untreated control). The surviving *A. melinus* females produced a mean number of progeny of 3.75±0.35 (buprofezin), 36.04±4.20 (pyriproxyfen) and 36.44±2.42 (untreated control) with the first value significantly different from the others. The sex ratio of the progeny (M:F) was 0.8:1 (buprofezin), 0.6:1 (pyriproxyfen) and 0.6:1 (untreated control). The surviving *C. lycimnia* females (pyriproxyfen) didn't produce any progeny while 39.98±7.59 mean progeny were produced by the untreated control. Semi-field and field trials are needed to better define the compatibility of the tested pesticides with IPM strategies in Citrus groves in Italy.

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The recruitment of native parasitoid species by an invading herbivore: the case of *Phyllocnistis citrella* (Lepidoptera: Gracillariidae) in Eastern Spain

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Abstract: The parasitoid assemblage associated with the invading herbivore *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) was studied in Eastern Spain over a seven years period just after its introduction (1995-2001). The recruitment of native parasitoids by the invading leafminer followed the expected patterns of hosts as invaders: lower species richness, generalized habits, idiobiont strategy and low to moderate rates of parasitism. Ten primary parasitoid species were reared from the citrus leafminer, indicating a rapid accumulation of native parasitoids on the invading host. They belonged to the families Eulophidae (nine species) and Pteromalidae (one species). From 1997 onwards, two main species, *Pnigalio* sp. and *Cirrospilus brevis* Zhu, LaSalle and Huang, represented more than 90% of the parasitoids identified. The spatial and temporal dynamics of native parasitoids, some host-parasitoid interactions and other life aspects of parasitoids are also reported. The study of native parasitoids of the leaf-mining niche showed that parasitoids considered minor or secondary on native hosts, such as *Pnigalio* sp., can play a major role as parasitoids of introduced herbivores.

Two native pupal parasitoids of *Ceratitis capitata* (Diptera, Tephritidae) found in Spain

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Abstract: Searching native parasitoids of *Ceratitis capitata* is one of the activities carried out in the Valencian Community in plots of citrus and other fruit trees. Adults of two different species of hymenopterous insects have been obtained from medfly puparia reared under laboratory conditions. The pteromalids *Spalangia cameroni* Perkins and *Pachycrepoideus vindemmiae* (Rondani) have been identified as idiobiont pupal parasitoids of the Medfly.

Influence of ground predators on the survival of the Mediterranean fruit fly pupae, *Ceratitis capitata* (Diptera:Tephritidae), in Spanish citrus orchards

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A survey of predaceous ground arthropods was conducted in two citrus orchards in Valencia, Spain, and their role as predators of *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae) pupae was evaluated under field and laboratory conditions. A total of 2,959 predaceous arthropods were collected by pitfall trapping in the two orchards from July 2003 to September 2004. Ants (Hymenoptera) were the most abundant group (83%), followed by Staphylinidae ($\approx 8\%$), Araneae ($\approx 5\%$), Carabidae ($< 1\%$), Cicindelidae ($< 1\%$) and Dermaptera ($\approx 1\%$). Pupae disappearance rates were higher during the warmer months of the year, from May to October, and in the orchard with the largest ant populations. In the warm season, average survival (mean \pm SE) of *C. capitata* pupae was $35.7 \pm 6.2\%$ and $14.3 \pm 6.7\%$, respectively, in both orchards. Symptoms of predation, inferred from broken or abnormal pupae, were more frequently observed in the colder months, from November to April, when spiders, Staphylinidae and other predators were present. In the cold season, the combined effect of predation and low temperature during the period, lasting between one and four months, when the pupae stayed in the soil led to an adult emergence rate of only $10.0 \pm 6.0\%$ and $4.7 \pm 3.4\%$ in both orchards. In no-choice laboratory trials, all predator species tested fed on the *C. capitata* pupae, with statistical differences in feeding rates between species. Preliminary data show that carabids [*Pseudophonus rufipes* (Duftschmid) and *Harpalus distinguendus* (Degeer)] were the most voracious species, consuming more than one pupa per day followed in order of importance by Cicindelidae, earwigs and spiders.

Population dynamics of *Ceratitis capitata* on citrus in northeast Spain: the influence of adjacent host fruit trees

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Abstract: The population of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae), was studied from April 2003 to December 2004 in the citrus grove area of Catalonia, northeast Spain. Tephri-trap traps were used baited with the male specific parapheromone trimedlure and with the female target attractants ammonium acetate, putrescine and trimethylamine. A total of 96 traps were placed on clementine trees, distributed at 23 observation points in different parts of the citrus area. Two main adult population peaks were observed in each year; one in summer and the other in autumn. From November, when T^a dropped below 15°C, populations drastically decreased. From mid December to mid May no females were captured, and from early March to mid April no adults, either male or female, were captured. No long distance movements were detected in the area. Adult females appeared in spring throughout the study area, but with no definite direction. The population dynamics and abundance of adult females in the citrus groves studied seemed to be related to the availability of alternative host fruits in the surrounding area. The most important alternative host fruits prior to population developments on citrus appear to be peaches in early summer and fig trees and *Ziziphus jujuba* in late summer and autumn.

The population dynamics and damage caused by the Mediterranean fruit fly (*Ceratitis capitata* Wied.) (Diptera: Tephritidae) in orange groves on Terceira Island, Azores

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Abstract: Given the dispersal capabilities and damage known to be caused by *Ceratitis capitata* (Wied.) it is important in a particular location to evaluate the areas and fruit hosts that are most affected by this pest, the local population dynamics and its seasonal presence in orchards. The work reported in this paper was one part of a wider integrated investigation developed in the INTERFRUTA project that had as one goal the use of GIS, especially ESRI software, ArcView 3.2, for the study of *C. capitata* dispersion in the tree fruit areas. To achieve better knowledge of the biology and also to monitor *C. capitata* population changes in each grove, a network of traps (Jackson with sexual attractant for males and Tephri with a three component food attractant for females) was installed in three fruit production areas (Biscoitos, Terra-Chã/Angra and S. Sebastião) on Terceira Island, Azores in orange groves using GPS. The results of spatial analysis in ArcView show some apparent dispersion within the three zones, with concentration of the pest population below 100 meters of altitude. With a three-dimensional analysis it was also possible to see that *C. capitata* has a preference for areas characterised by topographic depressions that may provide some climate protection which improves survival. The greatest utility of this type of analysis using GIS software is the possibility to define and apply a qualitative scale previously established for damage caused by this pest and to get maps of damage distribution in the different orange groves in order to provide consistent and more efficient control. It could also be useful to understand the relationship of population and infestation with factors such as altitude, topography, type and phenologic development of the surrounding vegetation and weather conditions. In the orange groves it could be seen that in the vicinity of Angra there are two periods that registered the greatest amount of adult *C. capitata* captures. A low first peak was in June and the second, higher peak was in September. In Biscoitos and S. Sebastião the greatest adult captures were registered in a single peak in September. The small early peak in Angra coincided with the maturity of some other nearby hosts. The September peak of trap catches throughout the island preceded the subsequent high infestation rates in oranges from October to November.

Ecological based control of the Mediterranean fruit fly through a novel technology

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Current control methods of *Ceratitidis capitata* (Wiedemann) use repeated sprays of pesticides to protect the crop against it. Although high level of protection is achieved, the side effects of such procedure are undesirable. Recent large-scale ecological study, by Israely et al., give evidence that flies do not survive in the same orchard year-to-year, but instead they continuously change their spatial position, searching and attacking available hosts. Hence, when hosts are becoming sensitive to attack, the source of flies must be external to the plot. Using this information together with thorough acquaintance with *C. capitata's* biology and behavior, the Biofeed, a suspended device, have been developed and tested in Israel during the last four years. The Biofeed is made out of a yellow, two dimensional, shape cloth (30X30 cm) with a red circle on its lower side and a pocket stitched to its upper side, into which a bait container is inserted. The bait diffuses out of the pocket, during an 8 weeks period to the devices' surface. Attracted flies land on the Biofeed's surface, feeds on it, and die due to a poison mixed in the bait. Due to the constant reinvasion of flies to the orchards, placement of Biofeed is dancer in the orchards' perimeter, to hinder invading flies. The Biofeed's efficiency was compared to alternative methods in 13 different hosts' species, in over a hundred plots and thousands of dunams throughout Israel. Results show that control achieved by Biofeed is as good as alternative methods used in Israel. It is concluded that the Biofeed is a viable cost-effective alternative for conventional and organic farming and has a potential for use in conjunction with SIT projects.

Four years of medfly control using chemosterilization: results and performance possibilities

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Ceratitis capitata (Wiedemann), medfly, is the major pest in the Mediterranean Spanish citrus area and control measure still consist of several malathion aerial applications over large areas. A four-year field trial was carried out in Valencia, Spain, in order to test efficacy of chemosterilization against medfly compared with malathion treatments. Chemosterilization was applied hanging 24 bait stations per hectare in an 80 Ha citrus plantation. Bait stations were hung in May and remained active in the field during the whole year. Each trap contains a protein bait with lufenuron and male and female attractants. Lufenuron prevents egg hatching from females that ingest the bait or females that mate with males which have ingested the bait. In this way, the population is reduced, generation after generation, affecting medfly fertility during the whole year. A check field was located 1 km away from the field treated with chemosterilants and was treated 4 to 8 times per year with aerial applications of malathion and protein bait. The efficacy of the new medfly control method was evaluated as adult medfly population reduction, and measured as weekly catches in a monitoring trap grid over the two areas. Results show a continuous medfly population reduction since the first year till the fourth year of chemosterilization application. 60% reduction of medfly population in chemosterilant areas was achieved in the fourth year when compared with malathion treatments. This medfly population reduction suggests that chemosterilization would allow the suppression of the aerial treatments and the reduction of terrestrial pesticide application in a sustainable way.

Alternative methods for mass trapping of Medfly, *C. capitata* (Diptera: Tephritidae), in Algarve

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The control of the common Mediterranean fruit fly (*Ceratitis capitata* Wiedemann) through the use of conventional pesticides is still the most used process in citrus orchards in Algarve region. Claiming for alternative solutions, without pesticide residues, trials based on mass trapping have been conducted in citrus orchards of AAZAP's farmers.

The high cost of conventional traps, like the McPhail type, led the technicians to try a different kind of trap. This trap consists of a plastic bottle (used in commercial water) with a yellow waist-band and four small holes bellow (0,8 cm diameter). Two different baits where tested: a commercial protein hydrolysate (*Endomosyl*, 600 g/l of protein) in a water dilution of 9 %; and a commercial three-component trimethylamine + putrescine + ammonium acetate (*Starce*) in a water dilution of 1 %. A pottery detergent at 1 % was added to solution baits.

In one experimental unit (five rows of trees) in the citrus orchard, the protein hydrolysate (*Endomosyl*) was placed in a proportion of one trap per tree (HP 1/1). In a second experimental unit, the three-component (*Starce*) was placed in a proportion of one trap per every two trees (ST 1/2). In a third experimental unit, the same tri-compost was placed in a proportion of one trap per every three trees (ST 1/3). Two types of observations were made in each experimental unit: number of captured flies (males and females) in six traps and number of damaged oranges on six marked citrus trees. The observations were carried out once a week from September to November of 2003.

In spite of a high growth rate of flies, as usual in this period, results were promising, with only a few damage fruits. The results suggest that a lower trap density may be enough. The costs of this method were lower comparing with other traps and baits. The study is continuing with the same traps and baits, and including a new one, but with a variable number of traps according to the dynamics of medfly population.

Using proprietary adhesive powders as carriers of active ingredients in advanced control of the Mediterranean fruit fly and other important pests

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Abstract Using pheromones and/or food baits as attractants, specific insect pests can be lured into baiting stations containing a mixture of adhesive powder formulated with an active ingredient (i.e. pheromones, slow-acting pesticides, or biologicals). Insects lured into the bait station pick up the powder, which adheres to the insect cuticle, thus ensuring that the insect leaves the station carrying the active ingredient. Consequently, insects are automatically turned into vectors of the active ingredient. Thus as part of an integrated program, male insects can become carriers of synthetic analogues of female-produced pheromones in a mating disruption system. The same system can be used in a lure and kill system to contaminate insect pest individuals, which later through mating, gregarious/social behaviour, and/or cannibalism, transfer the active ingredient to conspecifics. In this article, we describe parts of the initial research towards development of a system that involves a baiting station, attractants, active ingredients and adhesive powder, for control of the Mediterranean Fruit fly, *Ceratitidis capitata*.

Effects of gamma-radiation on midgut proteases of *Ceratitidis capitata* (Diptera:Tephritidae)

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The Mediterranean fruit fly or medfly, *Ceratitidis capitata* (Wiedemann), has a negative economic impact on citrus crops in Spain due to direct damage to fruits and to quarantine restrictions. Biologically based control methods, such as the Sterile Insect Technique (SIT) is gaining an increasing role in the control of medfly populations. However, gamma-radiation might damage the midgut epithelium cells, causing a lowering of nutritive assimilation and result in a short lifespan of adults. The studies of radiation effects on digestive physiology are well established for a number of insect pests, but there is no information on medfly. Our aim was to determine the effects of radiation on *C. capitata* digestive protease activity. Both larvae and adults were found to use a similar proteolytic system based on aspartyl-, trypsin-, chymotrypsin-, amino peptidase- and carboxypeptidase A- and B-like activities. Male pupae of the tsl vienna-7 strain were irradiated at 70 and 140 Gy, two days before emergence, and the adults fed during 5 days with solid diet (sugar:protein, in a ratio of 4:1). Protease activity was measured in midgut extracts and compared with males non irradiated reared in the same conditions. The results showed that the radiation doses tested do not affect the digestive proteolytic activities of the tsl vienna-7 strain.

Identification and abundance of ants (Hymenoptera: Formicidae) in Citrus trees from Valencia (Spain)

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Abstract: Ten commercial citrus plantations from Valencia (Spain) were sampled fortnightly all along the year for three years (1999 to 2001) to determine the identity, abundance and seasonal trend along the year of the ants found on the canopy of the trees. Samples were collected by aspiration with an engine-powered suction-machine and each sample came from about 8,000 leaves. From 15,983 adults, thirteen species of Formicidae were identified. The most common species, *Lasius niger* (Linnaeus), included 65% of the ants. The second species in abundance, with 21%, was *Pheidole pallidula* (Nylander). Followed in abundance *Plagiolepis pygmaea* Latreille, *Pl. schmitzii* Forel, and *Formica gerardi* Bondroit, which included altogether 11% of the ants identified. *L. niger* and *P. pallidula* showed two annual peaks between May and September. *L. niger* reached high population levels in spring and summer and *P. pallidula* mostly in summer. There was apparently a competitive displacement between the two species of ants as we found a negative correlation between their abundance in the same orchards. Positive correlations appeared between the abundance of *Ph. pallidula*, *Plagiolepis schmitzii* and *Tapinoma erraticum* Latreille. *L. niger* was associated to orchards with abundant aphid populations.

Interactions between ground cover management, hedges and aphids in lemon orchards

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Abstract: An experiment was carried out in three lemon orchards of Mafra region, in Portugal, aiming at studying the influence of ground cover management and hedges on the diversity and abundance of aphids. Three different weed management systems were considered, i.e., ground cover with resident vegetation, ground cover by sowing a selected seed mixture and herbicide application. Samples were collected from January up to November 2003 on lemon trees, ground cover vegetation and hedges both by visual observation and using “Vortis” arthropod suction sampler. A total of 1945 specimens were identified including 44 species from 28 different genera. Among these species, two were reported for the first time in Portugal, *Illinoia goldamaryae* (Knowlton) and *I. morrisoni* (Swain), and one in Continental Portugal, *Atheroides serrulatus* Haliday. From the identified aphid species, all but *Toxoptera auranti* (Boyer de Fonscolombe) and *Aphis spiraecola* Patch are non-economic important for citrus crops in Continental Portugal. *Aphis gossypii* Glover was never observed during the study. *T. auranti* was only detected on three plant species in ground cover vegetation, i.e., *Erodium moschatum*, *Senecio vulgaris* and *Trifolium campestre*, and on *Pittosporum undulatum*, in the hedges. The infestation level of aphids, mainly *T. auranti*, on lemon trees was low in all three orchards. However, the average number of aphids was higher in plots where herbicide was used compared with plots with ground cover vegetation. The possibility of exploring the interactions between aphids and ecological infrastructures, such as ground cover vegetation and hedges, to promote conservation biological control is discussed.

Developing a mating disruption tactic for pest management of citrus flower moth

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Abstract: The citrus flower moth (CFM), *Prays citri* (Millière), is a key-pest of lemon orchards in several citrus production areas including the Oeste region of Portugal. The management of CFM is actually dependent on chemical control. Up to 12 insecticide treatments may be carried each year in this region. The dependence on chemical control constitutes a major constrain to the development of IPM strategies.

Mating disruption may constitute an alternative tactic for changing the pest status of CFM, in a compatible way with IPM strategies. In order to evaluate the feasibility of using mating disruption to control the CFM in lemon orchards a project was initiated in 2002 (PO AGRO DE&D n°30), by studying the male flight activity of CFM and the dynamics of injury on flowers in 13 lemon orchards in the Oeste region of Portugal. Mating disruption experiments were carried out in 2003 and 2004, using Isonet-CFM, an experimental pheromone dispenser formulation developed by Shin-Etsu (Japan) in collaboration with CBC (Europe) and Biosani (Portugal). The results showed a clear “shutdown” effect on male captures in pheromone traps installed in mating disruption plots for both pheromone doses tested, i.e., 1000 and 2000 dispensers/ha. Further experiments are being conducted in 2005.

Molecular discrimination of Tetranychidae mite species present in citrus orchards in Eastern Spain

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Tetranychus urticae Koch (Acari: Tetranychidae) is a cosmopolitan and polyphagous mite which can be an important pest of citrus worldwide. This mite can be found feeding on many plant species occurring in the citrus agrosystem, moving freely from weeds to trees. However, high densities on cover plants do not always preclude high densities on the trees, and vice-versa, and this raises questions about the genetic structure of populations of *T. urticae* in citrus groves, and the nature of exchanges between mites from different host plants in the orchard. Because field samples consist of a mixture of different Tetranychidae species, as a first step necessary to further implement intraspecific characterization of *T. urticae*, species-discriminating criteria based on molecular techniques are needed. In this study, the nucleotide variation of the Internal Transcribed Spacer 2 (ITS2) fragment of nuclear ribosomal DNA (rDNA) of *P. citri*, *T. evansi*, *T. ludeni*, *T. turkestani*, and *T. urticae*, have been determined. The high homogeneity of the ITS2 sequence observed among the specimens of *T. urticae* obtained makes this DNA-sequence an excellent tool for species discrimination. We also tested the potential of PCR-RFLP analysis of the ITS2 for a quick screening of high numbers of field samples for species discrimination and estimation of species abundance in the different host plants.

Modified performance of *Tetranychus urticae* on NaCl-stressed citrus plants

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Tetranychus urticae is an important pest of citrus, especially lemon and mandarin under Mediterranean climate. Factors leading to this problem are poorly understood, but saline stress is suspected to contribute to spider mite outbreaks. In this study, the effect of NaCl concentration (0 to 60 mM NaCl) in nutritive solutions used to water potted young mandarin trees on population growth of *T. urticae* reared on leaf discs obtained from these plants was investigated. Although the differences observed between treated and control groups were in most cases not significant, when all biological parameters calculated were combined to obtain demographic parameters (R_0 , T and r_m), remarkable differences appeared, and a concentration-dependent effect was detected. Although high salt concentrations negatively affected *T. urticae*, at the lowest concentrations tested the r_m values were significantly higher than control and this may contribute to the observed field explosions of *T. urticae*.

Mites, lemon trees and ground cover interactions in Mafra region

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Abstract: Monthly samples were collected from April 2002 to March 2003 in three lemon orchards of Mafra (Oeste region of Portugal) aiming at identifying the species diversity and abundance of mites in both lemon trees and ground cover vegetation. Three modalities of ground cover management were installed in each of three orchards: resident vegetation, sowing of selected plant species and herbicide application. Low mite populations were observed on lemon trees, namely of the phytophagous species *Aceria sheldoni* (Ewing), *Panonychus citri* (McGregor) and *Polyphagotarsonemus latus* (Banks). Phytoseiids, especially *Amblyseius stipulatus* Athias-Henriot, and the tydeids *Orthotydeus californicus* (Banks) and *Tydeus formosus* (Cooreman) were the most common mites. The population levels of phytoseiids and tydeids on lemon trees were lower in herbicide, in comparison with both ground cover modalities. From the 208 plant species identified in ground cover vegetation, 33 were host plants of mites with agricultural interest, namely *Solanum nigrum* L., *Rubus ulmifolius* Schott, *Conyza bonariensis* (L.) Cronquist, *Lavatera cretica* L. and *Convolvulus arvensis* L. *Tetranychus* spp. and phytoseiids, especially *A. stipulatus*, were the predominant mites. Lists of phytophagous, predators and indifferent mite species associated to plant species of ground cover vegetation are given, as well as some acquisitions on the three different groups and the relationship existing between ground cover vegetation and lemon trees mite populations.

A. stipulatus, the most widespread phytoseiid mite in Portuguese citrus, was the predominant phytoseiid species found on lemon trees and ground cover vegetation in the three studied lemon orchards.

Ground cover and weed management in citrus orchards

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Abstract: Wild plants in the understories of orchards can be managed as cover crops and contribute for both weed management and enhancing biological control of pests. Aiming at understanding the potential of cover crops to promote natural enemies of citrus pests and to control weeds in citrus orchards, the influence of three systems of ground cover management on flora composition and abundance was studied in one sweet orange orchard in Algarve and in three lemon orchards in the Oeste region of Portugal (Mafra). Two modalities of cover crops, i.e., resident vegetation and sowing of selected plant species, were compared with herbicide application (diuron+ glyphosate+ terbutylazine). Sown species include *Lolium multiflorum*, *L. perenne*, *Medicago polymorpha*, *Trifolium fragiferum*, *T. incarnatum* and *T. resupinatum*, in Oeste region, and *Lolium multiflorum*, *Medicago polymorpha*, *M. scutellata*, *M. truncatula* and *T. resupinatum*, in Algarve.

Citrus phytosanitary survey project in the Comunidad Valenciana I: cultivated areas

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Following the Act 120/2004 of 16 July from the Consell de la Generalitat Valenciana, a citrus phytosanitary survey project was established on the citrus crops of the Comunidad Valenciana with two main objectives, to determine and report on the citrus pest situation along the year, and to detect new exotic pests that could arrive from abroad. A Survey Net was established with that purpose.

The Project was initiated on October 2004. The Citrus acreage from the Comunidad Valenciana was partitioned in 100 areas of 25 km² (5 x 5 km). One fixed and three mobile sampling points were established on each area. Five (for mobile points) to ten (for fixed points) trees were sampled per sampling point, with four branches observed per tree. All pests present were determined and quantified following a numeric scale from 0 to 3. Else, 10 different types of insect traps were placed on each fixed point.

Half the areas are sampled weekly, so that a complete vision of the phytosanitary situation of the orchards is obtained every two weeks. This information is placed in the web page of the Conselleria de Agricultura, Pesca y Alimentación. For each pest, a distribution or extension map and an abundance or intensity map are provided, together with a histogram with the number of orchards included in the four levels of abundance considered (from 0 to 3). Else, a short comment on the general pest situation and changes occurred in the last week is included. When an exotic species is provisionally detected, a quarantine area of 1 km and a special searching area of 3 km in all directions are established, following predefined specific protocols for each pest. If the presence of the exotic pest is confirmed, different measures are undertaken following the Sanidad Vegetal Act, as the official declaration of the new pest, application of phytosanitary measures, compulsory chemical sprays, elimination of fruits or trees, establishment of areas quarantined and compensations to the farmers.

Citrus phytosanitary survey project in the comunidad Valenciana

II: Packinghouses and commercial outbuildings

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Following the Act 120/2004 of 16 July from the Consell de la Generalitat Valenciana, a citrus phytosanitary survey project was established on citrus packinghouses and commercial outbuildings of the Comunidad Valenciana with the objective of detecting new exotic pests that could arrive from abroad. The project was initiated in July 2004.

To inspect the fruits in a packinghouse, the citrus commercial operator must report on the address of the packinghouse, design a contact person, keep the fruit isolated and not manipulated and facilitate the inspection. The fruits should be inspected in the three days following the report. Inspectors check carefully 5 fruits per box or 70 fruits per bin, thus making a total of 210 fruits per pallet. If the inspection is favourable, a certificate is issued stating that the commodity is free of exotic pests. If the inspection is unfavourable, a certificate is issued stating the quarantine organisms found and immobilizing the commodity. After confirmation of the identity of the exotic organism, fruits are disinfected, re-exported or destroyed.

Up till now 369 inspections have been carried out and 12 of them have been found contaminated with exotic pests. This represents 3.25% of the inspected commodities. The exotic organisms found were *Elsinoe* spp, *Guignardia citricarpa*, *Pseudomonas axonopodis* pv. *citri* and *Cryptophlebia leucotreta*.

Residue analysis of Azadirachtin A, the main compound of NeemAzal-T/S in/on fruits and vegetables

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Residue analysis of foodstuff like fruits and vegetables is an important issue in terms of consumer protection and therefore for registration of a plant protection product. Azadirachtin A (AZA) is the analytical lead compound which is used for clarification of the residue situation in Neem products (active ingredient: Azadirachtin). Generally the crops were treated 3 times in weekly intervals with a 0.5% NeemAzal-T/S spraying solution in water. First sampling was carried out after drying of the spray film. The concentrations of Azadirachtin A directly after application is depending on the crop. Roughly the crops can be classified into two groups: 1. Fruity vegetables and fruits, small surface to the mass ratio (e.g. tomato, apple); 2. Leafy vegetables and herbs, large surface to the mass ratio (e.g. spinach, dill).

Survey of Carabidae, Staphylinidae and Cicindelidae in soil of citrus orchards in Spain

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A survey of coleopteran species belonging to Cicindelidae, Carabidae and Staphylinidae families was conducted in four citrus orchards with different types of crop management in Valencia, Spain. Sampling was performed from August 2003 to December 2004 by using 12 pitfall traps per orchard. Traps were changed every 14 days approximately. A total of 4,121 individuals were collected. Staphylinidae was the most abundant-active family with 2,567 individuals trapped, followed by carabids with 1,380. Only 162 individuals of Cicindelidae were found. *Anotylus inustus* (Gravenhorst), *Atheta (Xenota) mucronata* Kraatz and *Platystethus cornutus* Gravenhorst, 1802 represented 82% of the total number of staphylinids recorded. *Pseudoophonus* (s.tr) *rufipes* (Degeer) and *Harpalus distinguendus* (Duftschmid) were the prevalent Carabidae species on the four orchards sampled, representing about 86% of the total individuals recorded in this group. 99% of Cicindelidae collected consisted of *Cicindela campestris* Linné.

Abundance and diversity of spiders in lemon orchards with different weed management systems

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Abstract: In 2002 and 2003, a study was carried out in three lemon orchards from Mafra, in the Oeste region of Portugal, aiming at study the abundance and taxonomic composition of spiders under three different weed management systems, i.e., ground cover with resident vegetation, ground cover by sowing selected plant species and herbicide application. A total of 3429 specimens were collected using two sampling techniques, i.e., suction and beating. All specimens were identified at the family and genus levels except when not possible (e.g., damaged specimens or some immature stages). The Linyphiidae and Salticidae specimens were not identified at the genus level due to inherent identification difficulties. The collected specimens were distributed among 43 genera and 17 families. The Linyphiidae was the dominant family (23%). Among the identified genera, *Cheiracanthium* (Miturgidae), *Araneus* (Araneidae), *Theridula* (Theridiidae), *Diaea* (Thomisidae), *Oxyopes* (Oxyopidae), *Synema* (Thomisidae), *Clubiona* (Clubionidae) and *Theridion* (Theridiidae) are considered potential predators of citrus pests. Web spiders were more abundant than hunting spiders in our samples. Spider captures in lemon trees were higher in both ground cover systems, in comparison with the herbicide application. The beating technique was more efficient than suction, for spider sampling, on lemon trees.

Natural enemies of the spider mites, *Tetranychus urticae* Koch and *Panonychus citri* (McGregor) (Acari: Tetranychidae) in Spanish citrus orchards

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The two-spotted spider mite, *Tetranychus urticae* Koch, is an important citrus pest in Spain and elsewhere in the Mediterranean areas. In the last few years, *T. urticae* has become one of the main pests in the clementines of the region of La Plana (Castellón), where more than 90% of Spanish mandarin is produced. *Panonychus citri* (McGregor) is maintained under a satisfactory control in all Spanish citrus areas by the phytoseid *Euseius stipulatus* Athias-Henriot. In contrast, predatory mites do not control *T. urticae*. As a first step to explain the inefficient biological control of *T. urticae*, a survey was carried out to compare the natural enemies related to the abundance of each mite in citrus orchards in the “Comunidad Valenciana”. A similar number of phytoseids per infested leaf was associated to both spider mites species, though the species composition of phytoseids was different. Thus, *Euseius stipulatus* was the most abundant on citrus groves infested with *P. citri*. In contrast, the abundance of *Phytoseiulus persimilis* Athias-Henriot and *Neoseiulus californicus* (McGregor) was higher on those infested with *T. urticae*. Differences on the abundance of other natural enemies were also found, being *Stethorus punctillum* Weise and *Contwenzia psociformis* Curt. the two prevalent species for both spider mites.

Quality control in *Aphytis melinus* mass rearing for the biological control of *Aonidiella aurantii**

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Abstract: Laboratory trials were conducted to test the quality of the parasitoid *Aphytis melinus* DeBach (Hymenoptera: Aphelinidae), the main bio-control agent of the California Red Scale *Aonidiella aurantii* Maskell (Homoptera: Diaspididae), reared in the insectary of the Sicilian Regional Phytosanitary Service. The trials were conducted following the guidelines of the IOBC working group “Quality control of mass reared arthropods”, under the following conditions 25±2°C, 60±10% RH, 16L:18D. The parameters analyzed were the number of adults as specified on the releasing container, the sex-ratio (100 adults from bulk material), survival in transport (1000 adults maintained at 17±2°C for 5 days in a container with honey on the lid) and fecundity (observed on 30 females placed individually in contact for 5 days with 100 specimens of *Aspidiotus nerii* Bouché (Homoptera: Diaspididae) on squash). The data on the number of adults confirmed the quantities indicated on the containers and averaged 5000 ± 500 (n= 3). The percentage of females was 70.8 ± 4.6% (n= 5) and the percentage of mortality after 5 days was 9.3 (n= 5). The mean progeny produced per single female was 39.67 ± 10.63% (n= 3).

Side effects of five acaricides on the predator *Cryptolaemus montrouzieri* (Coleoptera: Coccinellidae)

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The effects of 5 acaricides (fenazaquin, clofentezin, tebufenpirad, fenbutestan and mineral oil) on biological parameters (survival, fecundity, fertility and developmental time) of different stages of the mealybug destroyer, *Cryptolaemus montrouzieri* Mulsant (Col.: Coccinellidae), were evaluated under laboratory conditions by: (1) direct contact - topical application on larvae, pupae and adults; and (2) ingestion - feeding adult and larva with the citrus mealybug [*Planococcus citri* (Risso) (Hom.: Pseudococcidae)] previously treated by the correspondent acaricide. The five acaricides resulted harmless for adults and pupae of *C. montrouzieri*. All acaricides tested were slightly harmful to larvae of *C. montrouzieri*, except fenbutestan, which did not show any effect.

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New records of hymenopteran parasitoid species from citrus orchards in Terceira Island (Azores, Portugal)

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Abstract: Samples of parasitized aphids and scale insects were collected in different plant hosts nearby citrus orchards in three different places, in Terceira Island (Azores), namely, Biscoitos, S. Sebastião and Terra-Chã, aiming at finding plant species that can provide alternative hosts for parasitoids of citrus pests. Emerged parasitoids consisted mainly of braconids, i.e., *Lysiphlebus fabarum* (Marshall), and *Lysiphlebus testaceipes* (Cresson) from *Aphis fabae* Scopoli in *Pittosporum undulatum* and *Banksia* sp., and *Aphidius funebris* (Mackauer) from *Uroleucon sonchi* (Linnaeus), in *Sonchus* sp. One specimen of both *Aphelinus chaonia* Walker and *Microterys nietneri* (Motschulsky) from *Coccus hesperidum* in *Hedera* sp. *Scutellista obscura* emerged from *Parasaissetia nigra* (Nietner) in *P. undulatum* and also *Moranila californica* (Howard). Secondary parasitism of the pteromalid *Pachyneuron aphidis* (Bouché) was also collected from *Aphis solanella*, in *Solanum nigrum* L. These parasitoid species are reported for the first time from the Azores.

Time allocation, predation and gut capacity of eleven phenotypes of *Adalia decempunctata* L. (Col., Coccinellidae) on black citrus aphid *Toxoptera aurantii* B. (Hom., Aphididae)

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Time allocation, predation behaviour and effectiveness and gut capacity were studied in the laboratory with eleven phenotypes of the aphidophagous coccinellid *Adalia decempunctata* preying on *Toxoptera aurantii*, the most abundant aphid on citrus in Morocco. The response of the various adult phenotypes towards these parameters was assessed and discussed. The results showed that all phenotypes allocated a large portion of their time to resting. Significant differences were noted among phenotypes with respect to their time allocations to walking, resting, feeding, predation, degree of prey consumption, and grooming. The total predation rate was higher for phenotypes P1 (71.6%), P11 (70.3%), P9 (64.3%) and P4 (45.3%) than for others, and no selectivity was observed to the specifics of *T. aurantii* parts. The relative gut capacity of *A. decempunctata* is low and varied among phenotypes (0,154 10⁻³ to 0,267 10⁻³). Knowledge of the interactions of these aphidiphagous ladybirds with their prey is important for their employment as indigenous natural enemies in the context of IPM. *A. decempunctata* is an autochthonous predator of which only the P1, P11, P9 and P4 morphs could be effective against aphids, particularly *T. aurantii*. It should be released and studied on a large IPM schedule on citrus orchard.

Parasitoid complex of citrus leafminer on lemon orchards in Portugal

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Abstract: The citrus leafminer (CLM), *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae), was detected for the first time in Portugal during the summer of 1994 and rapidly dispersed throughout the citrus growing area. Since its introduction several parasitoid species have been reported including indigenous species that added CLM to their host range and, recently, exotic species, despite no classical biological control programme has been carried out in the country. During the summer of 2003, the rate of parasitism of CLM and the emerged parasitoids were studied in three lemon orchards from Mafra region, a major lemon production area, ca. 30 Km north of Lisbon. Eight parasitoid species were identified including the eulophids *Semiolacher petiolatus* (Girault) (25% of the specimens), *Pnigalio pectinicornis* L. (23%), *Cirrospilus pictus* Ness (17%), *C. vittatus* Walker (13%), *Citrostichus phyllocnistoides* (Narayanan) (12%), *C. brevis* Zhu (8%), *Neochrysocharis formosa* (Westwood) (2%) and a pteromalid, *Pteromalus* sp. (0,4%). *C. phyllocnistoides*, *N. formosa*, *P. pectinicornis* and *S. petiolatus* are reported for the first time from Portugal. Considering that *S. petiolatus* and *C. phyllocnistoides* were introduced in Spain during 1997-1999, data suggest that the presence of this two exotic parasitoid species in Mafra is the result of natural geographical expansion from Spain.

Parasitism of *Diachasmimorpha tryoni* on Mediterranean fruits infested with *Ceratitis capitata* larvae in the laboratory

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Abstract: *Diachasmimorpha tryoni* (Cameron) (Hymenoptera, Braconidae) was imported from Hawaii to the insect facilities of the Instituto Valenciano de Investigaciones Agrarias in August 2002, in order to study its use in the biological control of the Medfly *Ceratitis capitata* (Wiedemann) (Diptera, Tephritidae). Since then, it has been maintained in laboratory conditions in a successful rearing. Several experiments are being carried out in laboratory with the aim to know its potential as an effective biological control agent in the Valencian Community. One of these experiments is studying the attraction of different Mediterranean fruits infested by *C. capitata* and offered to females of the parasitoid by analyzing emergence and parasitism rates in choice and non-choice trials. In this work, loquat, plum, nectarine and apple were the selected fruits, obtaining a good parasitism in all cases. The knowledge of these biological parameters about parasitism in fruits is very interesting to determine the potential action of this species when it will be released in plots of sweet fruits and citrus of the Mediterranean area.

Laboratory experiments with *Fopius arisanus*, an exotic egg-pupal parasitoid of *Ceratitis capitata*

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Abstract: Since it was imported to the IVIA from the USDA/ARS in Hawaii (USA) in August 2002, the braconid *Fopius arisanus* (Sonan), an egg-pupal parasitoid of tephritid fruit flies, has been kept in laboratory conditions on *Ceratitis capitata* (Wiedemann) as host, with a continuous improvement of the rearing. To investigate the feasibility to use this insect in the biological control of the Medfly, several experiments were performed in laboratory to analyze their biotic potential. A methodology was developed to study adult longevity and reproduction in the parasitoid by using fruits and Petri dishes artificially infested with eggs of *C. capitata* as egg-laying units. The parasitoid produced a very high mortality on eggs offered to parasitization due to the ovipositional female attempts. Results showed that fertility in females was quite irregular and it was necessary to work with more than one couple of the parasitoid as reproductive units. More experiments are needed to analyze this behaviour.

Side effects on natural enemies of bait insecticide applications for the control of the Mediterranean fruit fly, *Ceratitis capitata* (Diptera: Tephritidae)

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Laboratory studies were performed to assess the side effect of three baited insecticides (spinosad, malathion and fenthion), used for the control of *Ceratitis capitata* (Wiedemann), on beneficial insects. The non-target species tested were four hymenopterans [*Citrostichus phyllocnistoides* (Narayanan) (Eulophidae), *Diachasmimorpha tryoni* (Cameron) (Braconidae), *Diglyphus isaea* (Walker) (Eulophidae) and *Anagyrus pseudococci* (Girault) (Encyrtidae)] and two heteropterans [(*Orius laevigatus* (Fieber) (Anthocoridae) and *Nesidiocoris tenuis* Reuter (Miridae)]. No effects of spinosad bait were observed on the mortality of the hymenopteran adults, except for *C. phyllocnistoides*, whereas the mortality induced by malathion and fenthion was significant higher (even 100%) for the four species tested. On the other hand, the surviving *C. phyllocnistoides* and *D. tryoni* adults were used to assess the effect of bait insecticide applications on the level parasitism, fecundity and developmental time of the progeny. No significant differences were recorded between the control and spinosad. In general, heteropterans were more resistant to the bait insecticides than hymenopterans, being spinosad the more friendly insecticide for both *O. laevigatus* and *N. tenuis*. The greater selectivity of spinosad compared to malathion and fenthion suggests that this product could be an alternative for the control of *C. capitata* in citrus crops.

The Mediterranean Fruit Fly *Ceratitis capitata* Wiedemann (Diptera, Tephritidae), a new pest in Montenegro

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Abstract: The Mediterranean fruit fly *Ceratitis capitata* Wiedem. was detected for the first time in October, 2000, in several mandarin orchards, in the southeastern part of Montenegrin seacoast. In the following years different host plants have been detected. Economically speaking, the most important is the mandarin (*Citrus unshiu* Marc.), which, with its several varieties, makes over 85% of Montenegrin citrus orchards. The other hosts are: the fig (*Ficus carica* L.), the kaki (*Diospyros kaki* L.), the orange (*Citrus sinensis* L.), the lemon (*Citrus limon* L.), the grapefruit (*Citrus paradisi* Macf.), and the ziziphus (*Ziziphus* spp.). Different male and female attractants were being used for population monitoring during 2003 and 2004. Monitoring covered the entire Montenegrin seacoast and showed presence of *C. capitata* in almost the whole region. Population density varied among localities. In 2003, first flies were caught in August and population reached its peak during September and October, depending on the locality. In 2004, first flies were caught in September and peak was reached at the end of October up to the middle of November. In both cases last flies were caught from the middle till the end of December. In 2003, first infestations were detected in fig fruits (end of August, beginning of September) and in the earliest mandarin varieties (middle of September). In 2004, when *C. capitata* appeared later than in the previous year, first infestations were also detected in some fig fruits (end of September and in October), but almost without symptoms on early mandarin varieties and other hosts. More serious infestations of mandarin fruits were detected on the varieties which ripe last, during November.

Influence of juvenile hormones and protein on male Caribbean fruit fly (Diptera: Tephritidae) sexual success

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Juvenile hormone levels and adult diet have important effects on the attractiveness and competitiveness of the male Caribbean fruit fly. Since the success of the Sterile Insect Technique requires the release of males that can compete in the wild, these effects are of crucial importance. Laboratory (sexual success, performance in a life time basis and sexual performance in a daily basis) and field cage experiments were conducted to compare male *Anastrepha suspensa* sexual performance when submitted to four different treatments: (A) Application of juvenile hormones (JH) and sugar and hydrolyzed protein as adult food (JH⁺/P⁺); (B) Application of JH and sugar as adult food (JH⁺/P⁻); (C) No application of JH and sugar and hydrolyzed protein as adult food (JH⁻/P⁺); and (D) No application of JH and sugar as adult food (JH⁻/P⁻). Methoprene, a synthetic juvenile hormone analog, was applied topically in the first 24 hours after adult emergence at a rate of 5µg in an acetone solution per fly. The adult diet was composed of sugar and water *ad libitum* in P⁻ treatments. In P⁺ treatments protein was added to the adult diet (mixed with sugar in a proportion of 3 parts of sugar and 1 part of protein). The insects tested were from a “semi-wild” colony, i.e. less than 2 years in domestication. Mating success among sexually mature males from the 4 treatments, in laboratory and in field cages, was observed. The percentage of matings was respectively for laboratory and field cages, in treatment A 55% and 59%, for treatment B 22% and 18%, for the treatment C 18% and 20% and for treatment D 5% and 3%. The results obtained from both the laboratory and field cage experiments, show a clear improvement of male competitiveness due to the hormone application, protein supply, and interaction of hormone and protein. At same time JH application causes an earlier maturation and protein supply a positive effect in male adult longevity. The sexual performance in a life-time basis show a positive effect of the protein diet on longevity and an better sexual performance when JH was applied. In a daily basis, treatment A males perform better and are capable in 10% of the cases to mate 3 consecutive times in the same day.

A new method to determinate TML release rate based on Thermal Desorption-Gas Chromatography-Mass Spectrometry

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Many control methods of Mediterranean fruit fly, *Ceratitidis capitata*, are based on Trimedlure (TML). It is very important to know the real TML release rates in order to assure that the dispensers are working adequately.

Our laboratory has developed a method to measure the TML release rate during a short time period based on thermal desorption and GC/MS. The dispensers are submitted to controlled air flow and temperature conditions and the released TML is adsorbed on a Tenax® trap as solid porous adsorbent. Once collected, the sample is thermally desorbed and analysed by a complete GC/MS system. An assay was carried out for two commercial dispensers. Release rates were determined for each dispenser type at several aging times.

The emission rates were related with field captures and with residual amount of TML in the dispensers quantified by solvent extraction and GC analysis. Preliminary assays showed marked differences in the amount of TML released between different types of commercial dispensers and at different aging times. The variation in release performance of commercial dispensers demonstrate the convenience of routine evaluation of them. This non-destructive method allows the quick and accurate evaluation of the current behaviour of dispensers along their useful life.

Evaluation of two trimedlure dispensers for Mediterranean fruit fly *Ceratitidis capitata* (Wiedemann) in field tests

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Trimedlure (TML) is a synthetic lure attractive to males of the Mediterranean fruit fly. The life-time of TML dispensers changes according to the type of support. This study contrasts the effectiveness of TML in two controlled-release dispensers, Aralure® (polymeric plug) and EPA-1® (mesoporous dispenser), in a field assay from April to November. Insect captures and laboratory-measured release rates and residual contents showed that polymeric plug was ineffective after three months of field exposure whereas mesoporous dispenser extended the duration of effectiveness to six months. Field-measured emission rates at temperatures until July showed linear correlation of rate with average temperature for the polymeric plug dispenser ($R^2=0,927$). On the contrary, release rate in mesoporous dispenser did not show this correlation ($R^2=0,437$). This fact demonstrates a greater sensitivity of Aralure® to temperature and explains the increase of emission in the warmest months. Residual contents and insect captures suggest a minimum value of TML release rate of about 2 mg / day to optimal attraction.

Compared efficacy assay of different systems for trapping *Ceratitidis capitata* Wied. adults

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Abstract We made an assay of trapping systems for *Ceratitidis capitata* in two Navel-Late orange groves in Malaga province (Spain). The traps tested were Tephri-Trap, Multilure, Probodelt and Easy traps. All of them were lured with trimethylamine hydrochloride, ammonium acetate and putrescine (tri-pack), which were installed together with a DDVP (toxicant) strip (Dichlorvos 20% w/w) to retain the insects inside (with the exception of the Probodelt trap, which holds its own retention means). We used three traps of each type in every grove, and weekly checked the captures from April to September 2004. Significant differences were observed among the efficacy of these traps for both male and female individuals. We got the most abundant captures with Multilure and Easy traps, followed by the Tephri-Trap. Probodelt was the least effective device, probably because of a retention problem when lured with a solid attractant.

Efficacy assay of mass killing for the control of *Ceratitidis capitata*

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Abstract We installed 100 Magnet MED traps per hectare in a 5-hectare Clementina de Nules mandarin orchard in Malaga province (Spain), lured with a sexual (trimedlure) and food (ammonium bicarbonate) attractant combination and impregnated with insecticide (lambda-cyhalothrin). In the remaining 12 hectares of the farm, *Ceratitidis capitata* was chemically controlled with malathion and proteins. The aim of this work was to compare the effects of both control systems on the *Ceratitidis capitata* adult populations and on the damages it caused to fruits. We monitored the adults with traps and took fruit samples weekly from September to November, when harvesting took place. Although the initial captures were high (20 to 35 adults per trap and day), the pest control was successful with both strategies, as the damaged fruit proportion at harvesting time was zero. When the adult captures and the proportion of damaged fruits were compared, we found no significant differences between the effect of mass killing and chemical treatment techniques.

Lethal time of toxic baits in *Ceratitis capitata* and *Anastrepha fraterculus* (Dip.: Tephritidae) in laboratory

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The use of bait sprays against fruit flies is a key component of IPM activities. Laboratory trials were conducted to measure the mortality caused by six organophosphates and two pyrethroids in insecticide baits against fruit flies. The protein BioAnastrepha® (5%) was added to all insecticides. Five females and five males of 2-4d-old medfly *Ceratitis capitata* (Wied.) and 4-5d-old South american fruit fly *Anastrepha fraterculus* (Wied.) were placed in each of ten replicate small cages. Aproximately 0.2 ml of bait was disposed through the Teflon® gutter situated on the upper third part of the cage. Evaluations of adult survival were carried out at 15, 30, 45, 60, 75, 90, 120, 150, 180 and 195 minutes after initial exposure. For medfly females, fenpropathrin (12.0 g IA/100 L) and trichlorfon (150.0 g IA/100 L) showed the lowest LT₅₀ (<5.0 min) and chlorpyrifos (96.0 g IA/100 L of water) presented the highest LT₅₀ (50.1 min). For *A. fraterculus* females, trichlorfon and dimetoato (200.0 g IA/100 L) showed the lowest LT_{50s} (7.9 and 8.8 min, respectively). The highest value (71.1 min) was obtained for ethion (100 g IA/100 L). *C. capitata* was more tolerant to malathion (200g IA/100 L), chlorpyrifos and dimethoate than *A. fraterculus*. Opposite results were found for deltamethrin (1.25g IA/100 L), ethion, trichlorfon, fenthion (50 g. IA/100 L) and fenpropathrin for which *A. fraterculus* adults were more tolerant than *C. capitata*. Except for chlorpyrifos, no differences in susceptibility between females and males were detected for all tested compounds. For chlorpyrifos, *A. fraterculus* females were slightly more susceptible than males of this species.

Comparing the efficiency of cover and mechanical bait terrestrial treatments in the control of *Ceratitis capitata*

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Ceratitis capitata (Wied.) has an important negative economic impact in Spanish citrus production. The most common method to control this pest are based on cover malathion treatments. Less aggressive alternatives like terrestrial bait treatments need to be more extended since they are less contaminant and aerial treatments are unfeasible due to high dense population in citrus growing areas. However, terrestrial bait treatments can not be performed with conventional air assisted sprayers, and currently are manually applied because they require large droplets and very low volumes.

The aim of this work is to compare the efficiency of a new machine specially designed for automatic distribution of mechanical bait treatments (20l/ha), like spintor cebo[®], against conventional practices in Spain, using malathion (1000l/ha). The efficacy of both treatments was assessed by comparing the evolution of captures in tephri-traps with tri-pack in two plots in the Valencia Region of Spain. We also estimated the amount of infested fruits at harvest time. Results showed that the efficacy of both applications was similar. Since the bait treatment was less hand labour, water and power consuming, the better efficiency of the developed machine has been proved.

First results of field trials on Bait Station Project in *Ceratitis capitata* (Wied.), in Algarve

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The objectives of this project are: the decrease of the population of *Ceratitis capitata* (Wied.) and reducing the number of chemical treatments needed to control this pest in commercial citrus orchards. The field trials started in June of 2004 in Faro and Tavira. Three kinds of traps were applied on the plots: traps with lufenuron, mass trapping and monitoring traps. The captures of *C. capitata* were controled once a week (in all traps) between June and December. This project will last for three years to achieve the proposed objectives.

Varietal influence of Citrus orange on armored scale fecundity (Homoptera: Diaspididae)

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We have studied the influence of orange citrus variety on the fecundity of three diaspidid (Homoptera, Diaspididae) species. The considered scale species were *Cornuaspis beckii* and *Parlatoria pergandii*. Twenty-seven samples were taken from two orchards, one of Navel Lanelate and another of Valencia Late. Per sample, the egg number in 30 gravid females was counted. Eggs were clasified into three categories: pre-laying, laying and hatching eggs. Three methods were undertaken to show the variety influence. 1) Two types of ANOVA, one-way (variety as factor) and two-way (variety and observation as factors). In both analyses, the factor variety was significant ($P < 0.01$) on *C. beckii*, in the laying eggs and in the sum of laying plus pre-laying eggs. 2) Only the sum of prelaying and laying eggs was considered, and the evolution of the fecundity was studied by means of the apparent increase rate of the logistic function which relates eggs.day to degrees.day. 3) As in 2, but measuring the evolution of fecundity using the parameters of a sinusoidal function for adjusting eggs.day variation to degrees.day. The last two methods did not show significant differences ($p < 0.05$) of the selected varieties on the scale fecundities.

Finally, three models for predicting the egg numbers were fitted. One of them is based on the estimation of the Weibull density function, the other two in regression and autorregressive models.

Cellophane tape with adhesive on both sides to monitor the emergence of armoured scale crawlers in Eastern Sicily lemon orchards

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Abstract: Oleander scale, *Aspidiotus nerii* Bouché (Homoptera: Diaspididae), is a cosmopolitan pest mainly spread in the Mediterranean basin. This scale insect usually has three generations *per* year. This corresponds to three waves of emergence of mobile nymphs, which can be assigned to succeeding generations. In the spring-summer 2003, 2004 and 2005 in lemon cv Femminello siracusano orchards we tested transparent cellophane tape with adhesive on both sides to monitor the emergence of first instar scales, called crawlers. The crawlers were captured on the tape as they move across a twig or branch. These tapes were used to confirm the arrival of the new generation and the beginning of crawler activity and predict when treat the Oleander scale. The first generation started in March-April. Mobile nymphs then moved towards sheltered areas of the tree, settling preferably on the underside of foliage and fruits. This generation developed in 8 to 9 weeks. A second generation then occurred in June, taking a similar amount of time to develop. Insecticide mode of action and formulation are important because the armor covers and protects all stages but the crawler and the adult male. Contact insecticides target the crawler stage, such as more selective Horticultural Mineral Oils. Care must be taken to conserve natural enemies. Populations of other pests, such as whiteflies, may increase if insecticides kill their natural enemies. Spray schedules can be determined by presence of scales in the field rather than by the calendar dates.

Survey of Resistance of the Citrus Red Scale *Aonidiella aurantii* (Homoptera: Diaspididae) to Chlorpyrifos in Spanish Citrus Orchards

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Abstract: California red scale *Aonidiella aurantii* (Maskell) is an important pest of citrus orchards in Spain. It causes cosmetic damage to the fruit resulting in downgrading in the packinghouses. Several populations of *A. aurantii* in citrus orchards from Valencia were tested for resistance to the insecticide chlorpyrifos during 2003-2004. All tests were made by bioassays. Fruits infested with first immature stages were dipped for 10 seconds in different concentrations of the chemical between 50 and 20,000 ppm of active ingredient. Mortalities were assessed after 15 days, considering dead those insects that had not developed to the second stage. The estimated CL₅₀ was used in order to compare the values of susceptibility. The results showed important differences between orchards. Susceptibility was usually correlated with the history of previous treatments made in the plot, with greater degree of resistance in orchards with more previous applications. Some plots showed a high degree of chlorpyrifos resistance, with CL₅₀ values 250 times higher than those found in the most susceptible plots.

***Planococcus citri* on ornamental Citrus plants in central Italy**

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Abstract: Research was carried out on the life cycle and population dynamics of *Planococcus citri* (Risso) in Tuscany (central Italy), at nurseries in the province of Pistoia where cultivations of potted ornamental citrus plants are very widespread. There, potted citrus are grown in greenhouses all year long or put outside during the summer. In two nurseries (Nursery 1 with plants in the greenhouse from October to May and in the open air during the summer; Nursery 2, in the greenhouse all year round) 10 shoots with 5 leaves were sampled every 2 weeks, and the males' flights were monitored by means of pheromone traps. In addition, trials were carried out, in the greenhouse and in the open air, on potted lemon trees prevalently infested by 1st instar larvae, using synthetic active ingredients having low toxicity and persistence (imidacloprid, thiamethoxam and chlorpyrifos methyl) or of natural origin (azadirachtin and *Beauveria bassiana*). Under both cultivation conditions, *P. citri* completed 4 generations, but with a much higher level of infestation in the greenhouse cultivation. In Nursery 1, the first peak of male emergence was registered at the end of May and the maximum number of males per trap was 116 in August. Instead, in Nursery 2 the flights began a month earlier, and the maximum number of males captured reached 2800/trap in June. During the year, there was the contemporary presence of all the stages for the partial overlapping of the cycles, with a prevalence of females and 1st instar larvae in the winter. Specimens of the Encyrtid parasitoid *Leptomastoides abnormis* (Grtl.) and of the Coccinellid predator *Cryptolaemus montrouzieri* (Muls.) were sporadically isolated. In the greenhouse, the product that gave the best results was the chloronicotinyl thiamethoxam (91.9% C), followed by chlorpyrifos methyl (84.8% C). Indeed, in the open air test, the latter was found to be the only efficacious a.i. (99% C). The products of natural origin, namely azadirachtin and *B. bassiana*, produced no results in either of the tests.

Investigations on population dynamics and mortality of *Phyllocnistis citrella* in western Sicily (Italy)

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Abstract: Population dynamics and mortality of *P. citrella*, and its natural enemies with parasitism levels in two different citrus orchards, sprayed and unsprayed, were investigated. The effect of host density on percentage parasitism and mortality was calculated by regression analyses. In both sites, over the 3-years period from 2002 to 2004, *P. citrella* was detected during the summer months and it was not found during the first flush. Population levels were low, never exceeding 3.0 /leaf. *P. citrella* began to increase from June in 2002 – 2003 and from July in 2004. The monthly percentage parasitism of *P. citrella* in sprayed orchard fluctuated from 0 to 19%, while in unsprayed from 0 to 30%. High mortality was found in both locations with maximum levels of 100%. No significant regression was found between CLM population and parasitism and mortality percentage. Small differences between results in two orchards were found.

Application of biorational pesticides on nursery trees against *Phyllocnistis citrella* Stainton in Sicily: the effects on different citrus species

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Abstract: In Sicily (Italy), citrus trees are cultivated in nursery conditions both for new plantation and for ornamental purposes. Since 1995, sicilian citrus nursery growers considered the citrus leafminer *Phyllocnistis citrella* Stainton [Lepidoptera: Gracillariidae] one of the most important pest in citrus nurseries, and normally about 20 chemical applications per year are conducted in order to maintain citrus leafminer populations at low level. In previous years, several biorational pesticides for the control of citrus leafminer *P. citrella* were compared for testing their compatibility with integrated pest management (IPM)-programs under nursery conditions in Sicily. Based on encouraging results, in 2002-2004, biorational pesticides were utilized, on large scale trials, for testing their effects on citrus plant growth. Repeated sprays of horticultural Narrow-Range oils and azadirachtin were applied on 4800 two-years lemon, orange, mandarin, kumquat and lime trees in replicated blocks, cultivated in protected conditions. The physiological effects on tree flushing pattern and growth was periodically monitored and compared with the presence of citrus leafminer mines. The presence of natural parasites was recorded with yellow sticky traps. On average, lemon trees resulted the most infested species compared with orange and kumquat; mandarin and lime were slightly infested. On average, the yearly mean percentage of flushing trees was greater in lemon, mandarin and orange, compared with kumquat and lime. In 2003, trunk diameter growth was reduced on kumquat. In 2002, percentage of leaf area damage, caused by *P. citrella*, was higher on lemon. The presence of Eulophid parasitoids was not excluded.

Survey of the Ants (Hymenoptera: Formicidae) in soil of citrus orchards in Spain

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A survey of the ants (Hymenoptera: Formicidae) was conducted in four citrus orchards with different types of crop management in the province of Valencia, Spain. The sampling period was extended from August 2003 to December 2004. A total of 12 pitfall traps were distributed per orchard, and they were changed around every 14 days. A total of 55,384 individuals of 13 species belonging to 12 different genera were collected. *Lasius grandis* Forel was the most abundant species with 21,472 individuals collected. *Pheidole pallidula* (Nylander) and *Linepithema humile* (Mayr.) with 16,545 and 11,275 individuals respectively, were the two following species in order of abundance-activity. These 3 species represented 89% of the total collected individuals. Data on abundance, biology, ecology and taxonomic keys for the species collected are also reported.

Thrips (Thysanoptera) associated to lemon orchards in the Oeste region of Portugal

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Abstract: Thrips were surveyed in three lemon orchards from Mafra, in the Oeste region of Portugal, each with three different weed management systems, i.e., ground cover with resident vegetation; ground cover with sowed selected plant species; and herbicide application. A total of 42 samples were collected, in 2002 and 2003, using two sampling techniques, i.e., suction and beating. Most of the collected thrips were Terebrantia (Aeolothripidae, Thripidae and Adiheterothripidae). The most abundant genera were *Pezothrips* (44%), *Aeolothrips* (30%) and *Thrips* (14%). Other identified genera include by decreasing order of abundance *Neohydatothrips*, *Melanthrips*, *Anaphothrips*, *Limothrips*, *Frankliniella*, *Rhipidothrips*, *Chirothrips*, *Heliothrips*, *Isoneurothrips*, *Scirtothrips* and *Holarthrothrips*. Four thrips species are reported for the first time from Portugal and 10 species are first records on citrus in the country, including *Pezothrips kellyanus*. Thrips diversity was apparently higher in ground cover modalities in comparison to the herbicide.

Study on Acari fauna of citrus orchards in southern Iran

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There are 8821 hectares of citrus orchards in southern Iran (Khuzestan provinces) with fruit yield of 12.1 t/ha. Since citrus trees are evergreen they need more care throughout the year. Some mites are major citrus pests in this area. Amongst them *Eotetranychus orientalis* (Klein) is the dominant phytophagous species. Its damage on leaf cause necrotic spots and finally infested leaves turn brown and fall resulting in weakness of tree. In this study in addition to this mite, we have collected some predatory mites:

Laelapidae

Hypoaspis (Hypoaspis) polyphyllae Khanjani & Ueckermann

Hypoaspis (H.) aculifer

Phytoseiidae

Kuzinellus kuzini Wainestein

Paraseilus jirofticus Daneshvar

Typhlodromus (A.) kettanehi (Dosse)

Anystidae

Anystis baccarum (L.)

Parasitidae

Parasitus consanguineus

Ascidae

Laseius youcefi McGroger

Proctolaelas sp.

Tydeidae

Tydeus caryae Khanjani & Ueckermann

Typhlodromus (A.) kettanehi (Dosse) was the dominant species in this area. Its natural efficiency was about 20%.

Population dynamics and specific composition of phytoseiid mites (Parasitiformes, Phytoseiidae) associated with lemon trees in three differently managed orchards in eastern Sicily

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Abstract: Surveys of phytoseiid mites were carried out in three lemon orchards in Sicily. The three orchards had different farm management and different environmental conditions: A) traditionally farm managed; B) organic farm managed; C) in state of neglect. The aim was to determine the specific composition of the above different types of orchards and to compare their population dynamics in order to obtain information on the influence of the different agricultural practices on the phytoseiid fauna. After two years of weekly samplings it can be assessed that no substantial differences were found in the phytoseiid specific composition among the three types of orchards. On the other hand, differences, sometimes remarkable ones, were found as far as concerns the role of the various species in the three orchards and in the various seasons. *Iphiseius degenerans* Berlese, *Amblyseius andersoni* (Chant) and *Euseius stipulatus* (Athias-Henriot) were present in the three orchards, *Typhlodromus cryptus* Athias-Henriot was found in A and B orchards, while *Cydnodromus californicus* (McGregor) was found only in orchard C. In orchard A the dominant species was *A. andersoni* (48%), followed by *I. degenerans* (44%) and *E. stipulatus* (7%). The first and the last species were present exclusively in the winter-spring period, while *I. degenerans* was the only species present in summer. On the contrary, in orchard B, the dominant species was *I. degenerans* (69%), present in all seasons, followed by *A. andersoni* and *E. stipulatus* (16 and 14% respectively). These latter ones were found exclusively in spring. In orchard C the dominant species was *E. stipulatus* (58%) mainly present in the hot seasons, followed by *I. degenerans* (38%) and *A. andersoni* (3%).

Sampling plans for *Tetranychus urticae* (Acari: Tetranychidae) for IPM decisions on Clementines in Spain

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Tetranychus urticae is a major pest in citrus. Clementine is the most affected citrus variety, where this mite can result in serious defoliation and fruit scarring. IPM requires pesticide application decisions to be based on estimations of mite density beyond the economic threshold. Several commercial Clementine groves in the provinces of Castelló and Tarragona (NE Spain) were sampled from 2001 to 2003. A total of 343 samples including random outer leaves, symptomatic leaves and fruit were taken. Because *T. urticae* showed an aggregated pattern of distribution both within and between-trees, bietapic sampling methods have been developed. These consist of a random choosing of both the primary units (trees in the orchard), and the secondary units (leaves or fruit in each tree). Furthermore, based on the precise relationships found between the different variables considered, sampling plans that combine the observation of symptomatic leaves in a ring 0.25 m² in diameter and population density on leaves have been developed.

Efficacy assay of different phytosanitary chemicals for the control of *Eutetranychus orientalis* (Klein) (Oriental Spider Mite) on Fine lemon and Valencia-Late orange crops

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Abstract: The Oriental Spider-Mite (*Eutetranychus orientalis*) is one of the most important citrus pests due to its great colonisation ability. Several phytosanitary treatments per year are usually required for its control. In this work we test the efficacy of several chemicals for controlling *Eutetranychus orientalis*. We carried out two assays between September and November 2004, one of them on a Fine lemon crop and the other on a Valencia-Late orange crop. We used the following substances: Dicofol 48%, Propargite 57%, Hexitiazox 10%, Etoxazol 11% and Fenpiroximate 5%, at the commercial doses, and also considered a non-treated area. Each assay was repeated three times, each of them with three trees per product, and we weekly revised six leaves per tree at random to evaluate the compared responses of the Oriental Spider-Mite to the different theses. All the substances tested produced an effective control on *Eutetranychus orientalis*. Nevertheless, the compared efficacy showed differences as the assay progressed: Dicofol 48% and Fenpiroximate 5% caused an early and persistent decrease by nearly 100%. Hexitiazox 10% and Etoxazol 10% showed a 95% efficacy but it was observed three weeks after the treatment. Propargite 57% showed a good early impact, but its efficacy finally decreased.

Flora of lemon and sweet orange orchards in Portugal

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Abstract: Flora surveys were carried out in lemon orchards, in the Oeste region of Portugal, in 2002, and in sweet orange orchards, in Algarve, in 2004, aiming at studying the potential of resident vegetation of citrus orchards to be managed as cover crops in order to improve biodiversity and promote natural enemies of citrus pests. The results of these surveys, including the frequency and abundance of plant species observed in both regions, are presented and discussed. The main plant species were *Anagallis arvensis*, *Arisarum vulgare*, *Beta vulgaris*, *Bromus diandrus*, *Calendula arvensis*, *Convolvulus arvensis*, *Conyza albida*, *Cynodon dactylon*, *Erodium moschatum*, *Galium aparine*, *Geranium dissectum*, *Lavatera cretica*, *Medicago polymorpha*, *Oxalis pes-caprae*, *Picris echinoides*, *Piptatherum miliaceum*, *Poa annua*, *Raphanus raphanistrum*, *Senecio vulgaris* and *Sonchus oleraceus*.

Molecular and morphological characterisation of *Colletotrichum* species involved in citrus anthracnose in Portugal

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Abstract: Three forms of anthracnose diseases of citrus caused by *Colletotrichum* spp. are recognised: the post-bloom fruit drop and the Key lime anthracnose due to *C. acutatum* and the anthracnose caused by *C. gloeosporioides*, a common postharvest pathogen. In Portugal, in the last few years, a significant percentage of the citrus production has been rejected due to chlorotic or necrotic spots, which apparently do not decrease yield or juice quality but affect market appeal, resulting in important economic losses. Anthracnose lesions associated with intact or injured rind of fruits after harvest have been important in 'Navel' oranges and 'Encore' mandarins. Lesions on leaves, shoot dieback and blossom blight leading to significant loss of flowers and young fruits have also been recorded. However, the behaviour and the relative importance of *C. acutatum* and *C. gloeosporioides* in citrus remain unknown in Portugal. The main objectives of this study were to identify the pathogen(s) associated with these symptoms and investigate the diversity of *Colletotrichum* spp. populations in citrus orchards. A total of 57 isolates from several citrus varieties were characterised by molecular and phenotypic analysis along with reference isolates. Morphological and cultural features and the use of diagnostic PCR for *C. acutatum* and *C. gloeosporioides*, based on ribosomal DNA and the β -tubulin 2 gene, revealed *C. gloeosporioides* as the main *Colletotrichum* species present on citrus in Portugal, although more isolates from other regions have to be studied. Furthermore, the use of ISSR-PCR analysis revealed a limited degree of molecular diversity among these isolates.

Distribution patterns and sampling design for “Wrinkle Rind” or “Rumple” on lemon crops

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Abstract: In autumn 2002 and 2003, samplings of “Wrinkle Rind” or “Rumple” symptoms in several lemon crops of Malaga province (Spain) were carried out to analyse the distribution of damages within the crops and within the trees, and then to design a suitable sampling method. Our results suggest different distribution patterns for the symptoms named here as type I and type II. Within the crops, Rumple type I showed an aggregate distribution, whereas type II showed a regular but nearly random distribution. Within the trees, Rumple type I was more abundant in the medium-higher branches, whereas the frequency of type II damages was greater in the medium-lower ones. Besides, the outward-facing fruits and those facing east or south showed Rumple with the highest frequency. Our analyses determined that a two-stage fruit sampling is the most precise method. For type I damage, the best primary unit is depth (outside, medium and inside position within the tree top), and for type II the best primary unit is height (high, medium and low).

Survey on the situation of citrus pest management in Mediterranean countries

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Abstract: A survey on the actual situation of citrus pest management practices, problems and constraints was carried out in Mediterranean countries based on a questionnaire sent to a list of experts in order to prepare a summary for the IOBC/WPRS meeting of the Working Group “Integrated Control in Citrus Fruit Crops” held in Lisbon, in 26th-27th September 2005. Data was collected from Algeria, Georgia, Greece, France (Corsica), Israel, Italy, Portugal, Montenegro, Morocco, Spain and Turkey. Results include statistics on IPM/IP situation and a list of pest problems and pest status.