Book of Abstracts

IOBC-WPRS Meeting of the Working Group on "Integrated Protection and Production in Viticulture"

13-17 October 2013

Ascona, Switzerland

Agroscope

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Impressum

Editing:	Research Station Agroscope www.agroscope.ch
Cover:	Agroscope
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European Meeting of the IOBC/WPRS Working Group

"Integrated Protection and Production in Viticulture"

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Sub-group "Integrated pest management: Biological – biotechnological control methods – Host plant interactions"

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Sub-group "Biology and epidemiology of pathogens, fungal, bacterial and physiological diseases, including grapevine trunk diseases – Forecast modeling"

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Acknowledgements

The meeting is generously supported by

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MUNICIPIO DEL BORGO DI ASCONA

		Hall 1		Hall 2
Monday 14 October				
8.30-9.30	Registration			
9.30-10.00	Opening Ceremony	Calonnec A., Gessler C.		
	Plenary Session	Chair: Gessler C., Kehrli P.		
10.00	Viret O.	Viticulture in Switzerland and integrated production of grape		
10.30	Baumgärtner J.	From vineyard IPM to re-thinking viticultural system study and management		
11.00 - 11.30	**Coffee break**			
11.30	Legler S.E.	Consumers' perception of sustainability in viticulture		
11.50	Haviland D.	Effects of exotic insect pests on pesticide use patterns in California table grapes: Implications for biological control		
12.10	Prevostini M.	Monitoring of Pest and Diseases: a technical Vision		
12.30-13.30	**Lunch**			
	1. The VitiMeteo forecasting system	Chair: Dubuis P-H.		
13.30	Viret O.	Historical background of VitiMeteo and its integration in viticulture		
14.00	Bleyer G.	Presentation of the VitiMeteo forecasting system		
14.30	Dubuis P-H.	VitiMeteo forecasting tools on www.agrometeo.ch		
15.00	Krause R.	Operating the VitiMeteo forecasting system – key factors to success		
15.30-16.00	**Coffee break**			
	2. Validation and institutional users	Chair: Viret O.		
16.00	Hill G.	Vitimeteo - a three-year experience in Rhineland-Palatinate		
16.20	Kast W.	Experience on the Vitimeteo-System in the German Wine Region Wuerttemberg		
16.40	Kührer E.	Experiences with the forecast model VitiMeteo (VM) in the Austrian viticulture		
	3. Need for research	Chair: Viret O.		
17.00	Kassemeyer H.H.	Expectations and requirements for effective forecasting models		
17.20	-------	Discussion on research needed to improve models		
		Technical aspects in form of 3 to 4 exhibition stand		
19.30	**Diner**			

		Hall 1		Hall 2
Tuesday 15 October				
8.30-10.00	Malavolta Carlo	Discussion: Revision of Guidelines, Policy forum		
10.00-10.30	**Coffee break**			
	Session Entomology: Mating disruption	Chair: Kehrli P., Lucchi A.	**Session Pathology: Biology**	Chair: Mugnai L., Broggini G.
10.30	Sharon R.	Mating disruption of *Planococcus ficus* is not as simple as for *Lobesia botrana* but might have additional advantages for natural enemy's efficiency	Dubuis P-H.	Susceptibility of Grape bunches to downy mildew
10.50	Lucchi A.	A ten-year research on vibrational communication in *Scaphoideus titanus*: science fiction or future prospect?	Gualandri V.	A new vine disease in Trentino: interdisciplinary approach to the study of issue. Territorial monitoring
11.10	Ioriatti C.	Assessment of mating disruption efficacy by using new prototypes of overloaded sex pheromone trap	Mugnai L.	Genetic variability of *Guignardia bidwellii*, the agent of black rot of grapevine
11.30	Hummel H. E.	Electrospun biodegradable mesofibers - a novel application in precision viticultural management of *Lobesia botrana*: Linking established technologies of pheromone communication disruption with mechanical labour saving approaches	Tisch C.	Black rot: Fungal development and putative resistance mechanisms
11.50	Carlos C.	Success of mating disruption technique against the European grapevine moth, *Lobesia botrana* (Den. & Schiff): a case-study in Douro Wine Region	Broggini G.A.L.	Quantification of endophytic *Phomopsis. viticola* in a Swiss-Italian vineyard
12.30-13.30	**Lunch**			
	Session Entomology: Lepidoptera	Chair: Lucchi A., Schwappach P.	**Session Pathology: Management and Modeling**	Chair: Calonnec A.,
13.30	Schwappach P.	The simulation model “TWickler”: stage related prediction of *Lobesia botrana* and *Eupoecilia ambiguella*	Caffi T.	Use of fuzzy control rules for decision-making about appropriate-ness of fungicide application against grape downy mildew
13.50	Varela L.	Update on the *Lobesia botrana* program in California	Calonnec A.	Modelling of powdery mildew spread over a spatially hetero-geneous growing grapevine
14.10	Verpy A.	Determining the time difference in *Lobesia botrana*'s life cycle at local scale: the example of St Emilion vineyard	Rossi V.	Large-scale application of a web-based Decision Support System for sustainable viticulture
14.30	Van Steenwyk R. A.	Control of European grapevine moth, *Lobesia botrana* (Lepidoptera: Tortricidae) under two different grape trellising systems	Calonnec A.	Impacts of plant growth and architecture on powdery mildew of grapevine and their consequences for epidemic behaviour
14.50	Bagnoli A.	Phicitin moths in Tuscan vineyards: a wine sticky delta trap for their monitoring	Reineke A.	Influence of different management practices on fungal and bacterial biota in the carpospheres of ripen-ing grape clusters (*Vitis vinifera* L.)
15.10	M. Jermini	Harmfulness of the American grape leafminer *Phyllocnistis vitegenella* on the grapevine 'Merlot' (*Vitis vinifera*)		General Discussion
15.30-17.30	**Coffee break & Poster**			
19.30	**Diner**			

		Hall 1		Hall 2
Wednesday 16 October (Morning)				
	Session Entomology: Mites and mealybugs	Chair: Hoffmann C., Duso C.	**Session Pathology: Control of diseases**	Chair: Pertot I.,
9.00	Gonçalves F.	The use of sex pheromone traps to monitor vine mealybug, *Planococcus ficus* and its main parasitoids, *Anagyrus pseudococci* in Douro Wine Region	Carlos C.	Evaluation of the efficacy of first fungicide application on the control of *Erysiphe necator* and the ascospores release on Douro Wine Region
9.20	Cocco A.	Effects of rearing host species and oviposition experience on host preference of *Leptomastix dactylopii* (Hymenoptera: Encyrtidae)	Angeli D.	Stimulation of conidial germination of the powdery mildew hyperparasite *Ampelomyces quisqualis*
9.40	Simoni S.	Long-term experiences on biological control of the yellow spider mite by phytoseiid mites (Acari: Tetranychidae, Phytoseiidae) in Tuscan vineyards	Pertot I.	*Trichoderma atroviride* SC1 can prevent infections of *Phaeoacremonium aleophilum* and *Phaeomoniella chlamydospora* on grapevine in nurseries
10.00	Hoffmann C.	Performance of mites (Acari: Typhlodromidae and Tydaeidae) on 75 different grape cultivars	Haunstein M.	Evaluation of the antagonistic potential of Trichoderma species to avoid ESCA and related trunk diseases in the field and in grapevine propagation
10.20-11.00	**Coffee break & Poster**			
	Session Entomology: *Drosophila suzukii*	Chair: Linder C., Ioriatti C.	**Session Pathology: Control of diseases II**	Chair Kassemeyer H.H.
11.00	Kehrli P.	The importance of *Drosophila suzukii* for grapevine production	Viret O.	Alexins as new antifungal compounds
11.20	Alexander S.	Occurrence of Drosophilidae in vineyards of Rhineland-Palatinate – with special focus on *Drosophila suzukii*	Bleyer K.	Ontogenetical resistance of grapes – a chance to reduce fungicide residuals in wine?
11.40	Linder C.	Susceptibility of various grape cultivars to *Drosophila suzukii* and other vinegar flies	Kortekamp A.	Penicillium on grapes – Molecular identification and secondary metabolism
12.00		Discussion	Mugnai L.	Protection of grapevine pruning wounds from fungal pathogens and reduction of leaf stripe disease incidence by a Trichoderma based product
12.30-13.30	**Lunch**			

		Hall 1		Hall 2
Wednesday 16 October (Afternoon)				
	Session: Vectors of phytoplasmas	Chair: Maixner M.,		
13.30	Maixner M.	Optimized monitoring of the Bois noir vector, *Hyalesthes obsoletus*, based on its spatiotemporal distribution		
13.50	Panassiti B.	Validation and practical use of previously developed habitat models of *Hyalesthes obsoletus*, vector of bois noir		
14.10	Rigamonti I. E.	Temporal dynamics of *Scaphoideus titanus* populations: from annual occurrence patterns to changing climate suitability assessments		
14.30	Chuche J.	Can differences in feeding behaviour between *Scaphoideus titanus* males and females be related to phytoplasma transmission efficiency?		
14.50	Gargani E.	Notes on distribution of *Scaphoideus titanus* and “flavescence dorée” phytoplasmas in Tuscany		
15.10	Strauss G.	Current research activities on *Scaphoideus titanus* and Grapevine flavescence dorée phytoplasma in Austria		
15.30-16.00	**Coffee break**			
	Plenary Session	Chair: Zahavi T., Jermini M.		
16.00	Rondot Y.	Potential of the entomopathogenic fungus *Beauveria bassiana* as an endophyte in grapevine *Vitis vinifera* plants		
16.20	Trivellone V.	Arthropods as bio-indicators in vineyard agroecosystem		
16.40	Berkett L.P.	Cold Climate Wine Grape Cultivars: A “New” Crop in the Northeast and Upper Midwest Regions of the USA		
17.00	Gessler C.	Biotechnology for a pesticide free Vineyard?		
17.20-18.30	Colonnec A.	General discussion and conclusions		
20.00	**Gala Diner**			

Thursday 17 October	
9.00	Departure for the excursion
15.00	End of the meeting

Viticulture in Switzerland and integrated production of grape

Viret O.
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Abstract: Switzerland (41'000 km^2) is mostly composed of hills and mountains with a central plateau (450–550 m elevation) and large lakes. One third of the land is covered with high mountains, the Alps, with summits up to 4'600 m elevation. Arable land represents about 10% of the surface. The viticulture area represents 15'000 hectares under alpine climate. Grapevine can only be planted according to a restricted vineyard cadastre, mostly along the lakesides facing south or in a few well exposed valleys.
Swiss viticulture is characterised by very steep vineyards, small plots (national average < 1 ha per grower), intensive labour (400-1000 h/ha/year) with high production costs and difficult mechanisation. A very large number of grape varieties are planted depending on the climate and historical background. In the Valais (Rhône river valley) for example, 5'000 ha of vines with over 40 varieties are cultivated by 20'000 growers.
In the seventies ecologically sensitive winegrowers and scientists from Agroscope ACW, developed the concept of integrated production for a sustainable viticulture, according to the definition of IOBC. In respect to the regional particularities, the general principles had to be adapted to each viticulture area. Grass-covered vineyards can easily be achieved in areas with sufficient rainfalls (Eastern and South parts: 1400 to 1800 mm rain per year), which is not the case with poor rain (Valais: <600 mm rain per year). Each canton has an office for viticulture, responsible for IP organisation. In 1993 a head-organisation, Vitiswiss, was created to represent the interests of the six regional associations. Vitiswiss is composed of a committee of viticulturists from each region and a technical commission of scientists. The technical commission is responsible for the regular upgrade of the requirements, based on new research results. This guarantees a dynamic system and a regular transfer of new technologies to practice.
Swiss IP started with the improvement of pest management by the bio-control of spider mites (*Panonychus ulmi* and *Tetranychus urticae*) with predator mites (*Typhlodromus pyri* and *Amblyseius andersoni*) and the control of grape berry moths (*Lobesia botrana* and *Eupoecilia ambiguella*) by mating disruption. The number of involved growers increased and the IP-concept affected all production steps (soil management, planting material, sprayer calibration, biodiversity, water and cover crop management, education, etc…). Today no acaricides and very few insecticides are used. This could only be achieved by applying fungicides neutral for the predators, a prerequisite included in the registration process. Forecasting systems, available on the internet (www.agrometeo.ch), represent the major progress for the control of mildews in accordance with their epidemics.
In the nineties, the economic pressure on agriculture was responsible for drastic production price reduction. Swiss government decided that financial support had to be linked to ecological durability, implementing the integrated production as reference. Vitiswiss developed basic check-lists, with the minimal requirements to obtain a financial support. A second level of higher ecological exigencies was created, giving right for the Vitiswiss certificate and the label Vinatura. Today, over 85% of the grape growing area is cultivated according to IP, as recognition of sustainability, respect of the environment and guarantee for high quality wine.

Key words: grapevine, integrated production, integrated pest management, Swiss viticulture, Vitiswiss, Vinatura, sustainability, high quality wine

From vineyard IPM to re-thinking viticultural system study and management

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Abstract: The paper deals with scientific aspects of viticultural system study and management, excluding pest control technology development and implementation, and covers the issues of *i*) early beginnings and promises of Integrated Pest Management (IPM), *ii*) uncertainties imposing limits and providing opportunities, *iii*) multidimensional aspects, *iv*) ecosystem service production, *v*) eocosocial system attributes and governance, and *vi*) integration of viticultural systems into sustainable rural development. These issues require a multidisciplinary approach to viticulture system study and management and show the utility of taking into account systems analysis and modelling, hierarchy and scale theories, socioeconomic aspects, sustainability sciences, and complexity theory. To some extent, the order of the issues reflect the historical development of viticultural system study and management; to a greater extent, however, the order reflects a view that accepts different legitimate perspectives or contexts for dealing with complex adaptive systems. The successful integration of different disciplines and scientific areas may continue to produce incremental gains in knowledge and rationalization of management procedures but appears to be unpromising to produce the leaps required to meet the challenges of modern agriculture. The re-thinking of viticultural system study and management leads to ethical reflections that point out the need to complement utilitarian by deontological and virtue moral value systems to obtain a comprehensive basis for decision-taking and actions, and postulates limits for a comprehensive commodification of good and services. Furthermore, the re-rethinking calls into question the modern denial of reality and rejects logical positivism, instrumentalism and philosophical relativism doctrines in agricultural system study and management.

Key words: pests, uncertainty, scales, ecosystem services, sustainability, ethics, philosophy of sciences

Consumers' perception of sustainability in viticulture

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Abstract: According to the Directive on the Sustainable Use of Pesticides (2009/128/EC), all Member States must create the necessary conditions for the implementation of Integrated Pest Management (IPM) by 2014. The compulsory adoption of IPM can be an occasion for the farmers to start switching towards a sustainable production, which potentially provides an added value for agricultural products and increases product competitiveness on the market. Sustainability in viticulture and wine making goes far beyond reducing pesticide use: it addresses air, water and soil quality, energy efficiency, biodiversity preservation, as well as social and economic aspects. Different market surveys showed that sustainability is a key aspect for the modern European consumers, but the sustainability concepts need to be communicated in a clear and efficient way. Vinisost.net is a project partially funded by the Emilia-Romagna Region (North Italy) aimed at giving value to the sustainable grape and wine production through a system approach, which starts form the vineyard, and ends on the bottle. Three SMEs are involved in the project: Horta S.r.l., a spin-off company of the Università Cattolica del Sacro Cuore, that develops Decision Support Systems (DSSs) for sustainable crop management; SL Design S.p.A., a company devoted to the graphical design of agro-food products; and Campana S.n.c., a grape and wine producer of the "Colli Piacentini" grapevine growing area in North Italy. The system approach involves: i) the sustainable management of the vineyard; ii) a traceability system; iii) a communication plan for the consumers; and iv) the development of intelligent bottle labels. The use of the DSS vite.net® is the basis for the sustainable management of the vineyard. The decision supports given by vite.net® are formulated on the basis of weather-driven, mechanistic models for plant growth, main grapevine pests and diseases, abiotic stresses, and pesticide use. The DSS calculates different sustainability indexes for the vineyard, which refer to the following compartments: water, air, soil, energy, biodiversity, and human health. In this work, the communication plan is shown which starts with an analysis of the consumer's perception of sustainability in the viticultural sector and of their expectations with respect to a "sustainable wine". A survey was prepared and submitted through the Internet to different audiences; hundreds of answers were obtained to date. The answers indicate that there is a high interest on sustainability, even if the concept is not completely clear for the majority of respondents. Nonetheless, responses clearly demonstrate that a guaranteed wine sustainability trademark on the bottle label would be effective in gaining the consumer's trust and that the consumers would be willing to pay more for a sustainable wine. Therefore, a specific logo was prepared meeting the consumer's expectations and a multifaceted communication plan was elaborated to emphasize on the bottle label the sustainability of the methods by which the grape has been produced and the wine has been made. A QR code enabling the consumer to access detailed information on grape production and wine making was also prepared.

Key words: sustainable viticulture, sustainable wine-making, market analysis, consumers, communication plan

Effects of exotic insect pests on pesticide use patterns in California table grapes: Implications for biological control

Haviland D.
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Abstract: California is recognized as a worldwide leader in table grape production with over 100 million boxes sold in 2012 from approximately 40,000 hectares. It is also recognized as a leader in the development of integrated pest management strategies. Through the late 1990s there were relatively few insect and mite pests of table grapes. Pests that were typically under good biological control, but sometimes required the use of pesticides, included one or more species of flower thrips, leafhoppers, *Planococcus* mealybugs, worms and spider mites. Other pests such as phylloxera, scale, twig borer, and other species of worms rarely required the use of insecticides.

Since the turn of the century integrated pest management programs have needed to adapt to the arrival of two new exotic pests. This includes the vine mealybug, *Planococcus ficus* (Signoret), and the glassy-winged sharpshooter, *Homalodisca vitripennis* (Germar). Management of each of these pests has required an increase in pesticide use. Additionally, over the past few years table grape growers have had to respond to a consumer-based phobia of spiders. In particular, growers have needed to utilize pesticides for the sole purpose of ensuring that black widow spiders, *Latrodectus mactans* Fabricius, do not inadvertently hitchhike from the field to the store shelf. The odds of this occurring are astronomically rare, but all it takes is one picture of one spider in a grape cluster on the front page of a newspaper to taint an entire industry. Growers cannot risk this negative publicity and are therefore driven to treat some spiders as pests instead of as biological control organisms.

Since 1990 California has implemented a mandatory pesticide use reporting system that requires that all farmers report pesticide use to the state. These reports are considered public information and can be obtained through the California Department of Pesticide Regulation. Analysis of pesticide use data allows researchers and government agencies to track changes in pesticide use patterns, including the ability to monitor the use of certain pesticides prior to and after the introduction of exotic pest species.

Since 2000 there has been a significant shift in the types and quantities of pesticides being used by table grape growers in the San Joaquin Valley. The introduction of vine mealybug has led to an increase in the use of chlorpyrifos before budbreak and after harvest, and in-season uses of buprofezin, multiple neonicotinoids, methomyl, and spirotetramat. Additional increases in neonicotinoid use have been caused by glassy-winged sharpshooter. For example, prior to the year 2000 imidacloprid was used primarily as a foliar treatment for leafhoppers at a use rate that averaged <80 g ai/ha; by 2011 average use rates increased to 454 g ai/ha, typically applied through the irrigation system, to control leafhoppers, mealybugs and sharpshooters.

With each change in pesticide use pattern there is a change in risk to the establishment and maintenance of biological control organisms in the vineyard. During my presentation I will use pesticide use data to describe changes in the pesticide components of table grape IPM programs and provide insights into what it means for conservation and augmentative biocontrol programs.

Key words: table grapes, pesticide use, beneficials

Monitoring of pests and diseases: a technological vision

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Abstract: The use of technology in agriculture starts from the early eighties, when in the United States the term “precision agriculture” had been coined. Initially, precision agriculture techniques were related to geolocation (Global Positioning System - GPS), with the aim of providing recommendations for an effective use of fertilizers.
Over the years, the use of technology has increased gradually up to an exponential growth, facilitated by the rapid development of the Internet.
The ability of electronic and informatics components to communicate wirelessly, the continuous miniaturization of these components, their low energy consumption and lower costs, especially in the last decade, led to an explosion of wireless devices. The use of sensors for data acquisition, storage, and the availability via Internet has led to new applications in precision agriculture, allowing a high degree of innovation. Such sensors were primarily used to collect information on soil retention in order to find the best irrigation timing. Since then, the use of IT solutions for taking decisions (Decision Support Systems - DSS) greatly expanded.
The distribution of predictive models, which describe the development of pests and diseases, has in recent years led to increasingly sophisticated DSS. And the electronic processing of data collected in the vineyards, allows real-time query about their status in relation to the risk of possible developments of diseases or predicting the development of disease-transmitting insects. This information is very useful to take adequate disease control measures.
By using DSS, wine growers, plant protection services and scouts are able to profit from a continuous dialogue with the agro-ecological system. They can operate in a controlled environment and customize their activities to the state of their vineyards.
The advantages are significant and the winemakers can optimize their resources, e.g. time, staff or the use of plant protection products, finally leading to a higher quality of grapes and wine at a lower cost. Moreover, a better environmental performance can be achieved by means of a more effective use of chemicals.
Although there is a positive trend in the use of technology in agriculture, we noted that there is still a conservative mentality, which considers the adoption of technology as a cost rather than an investment. In this paper we will propose our vision aiming at inverting such a perception. We envision a new futuristic system where wine growers and operators interact each others, sharing information and planning strategies by using proper high-tech tools and platforms with the ultimate goal of including the technologies in everyday best practices.

Key words: pests, diseases, integrated control, technology, wireless networks, DSS, prediction systems

Historical background of VitiMeteo and its integration in viticulture

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Abstract: Integrated production started in the fiftieth and was intensively developed from 1970 for viticulture at Agroscope in Switzerland. The concept leads to many progresses in reducing the use of pesticides. Durable bio-control strategies were developed and are still up to date against mites with predators and against grape berry moths using mating disruption. Despite many similar approaches to control fungal diseases, no convincing alternative to fungicides was found. Regular sprays are still needed, even in organic and biodynamic viticulture using copper and sulfur in addition to plant extracts. To minimize spray schedules for an ecological balance and to spray in accordance with the epidemiology of the fungi, reliable forecasting models are a must for all production systems.

The history on prediction of disease started 1930 for downy mildew with the incubation calendar allowing to calculate the time between the infection and the sporulation in a temperature dependent curve. Measurement instruments were manual thermometers and graduated cylinder for rain. With the development of electronics and computers in the eightieths the EPI-system (Etat Potentiel Infectieux) was designed in France. 1985 leaf wetness scriber was used and the first small weather stations appeared in Germany. At the end of the eightieths different forecasting systems to read on the field were developed, followed by the computerized model Milvit in France, integrating the EPI. In all these systems, the detailed content of the algorithms was partly kept secret and the parameters were not adaptable by the users. These models were mainly used by officials and by some growers having to invest by themselves. At the end of the ninetieth the fast oncoming of high performance computers, and especially GSM-communication and Internet allowed to work in a centralized way with large amounts of weather data.

Agrometeo, an Internet weather data platform was started in 2000 in Switzerland with the aim to make microclimatic measurement available for the users. Two years later, an expert-system for the forecast of downy mildew was designed by the State Institute of Viticulture and Enology of Freiburg (Germany), Agroscope Changins-Wädenswil and the company Geosens. The motivation of that group was to open the black boxes and to integrate the newest knowledge on the biology of the pathogens, as well as to identify the lack of knowledge in epidemiology, and to introduce new algorithms for a more accurate forecast. The open expert-system VitiMeteo (VM) was born in 2004, generating graphics and tables freely available on the Internet and managed by experts from both institutes. Control strategies against downy mildew being dependent of the shoots growth, a leaf area model was implemented and integrated in the graphs. VitiMeteo can use weather data from all kind of weather stations measuring temperature, relative humidity, rain and leaf wetness duration. All parameters can be modified by experts in accordance with particular local conditions and epidemiological observations. Five days weather forecasts at the microclimatic level are included, allowing an overview of the oncoming risks for a better management of the spraying schedule. The system is currently used in over 150’000 ha of vineyards in Europe. VM-insects simulate the phenological development of grape berry moths and a model for *Hyalestes obsoletus* was implemented in 2008. Since 2009, a powdery mildew risk index is calculated (VM-Oidium) and a black-rot forecast is in validation.

The results obtained using VitiMeteo over the last ten years in precisely conducted on farm experiments are a reduction up to 30% of the number of sprays, compared with calendar schedules from bud burst until veraison of ten sprays.

Key words: grapevine, fungal diseases, pests, forecasting system, agro-meteorology, www.agrometeo.ch, www.agrometeo.de, integrated production

Presentation of the VitiMeteo forecasting system

Bleyer G.[1], Kassemeyer H.-H.[1], Breuer M.[1], Krause R.[2], Augenstein B.[2], Viret O.[3], Dubuis P.-H.[3], Fabre A.-L.[3], Bloesch B.[3], Kehrli P.[3], Siegfried W.[4], Naef A.[4]

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Abstract: Forecasting systems are basic tools for integrated and biological plant protection. "VitiMeteo" (VM) is an extensive forecasting system for viticulture. It is a cooperative project between the State Institute of Viticulture and Enology, Freiburg (Germany), the Swiss Research Station Agroscope Changins-Wädenswil (Switzerland), and the company GEOsens, Ebringen (Germany). Basically, the system consists of data sources, a database, expert software and the presentation of data on the internet. The data flow is organized in the following steps: Weather data is stored in a database. The expert models receive the necessary parameters from the database. All expert software allows the publication of main results on the internet using graphs and tables. Core of this system is the database "Agrometeo", where all data from different weather stations and related forecast data are stored.
Over the years VitiMeteo grew step by step. “VM Plasmopara” was the first module, created in 2002; it calculates the most important steps of the life cycle of downy mildew. Next component was the growth model “VM Meteo Growth”, which was programmed in cooperation with H.-R. Schultz (HS Geisenheim). The software ”VM Oidiag”, based on work of W. Kast (LVWO Weinsberg), is a powdery mildew risk model. Other expert models are “VM Insects” and “VM Hyalesthes”. Practical applications are the calculations of the flight start of the grape berry moth and of *H. obsoletus”*. “VM Hyalesthes” is built on the works of M. Maixner (JKI Siebeldingen). The latest software is "VM Black rot”, which models the important parts of the life cycle of Black rot. The software was developed together with D. Molitor (CPR Belvaux), due to his recent work. "VM Data Graph" is an additional, valuable computer program for the visualization and validation of weather data. Linking weather forecast with all models, provided from the company meteoblue (Basel), marked a milestone in the development of the system. All expert software permits the change the important model parameters. The parameterization of the models has proved to be a main advantage in the development of the models. It allows the optimization of the models continually. In contrast to other forecasting systems, research institutions own the complete software. Therefore current research improvements will be integrated quickly. The "VitiMeteo system" is open, flexible and innovative, because research results and new models can be put into practice more quickly than before.

Key words: pests, diseases, forecasting systems, integrated control, VitiMeteo, decision support system

The VitiMeteo forecasting system – Internet website www.vitimeteo.de in Baden-Württemberg, Germany - online presentation

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Abstract: The internet has become an important information medium for the wine industry. Current decision support and forecast data are of great advantage for viticulture, in particular for plant protection. With the forecasting system "VitiMeteo" (VM) current data referring to disease infection risk are visualised twice a day on the internet and are freely available (www.vitimeteo.de).
"VM Downy Mildew" was the first model. Results were first published in 2003 for two weather stations. Over the years "VitiMeteo" grew step by step. Other models like "VM Powdery Mildew" followed. From 2008 on, all model results were published on the website www.vitimeteo.de – an important step forward. The main principle for data presentation is the same for all models: Overview on the situation of the disease risk, compiled specifically for each wine-growing region. Furthermore, the data of the models is presented for each weather station in basic and detailed expert graphics and tables. Currently, the following information is provided: "VM Downy Mildew", forecast model for downy mildew of grapevine; "VM Powdery Mildew", risk model for powdery mildew of grapevine; "VM Grape Berry Moth", temperature sum model for flight start of the grape berry moth; "VM Bois Noir", temperature sum model for flight start of *H. obsoletus*; "VM Weather Data", graphical presentation of measured and predicted weather data; "VM Meteograms", detailed weather forecast for seven days; "VM Station Overview": graphic with the locations of weather stations and their data. In order to get the most important information as quickly as possible, the free software "VM Widget" was programmed. This is a software, which displays the current graphs and tables of all models directly on the desktop. The desired information is available directly after starting the computer.
Meanwhile disease infection risk is calculated with 45 weather stations for about 26.000 hectares vineyards in various wine-growing regions from Baden-Württemberg. Twelve well-trained official advisors give recommendations in viticulture and also in the field of plant protection. In "VitiMeteo"-seminars users (advisors, winegrowers, etc.) improve their skills annually. They learn and discuss the practical application of the different models. The seminars are an important platform for the feedback, which helps to improve the models and the website. The use of www.vitimeteo.de is an important element to conduct sustainable plant protection in viticulture. The website is a daily service to the wine industry in Baden-Württemberg. More models and services are planned.

Key words: www.vitimeteo.de, www.vitimeteo.info, www.agrometeo.de, www.agrometeo.ch, pests, diseases, forecasting systems, integrated control, decision support system

VitiMeteo forecasting tools on www.agrometeo.ch

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Abstract: The use of forecasting systems, models and decision support systems (DSS) is essential to better control diseases and pests in a perspective of precision agriculture and reduction of the use of plant protection products. Agrometeo is a Swiss web platform run by Agroscope Changins-Wädenswil that provides access to decision support systems and information to improve the management of diseases and pests. It is based on a network of more than 150 weather stations. The model VitiMeteo-Plasmopara was one of the key elements in the development of Agrometeo. The Agrometeo project itself started in 2000 with the main goal to centralise weather data from microclimatic measurement units on the field. In the meantime, Agrometeo became an interactive platform including weather data, as well as sections for field crops, grapevine and fruit orchards.

The website www.agrometeo.ch was totally redesign and updated in 2013. The meteorology section provide easy access to a database containing all weather data measurements of all weather stations on hourly basis starting from 2003 for the first locations of the network. Weather graphs including five days weather forecast can be found. The grapevine section contains VitiMeteo models for downy mildew (VM-Plasmopara), powdery mildew (VM-Oidium) and grape berry moths (VM-Insects), as well as a calculation module for leaf volume adapted spraying. Model output can be found as a summarized table for a region or as detailed graphs and table for a selected location. All these information especially forecasting information and various documents on disease control strategies, allow the growers to make a decision for a treatment on an objective basis. The fruit orchard section contains forecasts for apple scab, a calculation module for leaf volume adapted spaying and a link to SOPRA for fruit orchard pests modelling. The field crop module contains no model to date but offers regularly update information on diseases and pests monitoring in the fields. In all sections useful links and documents are also available. Authorised advisers and officials can add observation or information easily. A mobile version of the website for Smartphones is under construction and will be available very soon.

Constructive suggestions of the users allow Agroscope to improve continuously the system to better meet the needs of Swiss farmers. As a consequence, the number of users of www.agrometeo.ch is increasing steadily over the years.

Key words: grapevine, downy mildew, powdery mildew, decision support system, model

Operating the VitiMeteo forecasting system – key factors to success

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Abstract: The VitiMeteo forecast system is based on extensive research work of the founding institutions *State Institute of Viticulture and Enology*, (Germany) and *Agroscope Changins-Wädenswil* (Switzerland). Over 10 years it has matured into a successful system that today is used in 8 countries on more than 300 weather stations, covering a surface of estimated 150.000 Ha of grapes.
The research institutes are owners of software and brands. GEOsens as commercial company is developing and supporting the software as well as operating it as a service. This unconventional type of partnership is one of the key success factors of VitiMeteo.
Beyond the business model there are other important aspects in making a decision support system successful. The day-to-day operation has specific technical challenges, among which reliability is the most obvious one. With 10 years of experience we can outline technical challenges of the operation as well as typical problems and the average effort to handle them.
Communication is another core aspect of the operation of a system like VitiMeteo. Models are basically mathematical expressions of biological observations. As such they produce numbers. These numbers must be visualized the right way, but even more important is the communication of context, a treatment strategy that helps integrating model output into effective action.

Key words: www.vitimeteo.de, www.vitimeteo.info, www.agrometeo.de, www.agrometeo.ch, pests, diseases, forecasting systems, integrated control, decision support system, modelling, treatment strategy

Vitimeteo - a three-year experience in Rhineland-Palatinate

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Abstract: The vitimeteo – platform and the Plasmopara precasting model was established by agricultural meteorology Rhineland-Palatinate in 2010 and replaced still existing systems, which were kept running for validation purposes. In 2011, the Oidium- model based on OIDIAG was set up, followed by an internet based spray interval calculator. Finally, a non-validated Black Rot –model came in work in June 2013. Now, data from 6 vine growing regions, based on 110 weather stations are processed in 3 hr intervals at Oppenheim and displayed as special model diagrams to the users by internet access. The information is available free for all growers, however intended to be an expert system. The experience made concerns hardware- and software based problems including trouble shooting, reliability of model prediction and feasibility for consultants and vine growers.
Bugs concerning disconnection in the output of data occurred during the vegetative season 2010-2013 on 8, 4, 5 and 4 d resp. due to hardware or provider problems. The validation of the models revealed in Vitimeteo-Plasmopara the underestimation of primary infestation in 2012. The use of OIDIAG index for the determination of spray intervals was hampered by local fungicide resistance since 2012, which caused lower efficacy on bunch attack as expected. Therefore, the listing of fungicides suitable for OIDIAG had to be revised.
Since 2011, advisors have adopted vitimeteo as the main information tool for plant protection bulletins. Growers however, only occasionally used the detailed diagrams on disease pressure and preferred instead the simplified bar indicating in green and red color the daily risk, also available for smart-phone application. Supervision, control of plausibility and replacing missing data afforded a labor demand of about 20 hrs p. week provided from skilled staff during the vegetative season.

Key words: P. viticola, E. necator, disease models, validation, internet based consulting, maintenance

Experience on the Vitimeteo-System in the German Wine Region Wuerttemberg

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Abstract: Powdery mildew (PM) was the most relevant fungus disease during the last five years in the Württemberg region. Unfortunately, in the year 2013 a lot of problems were caused additionally by the downy mildew. Pests are of minor interest since the confusion technology is broadly used in the region. The relevance of *Hyalesthes obsoletus* has been decreasing during the last three years, because vine growers radically eradicated their main host *Urtica dioica*. The Vitimeteo system offers vine growers a tool to use data of 16 state owned and 5 private owned meteorological stations, covering almost most of the wine region Württemberg. Vitimeteo-Plasmopara is broadly accepted in the Württemberg region. The main infections, sequences of incubation and time of sporulation were clearly pointed out. However, Vitimeteo-Oidium (VO) is only helpful to some extent. In Württemberg vine region the small scattered vineyards are severely influenced by the epidemic of PM in the neighboring vineyards. Using tool-1 of VO, vine growers had to make an assessment about the disease severity of the preceding year over the complete site and not on their own vineyard. This assessment caused some problems since no one was ready to tell its neighbor about the disease in his own vineyard. The 2nd OiDiag-tool is especially made for clusters of grape and integrates the ontogenetic susceptibility of this part of the plant. Gaps in the spray schedule during the period of susceptibility of clusters are the main source of PM-infected berries. Sporulating PM on berries was observed mainly during the period of decreasing susceptibility. We noticed that vine growers need some help and explanations by their advisers to avoid confusion and use Vitimeteo to its full extent.

Key words: *Plasmopara viticola, Erysiphe necator,* disease modelling, Vitimeteo, OiDiag, *Hyalesthes obsoletus*

Experiences with the forecast model VitiMeteo (VM) in the Austrian viticulture

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Abstract: In the year 2010 the forecast model VitiMeteo was tested in the Wein- und Obstbauschule Krems. Due to the satisfying results the number of test sites was gradually extended. Today 70 locations are part of the system www.vitimeteo.at and spread in those federal states of Austria, which practice viticulture: Lower Austria (62 plots), Burgenland (4 plots), Styria (4 plots). The program modules VM *Plasmopara viticola*, VM U*ncinula necator* are used in these research plots in addition to a test version of VM *Guignadia bidwellii* in some plots.
All units are allocated to the different wine growing areas; the results are accessible in www.vitimeteo.at. Organisation and technical responsibility are within Weinbauschule Krems and the system is supported by Rebschutzdienst Niederösterreich.

The metrological station of Weinbauschule Krems is situated amidst a research vineyard. Therefore it is possible to compare the infections, shown in VitiMeto, with the actual results in the field. At the same time plant protection experiments with sprayings in this vineyard are carried out which allows to verify the function of the System VitiMeteo, to observe the epidemiology of the fungus and to test the impact of fungicides. This knowledge is used directly in the advisory service for wine growers offered by Rebschutzdienst Niederösterreich.

The gained experience can be summarized as follows:

- the results are easily accessible on internet (computer or mobile phone)
- mainly used modules by wine growers: VM *Plasmopara viticola*, weather forecast as well as the model, which shows the vine growth. VM *Uncinula necator* is rarely used because there are problems with the interpretation with the actual design.
- the system provides reliable information regarding *Plasmopara viticola*
- the results of VM *Guignadia bidwellii* conform to the real occurrence (Weinbauschule Krems, 2013)
- the vine growth model conforms to the real growing situation of the vines (Weinbauschule Krems, 2013)
- the weather prediction is often not satisfactory and should definitely be improved
- the annual costs of this system are about 250€ per location

Viti Meteo can be considered as an essential key component in aimed plant protection and used by winegrowers as well as in the advisory service. This model has proven its worth in Austrian viticulture and it is hard to imagine modern viticulture without it.

Key words: pests, diseases, integrated control

Expectations and requirements for effective forecasting models

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Abstract: Forecasting models for a targeted control of plant diseases and pests are essential tools in sustainable agriculture. The purpose of such forecast models is to find the appropriated date for application of fungicides and insecticides according to the situation in field. Highest efficacy of fungicide treatments can be achieved at the beginning of an epidemic or infection cycle of a pathogen. For biological control of pests by means of pheromones or specific insect growth regulators the start of population development is the critical point. Both, conditions for beginning of an infection cycle and population development can be forecasted by models. It depends on weather conditions favoring propagation of pathogens and pests. Fungicides and insecticides application directed to first stages of the pathogen and pest development is highly effective. In this way epidemic course and population development can be stopped before yield and quality of crop is affected. Additionally, directed application contributes to the requirement that products are only applied in a dosage that is absolutely necessary. Regarding sustainability and high value for saving yield and quality, forecasting models are an essential part of modern agriculture. Hence, in the EC directive 2009/128 on sustainable use of pesticides, the implementation of forecasting models is codified.
Feasible forecasting models have to be exact and robust because vine growers rely on the system. In addition, models should be easy to handle and understandable for users. An adjusted model should be based on biological and epidemiological parameters. In particular it should take in account weather conditions driving the epidemic dynamic of diseases and population development of pests. Concerning grapevine diseases the most important biological parameters are infection process, incubation period and sporulation. All these processes are regulated by meteorological parameters such as temperature and humidity as well as photoperiod. Thanks to one century of research in phytopathology, and progress in biology and epidemiology, robust data on the influence of meteorological parameters are available. The effects on specific steps in the infection cycle and epidemic course are analyzed for the main diseases in viticulture (powdery and downy mildew). Nearly the same is true for forecasting models for pests. In general there is a relationship between weather conditions and reproduction events of pathogens and pests driving the epidemic and population development. The first steps of the reproduction of insects and mites (hatching of overwintered eggs and pupae, mating period, oviposition) as well as the migration of adults and larvae to the host plant are critical events for a directed control. These events can be determined using the temperature sum influencing the behavior of insects and mites. For mathematical specification algorithms have been prepared to develop corresponding software.
Another important step is the establishment of qualified systems in viticultural practice. That needs not only a working forecast system but also a sophisticated information transfer to the user. For this purpose, the internet is an adequate platform. For successful dissemination, establishment and a widespread use in viticultural practice, the output of a forecasting model should be presented clearly understandable and self-explanatory. A basic prerequisite for a working forecasting model is service comprising technical maintenance of facilities, administration and software update including internet presentation and training of users. If all these points are implemented, a forecast model is a highly efficient tool to realize sustainable viticulture.

Key words: Grapevine pests and diseases, forecasting models, sustainable viticulture, EC directive 2009/128 on sustainable use of pesticides

Mating disruption of *Planococcus ficus* is not as simple as for *Lobesia botrana* but might have additional advantages for natural enemy's efficiency

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Abstract: The vine mealybug *Planococcus ficus* (VMB) is a major pest in vineyards. Control methods of *P. ficus* population are based on organophosphates and neonicotinoids. However, the effectiveness of some is deteriorating and the demand for environmentally friendly control approach is growing. The VMB female is wingless and the winged adult male flies towards the female's pheromone source. Mating disruption (MD), based on the species-specific sex pheromones, is considered an efficient environmental friendly method that does not harm the natural enemies. Previous studies (e.g. Walton et al., 2006; Waterworth et al., 2011) concluded that mating disruption against VMB might effectively disrupt mate location by males. However, unlike the situation in MD for *Lobesia Botrana*, results of MD effectiveness were inconsistent.

We tested the effect of mating disruption patches dispensers (Suterra, CheckMate VMB-XL USA) method over two consecutive years on *P. ficus* population size and on the percent of infested vines in vineyards. The number of captured males in the control plots was significantly higher than in plots where mating disruption method was applied. Population density had a clear effect on the treatment efficiency. However, even when population level was high, the treatment reduction effect on the number of infested vines (from 77% to 39%) and the level of *P. ficus* on vines (from 28% to 14%) was significant in the 2nd year of application.

MD creates a pheromone saturated environment that might have other implications. One unstudied aspect of MD might be through the effects of excess sex pheromone as conceived by the VMB females. It was shown with moth species to reduce female fitness, suggesting there is a biological cost of pheromone production in females (Harari et al. 2011). In preliminary experiments in the laboratory we tested the effect of VMB pheromone on *P. ficus* females and found some hints that it affects the female fitness (mortality and offspring survival rate). Another aspect is the MD effect on the VMB natural enemies. The natural enemies, parasitoids and predators, help in decreasing *P. ficus* population and augmentation by the parasitoid *Anagyrus pseudococci* and the predator *Cryptolaemus montrouzieri* is now, in Israel, a supplement method. *A. pseudococci* have been shown to be attracted by their host sex pheromones (Franco et al., 2008). The effect of the pheromone as cue for *C. montrouzieri* was not yet shown. Using olfactometer we show that the predator *C. montrouzieri* is attracted to the mealybug pheromone.

We conclude that the mating disruption method against *P. ficus* is an effective control method when applied for two consecutive years even when the initial population level is high. We discuss the possible additive effect of the method through the pheromone influence on the VMB female and the implication of the pheromone saturated environment on the ability of the natural enemies to track the mealybugs.

Key words: *Planococcus ficus*, mating disruption, vineyards pests, mealybug, natural enemies

A ten-year research on vibrational communication in *Scaphoideus titanus*: science fiction or future prospect?

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Abstract: *Scaphoideus titanus* Ball (Hemiptera: Cicadellidae) is a feared Nearctic univoltine leafhopper, vector of Flavescence dorée phytoplasma (FD) in European vineyards. In this insect pair formation and mating are mediated by substrate-borne vibrational signals. Males call spontaneously, carrying out a specific "call and fly" behavior followed by a well-structured courtship song. Females emit signals only in response to males. Rival males compete for mating, producing a disruptive noise (DN) aimed at interrupting a duet in place between pairs.
Concurrently with the first description of this behavior, which took place at the Third European Hemiptera Congress (St. Petersburg 2004), we started thinking about how to utilize this knowledge in practice. The first step was to speculate on the use of a playback of the male DN in laboratory tests to prevent copula. The extremely positive results obtained stimulated us to take a step forward, testing a system of potted plants in plastic cages interconnected by a iron wire to simulate a vineyard trellis. A vibrational shaker prototype provided by industry (CBC Europe, Milan Branch) was applied to the wire and used to transfer DN to the plants. Virgin males and females were repeatedly released in the cages for the time of the experiment (18 hours). In this way, about 90% of pairs were disrupted up to 10 meters away from the shaker, whereas 80% of pairs mated in the non-vibrated control plants. Similar positive results were obtained by applying the system, with approximately same materials and methods, on plants of a vineyard. A further experiment, which is currently in progress, included the use of a new prototype of shaker designed to transfer DN to longer distances along the row while keeping the efficiency and the lowest possible power consumption. This is an important requirement by industry, which is concerned with developing and putting in the market an economically feasible device. In this test we found that 65% of mating disruption is still possible at 45 meters and 18 h of shaker operation are necessary to get success in 80% of cases. Some bottlenecks that have recently emerged in the field application (i.e. a reduction in system efficiency with the increase of the plant weight during the process of development and ripening of the grapes) make us think that further improvements of the device are required. Nevertheless, we hope very much that the results of this research, recently published in 5 international journals, not only affected our personal scientific rating but could represent - with the collaboration of the entire scientific community and an increasing involvement of industry - a hint for the implementation of a future system of 'low impact' pest control.

Key words: Hemiptera, Cicadellidae, Sound Communication, Disruptive Signals, Mating Disruption

Assessment of mating disruption efficacy by using new prototypes of overloaded sex pheromone traps

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Abstract: The grapevine moth *Lobesia botrana* Denis and Schifferműller (Lepidoptera,Tortricidae) is among the economically most important insects in Europe, and pheromone mating disruption (MD) has been successfully adopted to control this pest in several vine-growing areas. MD efficacy evaluation is carried out by assessing the presence of adults and larvae by monitoring and field scouting. Male captures in pheromone traps baited with 1 mg of the main sex pheromone component (E)-7,(Z)-9-dodecadienyl acetate (hereafter referred as standard) is considered the easiest way to evaluate MD efficacy. Zero capture in the traps is considered a "necessary but insufficient" indicator of effective MD. For this reason, the capture of even a few males in the same trap indicates a high risk of MD failure. The use of high-dose lures, effective for other tortricids, has not been sufficiently investigated for monitoring *L. botrana* in MD-treated vineyards. The addition of small amounts of minor components (i.e. (E,Z)-7,9-dodecadien-1-ol, (Z)-9-dodecenyl acetate, (E)-9-dodecenyl acetate and 11-dodecenyl acetate) to (E,Z)-7,9-dodecadienyl acetate (hereafter referred as 5-components) dramatically improved male attraction in a wind tunnel.
In the present study we aimed at assessing if either overloaded standard pheromone lures or addition of secondary components could improve the effectiveness of the pheromone traps as early warning tools of infestation levels that could potentially cause economic damages.
A field trial was set up in large plots (min. 4 ha) treated with either commercial (Isonet L plus - Shin Etsu CBC; Rak 2 Max - BASF) or experimental (Puffer Lb – Suterra; No Mate Lb – Syngenta; Hercon® disrupt EGVM - Hercon Environmental; Splat Lobesia - Isca Technologies) MD dispensers.
In a first experiment, 4 types of pheromone baits were tested; three doses (1 mg, 5 mg and 10 mg) of the main component of the EGVM pheromone blend (E)-7,(Z)-9-dodecadienyl acetate as well as a 5-components lure, where 1 mg of the main component was added along with the 4 minor components ratios reported to produce attraction in a wind tunnel. In a second field test, the two types of baits (standard and 5-components) were tested in two doses (1 mg and 10 mg). In both field trails, each pheromone lure was tested in 4 replications per MD treatment. The traps were installed before the start of the first flight and they were checked weekly, counting moth catches. Traps were maintained in the field until the end of the season and lures were replaced every 6 weeks. Infestation level was assessed by visual inspection of sampled grape clusters at the end of each generation. In a third field trial, the optimum ratio of the main and minor compounds was investigated by comparing three doses of the 5-component lures against the standard load. Each lure was tested in six replications in a MD plot treated with Isonet L plus as well as in an untreated control plot.
Addition of minor components did not significantly reduce the inhibition of the male catches (i.e., produce an increase in capture) in MD-treated plots compared to the standard lure at the same dose. Inhibition of male catches in MD-treated plots significantly decreased when the pheromone load of the trap bait is increased to 10 mg. Overloaded traps were more prompt in detecting male flight than the standard in MD treated plots. Indeed, when infestation level is low, overloaded traps generally (14 vs 2 in the single component lure and 12 vs 0 in the 5-components lure) captured at least a week before the standard lure. Higher efficiency in catching males and more prompt detection of the male flight come out on the side of using overloaded pheromone traps instead of the standard lure for monitoring male flight in MD.

Key words: mating disruption, monitoring, lure, pheromone traps

Electrospun biodegradable mesofibers - a novel application in precision viticultural management of *Lobesia botrana*: Linking established technologies of pheromone communication disruption with mechanical labour saving approaches

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Abstract: Among some 3 dozen known and identifiable clusters of innovative pheromone dispensers, 3 major domains may be named: Inorganic, organic, and physical- container (puffer) based substrates with programmable pheromone releasing capacity. Of those 3 domains, organic substrates are the most numerous materials known with about 2 dozen clusters of innovation. Organic mesofibers, the recently accessible cluster of our own design, occupy a prominent role because of their combined biodegradable, sustainable and renewable features and their lack of eco-toxicity and toxicity. Such nanofibers may also be mechanically deployed along with routine vineyard cultivation techniques and thus realize savings in labour and handling.
Electrospun mesofibers with fiber width of 0.5-3.5 µm, recently developed and patented both in the EU and the USA, have been found useful for mating disruption in vineyards and can claim worldwide uniqueness. Today, some 27,455 pheromone citations are listed in the database "web of science" in the English pheromone literature. By a newly developed search algorithm, only 618 “fiber-pheromone” and only 2 “mesofiber-pheromone” combinations can be found in the entire plant protection field. Those latter two citations from the years 2009 and 2011 are our own papers and prove the validity of our search algorithms for pinpointing literature sources. By expanding the search algorithm to simultaneously include the three search items “pheromone-dispensers-mating disruption”, 277 combinations could be identified from the literature as relevant for further evaluation. Among these sources, no similar publication could be discovered in more than 27.000 literature references.
Experimentally, mesofibers electrospun from a sex pheromone (*E,Z*-7,9-dodecadienylacetate) solution mixed with 66% Ecoflex® biodegradable co-polyester can disrupt male-female communication in *Lobesia* for a period of up to 7 weeks. This is enough to cover a full flight period of one of the 3 usually occurring annual generations of *Lobesia botrana*. The disruption effect nearly matches that obtained with the economically available Isonet® dispenser (positive control) from which it is statistically indistinguishable but is highly different from the untreated negative control (set at 0%).
Thus, in prospect, a combination between mesofiber treatment and vineyard cultivation measures can save treatment and management costs by combining more than one of the customarily and seasonally required treatments in the vineyard. Electrospun biodegradable mesofibers are therefore a step towards the "semi-intelligent" mechanical distribution system for precision vineyard management intensively wanted by vineyard managers.
Other insect pheromones for other key pests in horticulture are also accessible to this approach and may be combined with mesofibers.

Key words: communication disruption, Ecoflex®, (*E,Z*)-7,9-dodecadienylacetate, insect pest management, integrated control, organic mesofibers, pheromone dispenser, precision viticulture

Success of mating disruption technique against the European grapevine moth, *Lobesia botrana* (Den. & Schiff): a case-study in Douro Wine Region

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Abstract: The European grapevine moth, *Lobesia botrana* (Den & Schiff.) is the most important pest in Douro Wine Region (Portugal). In this region, this moth has, normally, three generations being the last one, the most damaging to grapes. Damages are highly variable between years, ranging from 0 to 90% of infested clusters, at harvest. The use of mating disruption, an environmentally friendly method to control this pest, has been widely recommended in IPM strategies. However, some constrains to its implementation have been identified, such as the high biotic potential of the pest, the high summer temperatures and the orography (high steepness). Moreover, the size of area under treatment is another important factor with impact on the success of this method, working better in larger and continuous extents. In fact, the landscape of this region is very fragmented, being typical wine farms characterized by a small size, often bounded by other crops, such as olive groves, and untreated natural habitats, where alternative hosts (e.g. *Daphne gnidium* L.) are common. The objective of this work was to investigate the effectiveness of the mating disruption technique against *L. botrana* in a case-study in Douro Wine Region. Moreover, it was intended to demonstrate to growers the importance of applying mating disruption on an area-wide scale. The technique has been applied in Quinta de S. Luíz (Sogevinus Fine Wines S.A.), since 2001, when an area of 4 hectares was treated, until nowadays with an extended area of 90 hectares. The technique showed to be more efficient after a long period of application, when large areas were involved and also in years of low pest population density.

Key words: mating disruption, *Lobesia botrana*, vineyard, pheromone, area

Susceptibility of grape bunches to downy mildew

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Abstract: Little is known about the changes in susceptibility of grapevine's bunches and the onset of their partial resistance to downy mildew (*Plasmopara viticola*). Grape clusters of four different genotypes, including *Vitis vinifera* cvs Chasselas and Merlot, and two interspecific grape varieties, Solaris and Divico (syn. IRAC 2091; Gamaret x Bronner) were inoculated with *P. viticola* at three developmental stages: inflorescences clearly visible (BBCH 53), end of flowering (BBCH 69) and berries pea-sized, bunches hang (BBCH 75). Samples were examined by scanning electron microscopy and synthesis of stilbenic phytoalexins was measured. At BBCH 53, zoospores germination was observed on all tested cultivars and three types of functional stomata were set up. At this stage, resistant cultivars accumulated a significant amount of toxic stilbenes, which participated to the stop the further development of downy mildew. The structural integrity of the stomata is crucial for the successful encystment and subsequent germination of zoospores of *P. viticola*. At BBCH 69 and 75, stomata are no more functional and no infection was successful. This result is consistent with the absence of stilbenes induction at these stages on resistant grapevine cultivars. The structural changes in stomata anatomy during cluster development participate to the onset of ontogenic resistance. However, under natural conditions white rot and late infections resulting in brown rot can be observed regularly. The way infections leading to brown rot happens need to be investigated and described further.

Key words: grapevine; bunch, lenticels; ontogenic resistance; stilbenes; stomata

A new vine disease in Trentino: interdisciplinary approach to the study of issue. Territorial monitoring

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Abstract: The spread of virus diseases in vineyards is often due to problems related to the production, in both quantitative and qualitative.
A new disease reported since 2004 in Trentino, is expanding from year to year affecting the most suitable wine-growing areas and most valuable varieties.
The description of this new symptom is imputable to a viral infection: on vines of Pinot gris has been noted serious manifestations of deformations and chlorotic leaf speckling, stunted growth of shoots with reduction of the canopy, poor and not uniform fruit set. Afterwards, in addition to Pinot gris, these symptoms were also found in Traminer vineyards, Pinot noir and Pinot blanc. The presence and spread of the disease is particularly relevant for the entire Italian vines and winemaking sector (nursery-Viticulture-Oenology).
Thanks to the studies conducted on samples of symptomatic plants at IVV UOS BA, has been identified the existence of a new hitherto unknown viral agent which has been provisionally given the name of Grapevine Pinot gris virus (GPGV) (Gianpetruzzi *et al.*, 2012). Currently waiting for diagnostic laboratory tests (serological and molecular) that can give rapid and reliable has been established a careful and more precise territorial monitoring, which helps us to understand the extent to which the disease is spreading. Since 2010, three different vineyards are mapped in order to follow the evolution of the disease in the field. Since 2011, according to the increase of reported cases, has prepared a plan for monitoring territorial initially "casual", from 2012, the monitoring was conducted in a systematic way in 56 different municipalities located mainly in the province of Trento. In Trentino region the vine area planted is about 10000 ha, 30% of which are planted with Pinot gris. The number of plants to be monitored has been decided on the basis of cultivated area planted to Pinot gris/Traminer of several towns.
In 2012 were checked 137547 plants: 114879 in 420 vines of Pinot gris, Traminer 20689 in 89 vineyards, Pinot noir 2179 in 10 vineyards.
The average incidence is 0.8 %, with peaks of 19 % and minimum equal to 0 %.
The 2013 monitoring is in progress and will be enhanced with the data regarding the year of planting, rootstocks and clones, in order to deepen the knowledge about the " viruses " and its spread.

Key words: GPGV, Monitoring, Pinot gris

Genetic variability of *Guignardia bidwellii*, the agent of black rot of grapevine

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Abstract: Black rot is a disease of grapevine, caused by the ascomycetous fungus *Guignardia bidwellii* producing both asexual and later sexual reproductive structures on the mummified berries. During the spring all the green parts of the vines could be affected by the disease: shoots, leaves, petioles, rachis, canes, etc. On these green organs, cankers appear on which, after a few days from infection, pycnidia of the fungus are appear. Nevertheless it is the berry infection that may cause severe economic losses, leading to the loss of the whole production. The pathogen was reported for the first time in Europe in 1885, initially in France, and it was surely introduced from North America and then spread through all the major wine-growing European regions and in the northern Italian regions. Although the pathogen was reported also in Central Italy since 1891, only all of a sudden starting in 2010 heavy damages were recorded. To find the reason of this increasing incidence, the genetic variability of the fungus was investigated using molecular techniques. ITS1-ITS2 regions, β–tubulin and calmodulin gene sequencing were employed to understand the phylogenetic relationships among the different isolates from all over the world, while the use of SSR (Short Sequence Repeat) obtained expressly for *G. bidwellii*, indicate that the genetic variability of the fungus, could be compatible with the development of a variability in the aggressiveness of some strains to grapevine.

Black rot: Fungal development and putative resistance mechanisms

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Abstract: Infections with *Phyllosticta ampelicida* (*Guignardia bidwellii*), the causal agent of black rot of grapevine, lead to increasing losses in German wine production in the last decade, especially in organic farming, where traditional varieties susceptible towards black rot are cultivated and effective chemical protection strategies are not available.
Since natural sources of resistance are limited, a new project was started in 2011 in cooperation with the Botanical Institute KIT Karlsruhe and the JKI Institute for Grapevine Breeding (Geilweilerhof) to characterise European wild grapes (*Vitis vinifera* ssp. *sylvestris*) regarding their potential resistance towards fungal pathogens and their usefulness in grapevine breeding. About 80 accessions were tested within the project. For this purpose, each genotype was inoculated with the black rot pathogen, then, fungal development and host response was analysed by light and scanning electron microscopy.
Fluorescence microscopy was used in addition to investigate the development of early infection structures of asexual conidia and hyphal growth on leaves of the susceptible variety Müller-Thurgau. These conidia need to attach tightly to the leaf surface to form a germ-tube and an appressorium that matures by incorporating melanin. Below the appressorium, a penetration peg grows through the cuticle and branched hyphae start to colonise the host tissue so that a hyphal network arises. Fungal growth is restricted to the extracellular space between the cuticle and the anticlinal walls of the epidermal cell layer. However, at about eight days post infection, short lateral branches of hyphae overgrowing parts of the periclinal cell wall can be detected.
It is well known that *Vitis* species or cultivars show different levels of resistance or susceptibility, respectively, towards black rot. As described above, cv. Müller-Thurgau is highly susceptible, whereas the varieties Börner (*Vitis riparia* x *Vitis cinerea*) and Solaris [cvs. Merzling x (Saperavi severneyi x Muscat ottonel)] are resistant. Thus, these varieties were used as controls and the resistance response was compared with that of European wild grapes, which are highly diverse and differed extremely in their response to an infection with the black rot pathogen.
An analysis of early infection events on three preselected European wild grapes revealed that conidial attachment, germination and formation of appressoria was not different compared to the fungal development on Müller-Thurgau, Börner, and Solaris. However, even though conidia were able to produce appressoria at the same level on all genotypes tested, formation of hyphae, hyphal branching, and mycelial growth was reduced on the resistant cultivars and wild grape accessions compared to the susceptible cultivar Müller-Thurgau.
First results obtained by light microscopy indicated that resistant varieties (Börner, Solaris, and some wild grape accessions) are capable to form papillae consisting of phenolic compounds and callose.

Key words: European wild grapes, *Guignardia bidwellii*, *Phyllosticta ampelicida*

Quantification of endophytic *P. viticola* in a Swiss-Italian vineyard

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Abstract: Phomopsis cane and leaf blight of grapevines is a fungal disease caused by the fungus *Phomopsis viticola*. This disease is present in several vineyards in the Canton Ticino, Southern Switzerland, and recent studies indicate that this fungus beside its parasitic life may be present in the wood as endophyte. We addressed the question if the symptoms of Phomopsis cane and leaf blight could be linked to the presence of the fungus as endophyte. For this purpose at first we evaluated two methods for the detection of endophytic *P. viticola*, either directly amplifying the fungal DNA out of crude wood extracts with specific PCR primers, or isolating the endophytes by isolation on Agar-Plates. We evaluated the phomopsis cane blight symptoms and compared to the presence of the fungus as endophyte. Detection of endophytic *P. viticola* by the two methods led to discordant results, with direct PCR method indicating presence in 28 out of 161 samples, while isolation method detected P. viticola in only 13 samples. Only 4 samples resulted positive to both tests. The presence of endophytic *P. viticola* was not correlated to the disease symptoms on the cane, as approximately one fifth of all samples, independently from the symptoms, showed endophytic presence of *P. viticola*. Further studies are necessary to survey this endophytic fungus in more vineyards and to understand if endophytic *P. viticola* may be a latent source of infection for the subsequent season.

Key words: Grape diseases, Phomopsis cane and leaf blight

The simulation model "TWickler": stage related prediction of *Lobesia botrana* and *Eupoecilia ambiguella*

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Abstract: The European grapevine moth *Lobesia botrana* (Den. & Schiff.) and the grape berry moth *Eupoecilia ambiguella* (Hübner), (Lepidoptera, Tortricidae), are one of the key pests of viticulture not only in Europe. Their control commonly relies on insecticide treatments, at least outside of areas, where mating disruption is applied. So far temperature related models are used to determine the start of moth flying in Germany and Central Europe. But there are at least four different models in use. They all have in common the calculation of particular temperature sums. Yet none of these models considers data of population dynamics, neither of *L. botrana*, nor of *E. ambiguella*. If exact and reliable information about the population dynamics of the moths are available, the effectiveness of insecticide treatments will be enhanced significantly. A prediction model that is able to estimate the right dates for relevant development stages would therefore be of great advantage.
Using the simulation model "TWickler" the effectiveness of insecticide treatments is enhanced by combining data from weather stations with data from population dynamics of earlier years that end up in forecasts concerning important biological stages of the grapevine moth, i.e. start of moth flying, of oviposition and/or begin of larvae hatching. The "TWickler" model was tested using datasets of population dynamics from several Franconian vineyards (Germany). The model simulates the population development of *L. botrana* and *E. ambiguella*. It predicts the start of flight occurrence, beginning of oviposition and first larvae-hatching. These modelled information coincided well with corresponding data monitored in the vineyards.
TWickler predicts the beginning of egg deposition and larvae hatching at the time when it was found outside in the vineyard. To achieve exact results it is important to have some information about the specific site where the simulation should be applied. The more information is available (historical data of moth flight period, population density and percentage of male and female insects) the better will be the results. This enables the farmer to apply insecticides at the right time and achieve a maximum efficacy and thus protect natural resources.

Key words: European grapevine moth, *Lobesia botrana*, grape berry moth, *Eupoecilia ambiguella*, simulation model, population dynamics, oviposition, larvae-hatching

Update on the *Lobesia botrana* program in California

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Abstract: *Lobesia botrana* (Denis & Schiffermüller), European grapevine moth, was discovered for the first time in North America towards the end of the 2009 growing season in Napa County, California. Upon confirmation of the first detection, the United States Department of Agriculture Animal and Plant Health Inspection Service established a regulatory program. To delimit the area of the infestation, the program deployed pheromone-baited traps at densities of 3 to 10 traps per km^2 in vineyards and high-risk urban areas throughout California. When 2 or more moths within 4.8 km of each other or any other life stage were detected, an 8-kilometer-radius quarantine area surrounding the find was established; the radius was decreased to 5-kilometers in 2012. Moths were detected in 11 California counties, 10 of which were regulated. The largest population was in Napa County where 100,831 moths were trapped in 2010, compared to 128 moths in the remaining counties. The treatment programs targeted all vineyard acreage within 200 m (Napa) or 1000 m (all other counties) of each detection in 2010; subsequently the treatment area was standardized to 500 m. In 2010, insecticide applications were recommended for all three generations and thereafter for the first two generations. At least one application of a conventional insecticide or two applications of an organic insecticide were timed based on degree-day accumulations (and vine phenology). Isomate Shin-Etsu pheromone dispensers were used in Napa County in 2010 through 2012 and other select counties in 2011. Mating disruption was not used in areas of California that were attempting to be released from quarantine regulations in 2011 and 2012. In 2013, mating disruption is limited to areas of Napa within 500 m of a 2012 or 2013 find, and insecticide treatments recommended for vines within 500 m of all finds from 2011-2013. In urban areas within 500 m of detection, property owners with grapevines were given the choice of flower and fruit removal or applications of *Bacillus thuringiensis* during the first two generations. All control measures in urban areas were performed by the California Department of Food and Agriculture. Areas that met the following requirements were deregulated: no moth captured during five consecutive generations; insecticide was applied to the first two larval generations; during the final two full generations mating disruption dispensers were not deployed and trapping density increased to 39 traps per km^2. Peak quarantine area of 6045 km^2 across portions of 10 California counties occurred in 2011. Four counties were deregulated in early 2012 and five additional counties were deregulated partially or in full at the end of 2012. The quarantine area in 2013 has been reduced to include most of Napa County (1434 km^2) and areas of two neighboring counties within 5 km of Napa traps that caught adult moths. As of August of 2013, traps in Napa County deployed at a density of 39 traps per km^2 of vineyard have caught 40 moths. Monitoring of vineyard acreage outside the quarantine continues without detections. Ongoing surveys of host plants cited in the literature have not identified any alternate hosts of consequence in California.

Key words: European grapevine moth, invasive pest, grape, Vitis, tortricid, berry moth

Determining the time difference in *Lobesia botrana*'s life cycle at local scale: the example of St Emilion vineyard

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Abstract: The winegrowers from the region of St Emilion and its surroundings are used to spray 1 to 2 insecticides per year to control grape moths. Insecticides must be targeted on specific stages (eggs / larvae) depending on their mode of action. Determining the optimal date for spraying is required to obtain the highest treatment efficiency. The winegrowers refer to the start of the flight to schedule the date of spraying. The beginning of the flight is established using forecasting models or by monitoring traps. These two methods permit to determine grape moth period of activity at a precise location. The information provided by this monitoring is then generalized to an entire vineyard region and is used by advisers to schedule sprayings. There is a lack of information about how *Lobesia botrana* 's flight varies at different spatial scales. The aim of this experiment was to study spatial and temporal distribution of *L. botrana* at local scale to provide precise information of flight activity to winegrowers.
Our experiment was conducted in a 12 000 ha vineyard in the surroundings of Saint Emilion. From to 2008 to 2013, a network of 240 yellow delta pheromone traps, with a framework of one trap per 40 ha, was monitored. The maximum distance between two traps was 20 km. Traps were localized every year in the same field, and were checked every week from mid-april to the beginning of September. The time difference in flight activity was studied both by variogramm analysis and by separating traps in three different zones according to their localization: the forward zone (South West (SW), the intermediate zone, and the late zone (North East (NE). In 2012 and 2013, 6 specifics fields with high grape moth population were selected within the network. A sample of 50 larvae from each field was collected at the same date. An estimation of larvae stages was done using the head capsule width method (Delbac *et al,* 2010).
Our results show a multi-annual spatial-temporal flight's pattern. There is a significant difference in the date of the catch depending on the localization of the traps. The SW zone is always the first and the NE zone is the latest. The time difference is significant considering the start of the flight or the peak of catches, however its importance changes from one year to another. During the year 2011, the time difference for the beginning of the second flight reached 9 days between the forward zone and the late zone.
The average head capsule widths measures done in 2012 and 2013 (first larvae generation) showed significant differences depending on the field localization. Samples collected in the late zone are composed of younger larvae, demonstrating that hatching did not occur at the same date in every field.
Our results show time differences in *Lobesia botrana* life's cycle at local scale that should be taken in account by advisers to schedule sprayings. These differences occur in a small region, historically know as homogenous regarding *Lobesia botrana'*s activity, and proving the importance of a better understanding of pest distribution among different spatial scales to reduce pesticide use. The similarity in flight pattern between years has great interest for modeling. In 2012 we started working on the link between these results and micro-climatic temperature conditions by adding 85 temperature sensors to our trap network.

Key words: *Lobesia botrana*, trap monitoring, spatial and temporal analysis

Control of European grapevine moth, *Lobesia botrana* (Lepidoptera: Tortricidae) under two different grape trellising systems

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Abstract: *Lobesia botrana* (Denis & Schiffermüller), European grapevine moth, was first discovered in the Napa Valley of California, USA in 2009. An eradication program was initiated in the spring of 2010 using insecticides supplemented with pheromone mating disruption. California produces over 83% of wine, raisin and table grapes in the United States with over 350,000 ha under a number of growing conditions and trellising systems. The trellising systems have a major impact on foliage development and airflow within the grape canopy. The foliage development can have an impact on insecticide penetration and fruit cluster coverage. This paper reports on the efficacy of several commonly used insecticides for control of both spring and summer generations of *L. botrana* on two trellising systems. The two trellising systems were Smart-Henry and Quadrilateral. The Smart-Henry system is a two-tier system that is highly manicured with maximum sun exposure and excellent airflow. The Quadrilateral system is a four cordon system that is minimally pruned and provides excellent shading but little airflow. All insecticides evaluated provided adequate control regardless of trellising system or generation. Mortality was significantly higher with the Smart-Henry compared to the Quadrilateral trellising system in both generations of *L. botrana*. There was greater mortality at the first generation as compared to the second generation with both trellising systems. However, there was greater difference in mortality between the first and second generations with the Quadrilateral compared to the Smart-Henry trellising system.

Key words: invasive species, pest management, chemical control, smart-henry, quadrilateral

Phicitin moths in Tuscan vineyards: a wine sticky delta trap for their monitoring

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Abstract: In Tuscany, ripening grape clusters of native and international varieties can host not only third generation larvae of *Lobesia botrana* (Denis & Schiffermüller), but also larvae of Pyralidae Phicitinae as *Cryptoblabes gnidiella* (Millière), which occurs mainly in the littoral vine growing areas, and *Ephestia unicolorella woodiella* Richards & Thomson, largely present in the most internal viticulture zones, including the renowned districts of the "Chianti Classico" and "Brunello di Montalcino" wine production areas. While for *C. gnidiella* adult monitoring is carried out since the Eighties by specific pheromone traps, for *E. unicolorella woodiella* no synthetic pheromone is available to date and a monitoring device is still lacking.
The detection of adults of *E. unicolorella woodiella* and other phicitins in wine pots and sticky experimental traps used for *L. botrana* monitoring in mating disrupted vineyards in 2012, has led us to develop a prototype trap baited with a blend of red wine and water, with the aim to collect information about the phycitin moth flight in the vineyard. For this purpose, in the current year we have modified the CBC ShinEtsu Pheromone IsoTrap (Model IT 400) in such a way to host on the sticky basal surface a handmade wine evaporator. The challenge was and still is to make a device with an acceptable compromise among simplicity of management, efficacy, and mechanical selectivity. Although the trap needs to be improved, especially with regard to the selectivity, we think that it is able to provide useful information about the distribution and biology of *E. unicolorella woodiella* and other phiticins in the vineyard. Recent observations confirmed the relationship between the beginning of ripening phenological stage and the beginning of catches in our device.

Key words: Pyralidae, grapevine, biology, ethology

Harmfulness of the American grape leafminer *Phyllocnistis vitegenella* on the grapevine 'Merlot' (*Vitis vinifera*)

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Abstract: *Phyllocnistis vitegenella* Clemens (Lepidoptera: Gracillariidae), a grape leafminer originally from North America, was first found in Europe in the 1995 in the viticulture areas of north-east of Italy. In Switzerland, the damages were observed for the first time in 2009 in the Ticino (south part of Switzerland).
The impact of *P. vitegenella* leaf damage on the plant growth, gas exchange and yield was analysed during 2011 under field conditions in a vineyard located in the south of Switzerland and characterised by a high adult density in 2010.
The results showed that: *i*) the leafminer presented three generations with an important increase of population and damaged leaves between August and September in correspondence with the third generation. In this period, the leaves of the lateral shots were more infected than the ones of the main shoot, thus at harvest, 29% of the lateral leaves presented mines in comparison with only the 8% of the main leaves; *ii*) the number of mines per leaf was very variable, but the damaged leaves of the lateral shoots presented, in average, a maximum of 4 mines/leave; *iii*) a high correlation between the number of mines per leaf and the amount of destroyed tissues was found; *iv*) damaged tissues of infected leaves did not reduce the total photosynthetic activity of a leave in comparison with healthy leaves; *v*) at harvest the total damaged leaf area was 10.5% in comparison with the 4.0% of the control plants; *vi*) there was no evidence that mines influenced plant growth as well as yield quantity and quality.
These results show that *P. vitigenella* does neither affect the growth nor the yield on the grapevine Merlot in Southern Switzerland. The loss of the assimilating leaf area caused by *P. vitigenella* does not induce any economic damage and the application of control measures are, at this moment, not necessary.

Key words: pests, photosynthesis, growth, yield, fruit quantity and quality

Use of fuzzy control rules for decision-making about appropriateness of fungicide application against grape downy mildew

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Abstract: IPM (Integrated Pest Management) is based on dynamic processes and requires careful and detailed organisation and management of farm activities at strategic, tactical, and operational levels. IPM works only if all the decision makers (owners, directors, and employees) are in a position to select the most appropriate measures and to ensure that plant protection is done following the IPM principles and with consideration of all possible interactions and consequences of any intervention. Because the decision-making process in modern agriculture has increased in complexity, farmers must invest time in management, business planning, identification of required skills, and training to ensure that the correct crop management operations are selected. This means that they must have access to detailed, factual and up-to-date information. Recently, a decision-support system (DSS), named vite.net®, was developed for sustainable management of the vineyard. Part of the DSS is devoted to support the farmer in taking decision about downy mildew management: mechanistic, weather-driven, dynamic models provide information and 4-day forecasts about: (i) the main events of the primary and secondary infection cycles of *Plasmopara viticola*; (ii) the growth stages of vines and the leaf emission rate; and (iii) the depletion of previous fungicide applications and the residual protection they provide. Usually, expert farmers and advisors take into consideration all the above factors at the same time in order to decide about applying a fungicide or not. To mimic the expert's reasoning, fuzzy control rules were implemented in the DSS to provide a measure of the degree of suitability of each alternative decision (i.e., the degree of suitability of applying or not a fungicide against *P. viticola*) with respect to a set of criteria presented by linguistic rules capturing the available knowledge. The performances of the fuzzy control rules implemented in vite.net® were evaluated for their ability to support fungicide scheduling under different epidemiological conditions and disease pressures (i.e., vineyards from North, Centre or South Italy, in different seasons). The results obtained so far are encouraging. During the most critical periods for downy mildew management, the fuzzy system always advised for preserving fungicide protection, while the fuzzy system suggested to save applications when there was no or low risk of infection.

The research was partially funded by the European Union's Seventh Framework Programme managed by REA-Research Executive Agency http://ec.europa.eu/research/rea ([FP7/2007-2013] [FP7/2007-2011]) under grant agreement n° [262059].

Key words: *Plasmopara viticola,* Decision Support Systems, decision-making process, fuzzy control, Integrated Pest Management

Modelling of powdery mildew spread over a spatially heterogeneous growing grapevine

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Abstract: A PDE-ODE model was developed to describe the spread of powdery mildew on grapevine at the plot scale. The model was able to retrieve the main characteristics of the system: 1) a crop growing during the whole season with time evolution in susceptibility, 2) a crop highly structured in rows with potential heterogeneities of plant growth and susceptibility within and between plots. Simulations were performed to test the effect of spatial heterogeneities within and between plots, on powdery mildew spread. Heterogeneities considered were the vine vigour, phenology between areas, susceptibility (susceptible vs. resistant, treated vs. untreated) and spatial arrangements (patches vs. rows).

Key words: pests, diseases, integrated control

Large-scale application of a web-based Decision Support System for sustainable viticulture

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Abstract: A new Decision Support System (DSS), named vite.net®, was developed for sustainable management of vineyards and is intended for the vineyard manager (the person who makes decisions about the vineyard management or suggests the proper actions to the grape-grower). The DSS has two main parts: (i) an integrated system for real-time monitoring of the vineyard components (air, soil, plants, pests, and diseases); and (ii) a web-based tool that analyses these data by using advanced modelling techniques and then provides up-to-date information for managing the vineyard in the form of alerts and decision supports. The information is tailored to a vineyard, or part of a vineyard, or a number of vineyards that are uniformly managed throughout the season. In the design and development of vite.net®, the so-called 'problem of implementation' which frequently leads to under-utilization of the DSSs was specifically addressed by different solutions, including involving potential users. During the development of the DSS, selected end-users (i.e., leading grape-growers and advisors belonging to grower associations) in Europe have contributed to seminars and participated in visits to demonstration vineyards. Involving the end-users in these activities: (i) enabled researchers to obtain information about how the end-users usually make decisions and manage the vineyard, e.g., it clarified criteria and methods used by end-users and time needed to make decisions concerning vineyard management; (ii) demonstrated to end-users how vite.net® works and its potential advantages; (iii) facilitated the collection of end-user opinion on the usability of the DSS compared to their standard methods and tools; and (iv) provided information on end-user willingness to pay for and use the DSS. Twenty-one organic farmers were involved in the large-scale evaluation phase of the DSS, i.e., they participated as testers. Most of the testers consulted the DSS regularly, and most increased their use over the season; none stopped using or reduced their use of the DSS. Concerning the effect of the DSS on the decision-making process, about one-half of the testers reported a reduction in the time spent making decisions, and most indicated that decision making was made easier (and was better supported by an understanding of the underlying biological processes) by use of the DSS. All the testers declared that the use of DSS improved their decisions. DSS alarms and decision supports were evaluated as user-friendly, explicit and easy to understand. All the testers indicated that they wanted to continue using the DSS and that they were willing to pay an annual fee. The DSS vite.net® has been commercially available since January 2013. It is currently used in about 3000 ha of vineyards across Italy. Statistics about the use of the DSS by these growers based on their access to the web portal of vite.net® as well as the feedback collected during the regular contacts with the growers suggested that the 'implementation problem' had been solved by the solutions used for development and delivery of the DSS to end-users.

The research was partially funded by the European Union's Seventh Framework Programme managed by REA-Research Executive Agency http://ec.europa.eu/research/rea ([FP7/2007-2013] [FP7/2007-2011]) under grant agreements n° [262059] and n° [311775].

Key words: decision-making, implementation problem, co-innovation, commercial use

Impacts of plant growth and architecture on powdery mildew of grapevine and their consequences for epidemic behaviour

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Abstract: The definition of an epidemic "a change in disease intensity in a host population over time and space" emphasizes the fact that epidemics are dynamic processes with variable disease rates. How many of those disease rate changes are triggered by the host population is an ongoing issue. Epidemics are driven by the proportion of susceptible tissue, the disease transmission rate, and the infectious period duration therefore any modification in the host population, whether quantitative or qualitative (distribution of plants or of susceptible organs), can have an impact on the epidemic dynamics.
For grapevine, significant changes in growth and architecture can be generated by cultural practices. Some of those practices act on exogenous factors; that is the case for irrigation, fertilisation, root-stock and low density of plantation, which have a positive effect on primary growth and ramification. In contrast, cover-cropping has a negative effect due to root competition for water and nutrients. Practices such as shoot pruning, topping, thinning and training will have an effect on endogenous factors modifying plant ramification and reiteration, thereby effecting the balance of young vs. older leaves, but also effecting exogenous factors, such as light distribution through an indirect effect on leaf density. The production of new organs continuously modifies two aspects: the plant or canopy porosity, as well as the plant's level of susceptibility when organ susceptibility changes with age (ontogenic resistance). Spatial heterogeneity in the host population can also be generated by differences in phenology (variety, pruning) or plant growth rate (soil variation, vigour, rootstock...). There is evidence that those variations within host populations do impact disease incidence, severity or spread for many pathogen such as powdery mildew. Tracking back the impacted pathogen processes from the global dynamics of an epidemic, and then ranking the host traits involved in their modifications, constitutes a challenge (Calonnec *et al.*, 2013).
As part of a project ANR 'Archidemio' (ANR-08-STRA-04), we tested whether one could act on the epidemic dynamics by changing the vine vigour and if one could quantify the contribution of the two mechanisms: the dynamics of appearance of susceptible organs and the changes of tissues susceptibility. A plot consisted of two susceptible varieties (Merlot and Cabernet Sauvignon), three rootstocks (Riparia So4 and 110R) and two areas (cover-crop and weed control) was used to generate varying levels of vigour. This plot was monitored over time to characterize the plants growth and physiology and the disease dynamic and shoots were taken out to quantify *in vitro* the intrinsic susceptibility of tissues.
We can conclude that a high level of vigour by generating a large amount of secondary leaves, as soon as flowering stage, explains the higher level of disease. A low vigour has no direct impact on the susceptible tissue but reduces the production of susceptible organs at a given time. Measurement of sugar is an indirect marker of ontogenetic resistance and of their transition from 'sink' to 'source' corresponding to their loss of susceptibility. Detailed results will be presented at the workshop.

Key words: Canopy structure, disease transmission, ontogenic resistance, vigour, powdery mildew

Influence of different management practices on fungal and bacterial biota in the carpospheres of ripening grape clusters (*Vitis vinifera* L.)

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Abstract: Bunch rot of grapes represents one of the most important fungal diseases in Central European viticulture and is caused by a complex interplay of the ascomycete *Botrytis cinerea* as well as several other fungal and bacterial species. As putative fungal or bacterial antagonists present on the grape carposphere as well, might be relevant for outbreak, extent and progression of bunch rot epidemics, a focus of this study was to analyse the composition of microbial communities on ripening grape berries and how these communities are influenced by different plant protection strategies in viticulture.
Grape clusters (*Vitis vinifera* L. cv. Riesling) were collected in 2010 and 2011 during the ripening period on three sampling dates (BBCH 81 – beginning of ripening, BBCH 85 – softening of berries and BBCH 89 – berries ripe for harvest) from one vineyard located in the German grapevine growing region Rheingau (49°59'N, 7°57'E). This experimental vineyard contains plots, which have been cultivated according to three different management systems (integrated, organic and biodynamic) for the last six years.
Total microorganisms from the berry skin surface were washed off and DNA was isolated. High-throughput tag-encoded FLX amplicon pyrosequencing of an ITS fragment and bacterial 16S rDNA fragment was used to characterize fungal and bacterial communities on grape berry skins. By sequencing about 46,000 bacterial and 98,000 fungal amplicons, more than twelve different fungal and 26 bacterial taxa, respectively, could be identified.
The four most abundant fungal genera or species present on the grape carposphere in both years were *Sclerotinia sp.* (anamorph *Botrytis cinerea*), *Alternaria alternata*, *Cladosporium sp.* and the putative fungal antagonist *Aureobasidium pullulans*. Statistical analysis showed that there was no significant effect of the management practices on abundance of these fungi except for *A. alternata* at the first sampling date (BBCH 81).
Presence of the five most abundant bacterial genera (*Sphingomonas*, *Pseudomonas*, *Erwinia*, *Gluconobacter* and *Massilia*) was significantly different between the two years of sampling with a higher abundance at BBCH 89 in samples from 2011. In addition, abundance of *Pseudomonas* sp. was significantly influenced by the management practice applied in the respective plots.
A detailed knowledge about the functional and structural diversity of the microbial community of berry skin surfaces is a relevant basis to promote indigenous antagonists in a stable microbial community with the aim to suppress bunch rot of grapes. Considering the recent effects of climate change on the extent of bunch rot epidemics, such an approach might be an important tool of future pest control programs in viticulture.

Key words: bunch rot, pyrosequencing, metagenomics, microbial diversity, biological control agents

The use of sex pheromone traps to monitor vine mealybug, *Planococcus ficus* and its main parasitoids, *Anagyrus pseudococci* in Douro Wine Region

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Abstract: The vine mealybug, *Planococcus ficus* (Signoret) (Homoptera: Pseudococcidae) has becoming an increasingly important pest of some vineyards of Douro Wine Region (Portugal). The presence of this insect can, under high pest pressure, and after repeated annual infestations, cause the vine decay, not only due to their direct feeding activity, but also due to the excretion of carbohydrate-rich honeydew, which can accumulate on the leaves and grape clusters and which is a good substrate for the development of sooty mold fungi. In order to better understand the population dynamics of this insect, as well as to improve pest control strategies, a study is carried out in two wine farms from Douro Wine Region. During 2013, the flight curve of *P. ficus* males was obtained using pheromone traps baited with the synthetic female sex pheromone ((S)-lavandulyl senecioate). Moreover, the attraction of the females of its main parasitoid, *Anagyrus pseudococci* (Hymenoptera: Encyrtidae) to these traps was also investigated. The first captures of *P. ficus* occurred in mid-May, however, captures increased from the end of July onwards with a peak of captures in mid-August. The females of *A. pseudococci* also showed to be attracted to the sex pheromone of *P. ficus*, with the first captures occurring in mid-April. *A. pseudococci* captures increased also from the end of July onwards in synchrony with its host. The use of pheromone traps baited with the synthetic female sex has been widely recommended in IPM monitoring programs as they are good indicators of pest population density and trap counts can even be used to predict grape damage.

Key words: mealybugs, *Planococcus ficus* vineyard, pheromone, *Anagyrus pseudococci*

Effects of rearing host species and oviposition experience on host preference of *Leptomastix dactylopii* (Hymenoptera: Encyrtidae)

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Abstract: The koinobiont endoparasitoid *Leptomastix dactylopii* Howard (Hymenoptera: Encyrtidae) has been widely used as a biological control agent of the citrus mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae), in citrus orchards and ornamental greenhouses. Previous studies showed that also the vine mealybug, *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae), was a suitable host for the complete development of the parasitoid. In the current experiment, the preference of *L. dactylopii* for the two hosts was investigated in a two-choice test. Newly-emerged parasitoid females, reared on one of the two mealybug species, were mated and exposed to third-instar nymphs and young adult females of both *P. ficus* and *P. citri* in an experimental arena. In order to investigate the influence of a previous oviposition experience on the host preference, the experimental wasps were naïve (inexperienced) or had oviposition experience with one of the two hosts before the release in the test arena. The foraging behavior of female wasps was observed for 30 minutes. *Leptomastix dactylopii* females reared on *P. ficus* showed a strong preference for vine mealybugs, irrespective of the oviposition experience, while those reared on *P. citri* did not show a clear preference. The oviposition experience before the two-choice test did not affect the percentage of *P. ficus* encountered and examined by parasitoids; on the other hand, *L. dactylopii* females experienced on *P. ficus* probed and laid eggs preferentially on vine mealybugs. During the test, *L. dactylopii* females were observed feeding on mealybug fluids exuding from oviposition wounds (host-feeding), although rearing host species and oviposition experience did not affect the wasp behaviour. Further experiments on host-parasitoid interactions under field conditions are being developed in order to verify the effectiveness of *L. dactylopii* in controlling *P. ficus* infestations in vineyard agroecosystems.

Key words: vine mealybug, citrus mealybug, two-choice test, host feeding

Long-term experiences on biological control of the yellow spider mite by phytoseiid mites (Acari: Tetranychidae, Phytoseiidae) in Tuscan vineyards

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Abstract: Infestations of the yellow spider mite *Eotetranychus carpini* (Oud.) (Tetranychidae), have increased during recent years in conventional and IPM as well as organic vineyards in high quality wine producing areas of central-southern Tuscany (‘Brunello of Montalcino‘ ,‘Col d’Orcia‘, Siena). We report results and evidences acquired over an eight years of monitoring and experiment, attempting to re-establish/consolidate populations of mite predators, phytoseiids *in primis*, in these vineyards, in order to achieve biological control of the yellow spider mite. The results derive from more than 40 vineyards monitored for at least 2 years; the most studied wine grape variety was ‘Sangiovese‘ (about 70% of the vineyards), followed by ‘Petit Verdot‘, ‘Cabernet Franc‘ and ‘Merlot‘. First, research was investigating the components and interactions of the natural enemy community affecting density of spider mites in these vineyards. Preliminary results confirmed that multiple applications of sulfur for disease management, in combination to other factors, tend to increase incidence and severity of spider mite problems by inhibiting the function of phytoseiids. The action and efficiency of three generalist phytoseiids were compared: a commercialized strain of *Neoseiulus californicus* (McGregor), a laboratory strain of *Typhlodromus exhilaratus* Ragusa and a wild strain of *Kampimodromus aberrans* (Oud.). In the following, the control of yellow spider mite was more expensive and difficult in the vineyards where *T. exhilaratus* and *N. californicus* were released; on the contrary, *K. aberrans* colonized uniformly the vineyard, lowered efficiently the infestation of yellow spider mite and settled down permanently in host vineyards in the years following the phytoseiid introduction; the most aged experiences last up to six years. Data are reported and discussed on: a) the adaptation and persistence of *K. aberrans* to varying environmental conditions; b) its tolerance to some pesticides and bio insecticides; c) its susceptibility to cumulative effect of sulphur impact and d) its competitiveness towards other phytoseiid species.

Key words: *Kampimodromus aberrans*, *Eotetranychus carpini*, diseases, biological control

Performance of mites (Acari: Typhlodromidae and Tydaeidae) on 75 different grape cultivars

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Abstract: During the years 2010-2012 population dynamics of mites where studied in an international collection of 75 grape varieties planted in a single vineyard at the JKI- Institute for Plant Protection in Fruit Crops and Viticulture in Siebeldingen / Germany. The idea of the trial was to understand the population dynamics and functional biodiversity of mites in vineyards with regard to an eventual use as indicators to measure the sustainability of individual growing systems (in the context of agro environmental subsidies). The varieties were sampled four times a year (June, August, September and October) by collecting 25 leaves each. Mite density was determined according to the washing method by HILL & SCHLAMP (1984).
Taking random samples and making microscopic slides over the years and varieties we found the following species of Typhlodromidae on grapevine leaves (n= 200): *Typhlodromus pyri* (96%), *Euseius finlandicus* (2,5 %), *Anthoseius rhenanus* (1,0%), *Paraseiulus soleiger* (0,5%). From the family Tydeidae (n=40) only one species, *Orthotydeus götzi*, was found. As Spider-, Eriophyid- and Tydeid mites occurred only on a low level and diseases were well under uniform control we suppose that food for predatory mites mostly consisted of pollen and fungi. We observed *Typhlodromus pyri* as well as *Orthotydeus götzi* in the laboratory feeding on Downy- (*Plasmopara viticola*) or Powdery Mildew (*Erysiphe necator*).
Different types of population dynamics as well as different densities of *T. pyri* were found on the grape varieties. There was no relation between leaf area and mite abundance. DUSO (1992) supposed that leaf hairiness is a factor that can enhance *T. pyri* populations. To quantify the phenomenon we used modified OIV descriptors as described in Hoffmann & Michl (2011) and found a relation between the density of the prostrate hairs (= wooly hairs) and the number of *Typhlodromus pyri*. Using cluster analysis (JMP 9, SAS Institute, 2010) we found no correlation between hairiness and the diverse types of population dynamics. Therefore, further descriptors are probably necessary to analyze, which factors are crucial for the population size of *T. pyri*. *Orthotydeus götzi*, the only occurring tydeid mite showed no relation to hairiness and its distribution was clustered within the vineyard.
In addition we tested if the leaf surface area was related to the abundance of *T. pyri* per leaf. The total leaf surface was estimated for each cultivar by multiplying the mean number of leafs per m^2 of the canopy (4 replicates), with the mean leaf size. There was no correlation between leaf size and the number of leafs per m^2, but the total leaf-surface varied between varieties.
In conclusion, the comparative population dynamics of *T. pyri* on different grape varieties is still not fully understood.

Key words: *Typhlodromus pyri*, leaf structure, hairiness, OIV descriptors

The importance of *Drosophila suzukii* for grapevine production

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Abstract: The spotted-wing drosophila, *Drosophila suzukii*, is a vinegar fly native to Asia that has recently been introduced to Europe. Unlike most other vinegar flies, *D. suzukii* females lay their eggs thanks to their serrated ovipositor in healthy fruits. Besides berries and stone fruits, table and wine grapevine production might also be at risk, since the pests' development in grapes has already been reported. However, the economic importance of *D. suzukii* for grape production is still unclear and debated. In the framework of Euphresco we assessed the threat that *D. suzukii* poses to European vineyards in 2012 by an electronic questionnaire. We received 21 responses from 14 different regions that covered about 10% of Europe's viticultural area. At eight locations the population of Drosophilidae consisted of an assemblage of native species and *D. suzukii*, but *D. suzukii* dominated nowhere the vinegar fly community. Although *D. suzukii* was present, it did not cause any major damages to table and wine grapes in 2012. Moreover, its management was based on sanitation measures and winegrowers renounced almost completely from the use of insecticides. Most respondents considered the potential of *D. suzukii* as an important viticultural pest therefore as low to medium. This is in contrast with respondents' assessment of the situation in other late-maturing crops such as raspberry, blackberry and blueberry. Thus, at present *D. suzukii* is considered as a minor pest of table and wine grapes in Europe; however, time will tell if this first assessment is accurate or if this new pest can nevertheless cause major damages in vineyards.

Key words: *Drosophila suzukii*, *Vitis vinifera*, integrated pest management, monitoring, pest control measures, information flow

Occurrence of Drosophilidae in vineyards of Rhineland-Palatinate – with special focus on *Drosophila suzukii*

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Abstract: In recent years vinegar flies (Diptera: Drosophilidae) became an increasing problem in German vineyards, especially her best-known member *Drosophila melanogaster* (Meigen 1830). The flies are attracted by the smell of injured fermenting grapes, caused by acetic bacteria (Gluconobacter, Acetobacter). With their densely setaceous body, they contribute to dissemination of spores of many microorganisms (e.g. Botrytis, Penicillium) from infected to healthy grapes. A short generation time (~10 days at 25 ° C) and high reproduction rates make it difficult to combat the pest.
In 2011, a new drosophilid species was first reported for Germany - the cherry vinegar fly *Drosophila suzukii* (Matsumura 1931), an invasive pest with high risk potential, which originally comes from South East Asia. Unlike their domestic relatives the spotted wing drosophila attacks healthy ripening fruits. The female flies posses a heavily sclerotized, serrated ovipositor to lay their eggs directly into unwounded fruits. This polyphagous species uses many plants (especially soft-skinned, red berries) as hosts for their reproduction.
In 2012, a monitoring was started at the Agricultural Service Centre Palatinate (Neustadt an der Weinstraße) to observe the occurrence, phenology and migration of *D. suzukii* in Rhineland-Palatinate.
Additionally in various laboratory bioassays insecticides and repellents were tested against different developmental stages of vinegar flies. First results of these studies are presented.

Key words: *Drosophila suzukii*, monitoring, pest control

Susceptibility of various grape cultivars to *Drosophila suzukii* and other vinegar flies

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Abstract: In 2011, the spotted-wing drosophila *Drosophila suzukii* native to Asia has been identified for the first time in Switzerland. Since then this vinegar fly has established itself all over the country and it has also been observed in many vineyards. It has been reported that *D. suzukii* is able with its long, sharp, serrated ovipositor to attack healthy grapes just before vintage and that the level of infestation depends on the grape cultivar. It is assumed that in particular red and thin-skinned cultivars are at higher risk. Our laboratory studies confirmed that *D. suzukii* was able to lay eggs within grape berries. However, none of the eggs laid at the beginning of grape ripening allowed the development of adults. In subsequent tests, oviposition was highest on the red and thin-skinned cultivars Bondoletta and Gamay followed by the red cultivars Pinot Noir and Divico, and the two white cultivars Müller-Thurgau and Chasselas. Yet, the development of adults remained very low and did not exceed 9% of eggs deposited, which is much less than on an artificial diet. These results confirm the lesser attractiveness of white compared to red grape cultivars and the importance of the thickness of skin. Although we were not able to directly relate the number of eggs laid with the sugar content of berries, we hypothesize that the latter plays an important role in the success of larval development and partly explains the differences observed in the proportion of emergence of adults over the season. Moreover, preliminary experiments indicate that grape infestation by *D. suzukii* may favor the development of other Drosophilidae by hurting the skin and providing an “entrance door” for native vinegar flies as well as grey mold and sour rot.
Overall, our various observations confirm that grapes can be damaged by *D. suzukii*, but they are probably not very suitable for the development of adults and the buildup of large pest populations. Nonetheless, it is not excluded that *D. suzukii* enhances the infestation of grapes by native vinegar flies and pathogens and its development in vineyards should therefore be examined.

Key words: Drosophilidae, preference, viticulture

Evaluation of the efficacy of first fungicide application on the control of *Erysiphe necator* and the ascospores release on Douro Wine Region

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Abstract: Powdery mildew (*Erysiphe necator*) is the most harmful disease of grapevines in Douro region, inducing a decrease in yield, as well as on the quality of the wine.
An experiment was conducted in the Douro Wine Region (Portugal), in a field plot located at Cima Corgo, with the *CV* Tinta Roriz (Tempranillo), the second variety most used in Douro, and very sensitive to powdery mildew. The vines of the study were grown in two rows terraces. During the phenological stage dormant bud, on beginning of March, the ascospores release started to be monitored using glass microscope slides placed in three vines, one per plant. The slides were replaced always after the occurrence of some rain. The temperature data (˚C), relative humidity (%) and rainfall (mm) during these periods were also recorded in order to verify the period of greatest ascospores release to do a better position of the first spraying.
The experimental design consisted in four treatments arranged in a randomized block design with four replicates; each plot had 14 vines (10 evaluated). The treatments consist in **T1 -** (control) with any spray applied; **T2 -** three fungicide sprays applied before blooming: the first spray was at two to three leaves unfolded, the second at inflorescence clearly visible and the third at inflorescence fully developed; **T3 -** the fungicide spray started at inflorescence fully developed, which is the common practice in Douro, and the second spray was at pre-blooming and **T 4 -** the spraying started only at pre-blooming with a DMI. After blooming, all the treatments (T1, T2, T3 and T4), with exception of the control, were sprayed at the same time with the same product.
The severity of powdery mildew was assessed in grapes and leaves, based on the scale of OEPP (1981), in all plots in three different periods. The average weight of bunches (PM), the number of bunches per vine (NC) and the production per vine (kg / vine) was evaluated. Moreover, the pruning buds and the buds evolved were counted, and the pruning wood of each vine was weighed to compare the effect of vigor of plants on the intensity of powdery mildew.
The preliminary results reveal significant differences to the control, but no difference was observed between the treatments T2, T3 and T4. This shows that, nevertheless the event of ascospores release initiate early; the beginning of development of disease only starts close to blooming. It is necessary to develop further studies on the powdery mildew control strategies, and confirm the results here obtained in years with different climate conditions.
We can then say that the disease might be controlled as effectively with a smaller number of treatments, positioning the first time only in pre-flowering. The reduction on the number of treatments (even if only one) can contribute significantly to improving the environment, in particular, through the reduction of residues on grapes, with effective benefits to public-health, the reduction of soil compaction, and pollution of atmosphere, saving costs of the treatment itself (product, labor, machine application and fuel).

Key words: Douro Wine Region, fungicides, grapevine, powdery mildew

Stimulation of conidial germination of the powdery mildew hyperparasite *Ampelomyces quisqualis*

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Abstract: Pycnidial fungi belonging to the genus *Ampelomyces* are the most widespread natural antagonists of powdery mildew and they are unique in their ability to actively infect and kill the causal agents of this disease (*Erysiphales*). The level of biological control of *A. quisqualis* is often inconsistent under field conditions. This research has focused on novel approaches to improve biological control of *A. quisqualis*. A major focus of our research is optimizing nutritional conditions to produce conidia that germinate rapidly. We studied the role of external factors affecting the physiological processes of the mycoparasitic fungus. Conidial germination in most filamentous fungi requires the presence of low-molecular mass nutrients, such as sugars, amino acids and inorganics salts. Condia of *A. quisqualis* germinate poorly in the absence of any exogenous nutrients in the environment, most probably because they do not possess sufficient endogenous reserves to sustain initial growth of germ-tube. Conidia must be supplied with one or more exogenous nutrients to induce germination and growth. We measured the effect of different chitin based compounds on the hyphal growth and conidia germination of *A. quisqualis*. Furthermore, we investigate on the germination process at the molecular level by the quantification of the expression level of genes playing a role in the early signal-transduction events.

Key words: *Erysiphales*, biocontrol, mycoparasitism, conidial germination

Trichoderma atroviride SC1 can prevent infections of *Phaeoacremonium aleophilum* and *Phaeomoniella chlamydospora* on grapevine in nurseries

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Abstract: Esca is a destructive wood disease of grapevine (*Vitis vinifera* L.) worldwide. Several microorganisms are associated with the disease. However *Phaeoacremonium aleophilum* (Pal) and *Phaeomoniella chlamydospora* (Pch) are frequently isolated from wood of plants showing esca symptoms and are responsible for the vascular disorder. Esca is commonly a major problem in old vineyards, even if young esca can be increasingly noticed on young newly planted vineyards. In this case infection may take place already during propagation of the plants in nurseries. Plant colonization by these two microorganisms is supposed to take place from the wounds, which are created during the preparation of the new plants. Chemical treatments are ineffective against the disease and the efficacy of hot water treatments of dormant cuttings to eradicate or even reduce populations of the pathogens is debated and in many cases can result in reduced plant quality. Therefore protection of wound could be of extreme importance to prevent infection by these two microorganisms. Biocontrol microorganisms colonizing wood can offer a solution. The strain *Trichoderma atroviride* SC1 was isolated from decayed wood and has been shown a good capacity of colonizing wounds in established vines. When applied in the nursery process it successfully colonizes almost all parts of the plants (rootstocks and scions). It fully controls infections of Pal and Pch during grafting and the level of colonization is stable during the entire process, showing a percentage of colonization of plants close to 100% at the time of commercialization. Applications at different stages of the nursery process indicated that crucial times for the application are just after the collection plant material from mother plants and before grafting, while treatments during stratification or rooting did not fully control the disease. Increasing time of dipping in the solution and increasing concentration of the conidia did not result in any further increase of the efficacy. In contrast a chemical disinfectant commonly applied by growers resulted in increased incidence of Pal and Pch. *T. atroviride* SC1 also controlled grey mould, which commonly developed during stratification. The trials were carried out for three years in two sites in Italy indicating a good adaptability to different environmental conditions and consistency of results. *T. atroviride* SC1 may represent an interesting strain for further developments in the protection of grapevine wounds from esca-associated microorganisms.

Key words: ESCA, wood diseases, integrated control, biocontrol, biofungicide

Evaluation of the antagonistic potential of *Trichoderma* species to avoid ESCA and related trunk diseases in the field and in grapevine propagation

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Abstract: ESCA and related trunk diseases still are the cause of serious problems in viticulture not being sufficiently controlled by direct plant protection management. Thus, the need for alternate methods to protect grapevine against infection and to prevent detrimental effects remains acute. To resolve the spectrum and antagonistic potential of *Trichoderma* species naturally occurring in grapevine, *Trichoderma* strains were subsequently isolated from symptomatic and not symptomatic grapevine plants in the region of Rhineland-Palatinate. Species identification based on molecular methods revealed 11 species detectable in grapevine, with *T. harzianum* being the most abundant. A total of 53 isolates were screened in dual cultures to characterise their antagonistic potential against ESCA and Esca-associated pathogens. Four species showed high antagonistic capacities and inhibited the growth of trunk disease pathogens such as *Botryosphaeria* and *Cylindrocarpon* species that had been isolated from affected grapevine plants from different German wine growing regions and subsequently identified. Two isolates of *T. koningiopsis* and *T. gamsii* were not only able to inhibit spore germination and mycelial growth in dual cultures, but also when exudates of liquid cultures were applied to spore suspensions. The degree of inhibition significantly correlates with the age of applied *Trichoderma* culture.
First *in vivo* experiments, in which shoots were pre-treated with spore suspensions of different *Trichoderma* species instead of a hydroxychinoline, revealed that an inoculation with *T. gamsii* prior an infection with *Phaeomoniella chlamydospora* effectively reduced the recovery rate of the pathogen. This was also the case when *Trichoderma* products were applied in the field to grapevine plants with freshly created wounds. These studies demonstrated the high antagonistic potential of *Trichoderma* species naturally occurring in grapevine against a wide range of trunk pathogens that may also be of use in grapevine propagation.

Key words: *Botryosphaeria*, *Cylindrocarpon*, grapevine propagation, plant protection

Alexins as new antifungal compounds

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Abstract: In agriculture and in medicine, fungi play a crucial role in achieving the carbon cycle, but can also be important pathogens for plants, humans and mammals in general. To control fungal diseases, fungicide treatments are required and have to be applied preventively before the occurrence of symptoms. In agriculture many active ingredients are registered and regularly used to ensure yield and crop quality. In fruit production their use is proportional to the expected quality of the market and the consumers. In this instance viticulture, fruit orchards and vegetable production are among the most fungicides consuming crops. In all cases the regular use of such compounds has to face with the adaptation of the fungi to those active ingredient, becoming resistant. More precise the working mechanisms at one biochemical site of the fungal metabolism, more often the products are used, and more rapidly resistance appears.
The need to find new active compounds is a permanent challenge in agriculture and in medicine. To found new molecules with high antifungal activities, two sources of alexins, are exploited. Alexins are secondary metabolites of microorganisms or plants induced by stresses. On one side host plants are producing phytoalexins as defence molecules after infection by a pathogen or after exposure to UV-light. In grapevine these well-known compounds, have been purified and tested as new active ingredient against fungal pathogens. In the resistant cultivar Divico (Gamaret x Bronner), the amount of the known grapevine phytoalexins is largely higher and new highly biocide compounds could be found. Those compounds were found constitutively in lignified canes and induced in UV-exposed leaves. Biotests have been performed and indicated high antifungal activities of several compounds against the major grapevine fungal diseases and the human pathogens *Fusarium* and *Candida*.
On the other hand, fungi themselves are able to produce new compounds when they are in competition, so called mycoalexins. The different species of fungi involved in grapevine wood diseases, as esca, Eutypa or black dead arm, pairwise in confrontation produce natural compounds with high antifungal activities and which have never been described in chemistry. The nature of interaction can lead to different reactions, from indifferent growing, to complete inhibition of both organisms due to secondary metabolites.
The potential of primary and secondary constitutive metabolites naturally occurring in different organisms as fungicides has been largely exploited by the industry. The research of induced new active chemical compounds in different organic systems opens new perspectives to found lead fungicide active ingredients for agriculture and medicine.

Key words: grapevine, phytoalexins, mycoalexins, fungicides, secondary metabolites, grapevine diseases

Ontogenetical resistance of grapes – a chance to reduce fungicide residuals in wine?

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Abstract: Even extremely low values of pesticides in wine cause big problems in wine marketing in Germany. Values, much lower than the maximum of tolerable residuals, are ranked as negative quality parameters in newspapers and professional gourmet journals.
Investigations of Stark-Urnau and Kast (1999) and Gadoury *et al.* (2003) indicated that growing grapevine bunches are highly susceptible to infections of *Erysiphe necator* from one week before flowering time to the date when the berries reach the size of a pea. Young plant tissues like flower clusters and little berries offer optimal conditions for infections of powdery mildew (Kast, 2012). During this critical period (OWP = "open window period"), three sprays against the powdery mildew show nearly the same effect as seven sprays throughout the season, even under extreme disease pressure (Bleyer *et al.*, 2013). Downy mildew (*Plasmopara viticola*) penetrates its host exclusively via the stomata (Pearson and Goheen, 1988). When grape berries reach the size of a pea, no functional stomata are present on the berries surface. Few functional stomata are situated on the rachises, yet, which are mainly damaged by a high number of infectious spores. The spores are normally produced on the upper leaves and get on the grapes during rainfall (Hill, 2012).
In several field experiments in the years 2009-2012, fungicides against downy and powdery mildew have been used, leaving out the grape zone for the last or the last two sprays of the season. The effect was nearly the same as when spraying the whole canopy including the grapes. Compared with spraying the grape zone throughout the whole season, there where no differences in the amount of downy mildew attack at grapes and leaves, even under a high disease pressure. The powdery mildew experiments in 2011 had to be cancelled due to extreme frost damage. Small differences on leaves and grapes were detected in 2012, a year in which fungus diseases were very high, but even these differences did not exceed the significance level of 5%. In 2009, a field trial against grey mould (*Botrytis cinerea*) with different spray schedules indicated that residuals were higher for later sprays. Nevertheless, the infestation with Botrytis showed no difference.
In the same year, when leaving out the last or the last two sprays, in the powdery and downy mildew trials there could be found no residuals in wines for all applied fungicides (Folpet, Myclobutanil and Quinoxifen). When Boscalid was treated in tests with Botrytis fungicides showed before bunch closing (beginning of July), the residuals were on the detection limit. For normally treated grapes (until mid of August) however, residuals could be detected, but on a very low level. Boscalid could only be detected in an extremely low value in wine, which was about 1/100 of the tolerable level.
We recommend to treat the canopy above the grapes and to leave out the grape zone for the last or two last sprayings, if there have been no severe earlier infections, in order to reduce residuals in wine.

Penicillium on grapes – Molecular identification and secondary metabolism

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Abstract: *Penicillium* species causing blue mould on grapes are capable to produce metabolites that interfere with must and wine quality. The most relevant species (95 %) in German wine growing regions is *P. expansum.* Other species such as *P. minioluteum, P. crustosum, P. commune, P. purpurogenum, P. brevicompactum, P. spinulosum and P. solitum* were found less frequently. An identification of *P. expansum* was successfully conducted by species-specific PCR, generating a 404bp PCR product of the polygalacturonase gene. However, other species could not be identified. Therefore, an amplification of a part of the cytochrome oxidase-gene (*cox1*) was performed followed by a triple restriction. The restriction with *Hpy*F3I, *Bsm*1, and *Bst*1 resulted in a species-specific fragmentation and allowed a discrimination even of closely related species.
Since *P. expansum* is the most relevant blue mould pathogen on grapes in Germany and able to produce patulin and citrinin as mycotoxins, and also geosmin, which is responsible for distinct off-flavours in wine, this species was analysed in more detail.
In i*n vitro* experiments, *P. expansum* produced high amounts of geosmin in liquid rich nutrient medium, whereas citrinin was never detected. *P. expansum* also never produced geosmin in grape juice. As recently published by French colleagues, some *Botrytis cinerea* strains [Bot(+)] isolated from grapes are capable to induce the production of geosmin in grape juice by *P. expansum.* Geosmin was never detected in grape berries *in vivo*, even if disease severity was up to 100 % or berries were coinfected with Bot(+) strains. However, *P. expansum* produced high amounts of patulin (up to 7 µg/ml) on grape berries, but not in each case. Replications differed extremely regarding the quantities of the metabolites analysed. Therefore, the production of these metabolites by *Penicillium* species was not associated with selected environmental conditions, such as temperature, grape variety, and fungicide application. Besides that, some isolates of *P. crustosum* and *P. purpurogenum* obtained from infected grapes were able to produce ochratoxin A *in vitro* and *in vivo*. No contaminations with patulin or citrinin were detected in field samples with disease severity less than 1% in the years 2010 and 2011, but in field samples collected in 2012 that were highly affected by blue mould. Geosmin and mycotoxin contamination with did not correlate with visible *Penicillium* symptoms. Therefore, another chemical marker that strongly correlates with *Penicillium* infections is needed.
A new secondary metabolite produced by *P. expansum* on different host plants could be identified by LC-MS/MS. This metabolite was found in different food sources contaminated with *P. expansum*. Pathogen strains produced the metabolite on all tested grape varieties from different origins. The metabolite was detected in different media, berries, must, wine, and field samples, as well as in tomatoes, apples, and pears artificially inoculated with *P. expansum.* Controls were completely free from this secondary metabolite, which is also the case if samples were inoculated with other *Penicillium* species (n=7) or pathogens, such as *Botrytis cinerea*, *Trichothecium roseum*, *Eryphise necator*, *Cladosporium* sp., *Rhizopus* sp., *Alternaria* sp., and *Aspergillus* species. This indicates that the molecule is very specific for *P. expansum* even growing on different hosts. Thus, this molecule represents a useful chemical marker and an appropriate tool for the identification of *P. expansum* contaminations in must, wine and other food products and allows a wide range of practical applications.

Key words: blue mould, geosmin, grapevine, mycotoxins

Protection of grapevine pruning wounds from fungal pathogens and reduction of leaf stripe disease incidence by a *Trichoderma* based product

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Abstract: Grapevine leaf stripe disease (one of the diseases within the esca complex) is surely the most widespread wood disease of grapevine in Europe, and surely the most destructive. Losses in number of affected vines and in wine quality were shown to have increased widely in the last 30 years. The foliar symptom is reported by several authors to be linked to the presence of wood infections, mainly via pruning wounds, by fungal pathogens, namely *Phaeomoniella chlamydospora* and *Phaeoacremonium aleophilum.* During wood colonization the fungal pathogens, producing phytotoxins, which interact with the leaf tissue and environmental factors, contribute in causing the typical discolorations and necrosis in the leaves which in turn correlated with yield losses. Wound protection is therefore a most important prevention tool, as no curative method is at present recommendable. The application of a biological control product containing spores of *Trichoderma gamsii* and *Trichoderma asperellum* was therefore tested in 15 different commercial vineyards located in Piedmont, Veneto, Lombardy, Friuli, Emilia Romagna and Tuscany soon after pruning. The experiments were repeated for 4 years, surveying the foliar symptoms incidence in control and treated vines during the first half of September. In experimental plots the treatment was applied in 4 repetitions, 30 pruned canes each, which, after pruning, were artificially inoculated by *P. chlamydospora.* Data are reported on the efficacy in protection after artificial inoculation, persistance of the product, timing of efficacy and on the reduction in foliar symptoms incidence recorded in the 4 years of the experiment.

Key words: grapevine, wood diseases, biological control, *Phaeomoniella chlamydospora*

Optimized monitoring of the Bois noir vector, Hyalesthes obsoletus, based on its spatiotemporal distribution

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Abstract: Bois noir (BN) caused by stolbur phytoplasmas is the most widespread grapevine yellows in Europe, with a high economic impact. The principal vector of BN is the planthopper *Hyalesthes obsoletus*. Specific plant host affiliated pathogen strains and vector populations lead to different epidemiological cycles of BN. Occasional feeding by infected vectors on grapevine may result in BN infection. Rational decision making for control requires sound information about the plant sources of infection and the local infection pressure. Monitoring the occurrence and abundance of *H. obsoletus* and its infestation with stolbur will provide this information, but the vector's temporal and spatial distribution patterns within vineyards have to be considered, too. The latter parameters were studied over three years. A fallow vineyard was divided into sectors, each with two sticky traps in the center. The presence and distribution of host plant bushes (stinging nettle) was mapped. Vectors were sampled by sweep netting all nettle bushes individually.

The time of emergence of adult *H. obsoletus* depends on the host plant population (delayed development of nettle-populations) and temperature. First adults were found between June 6 (2011) and July 1 (2013). These dates were readily predicted by a degree-day model, which was published previously for bindweed populations and adapted for nettle populations. The peak flight activity was observed four to five weeks after first emergence while the total flight period lasted for 10-11 weeks. More than half of all individuals were caught between the week before and the week after the peak (week with most individuals).

Nettle plants were highly aggregated among the sectors, with the coverage varying between 0 % and 13% per sector. The size of individual bushes ranged from 0.2 to 6 m^2. The abundance of *H. obsoletus* among sectors was positively correlated with that of the nettle host. However, the distribution between individual nettle bushes was also highly clumped. The number of vectors caught on sticky traps decreased exponentially with the distance to the next bush, although a few specimens were caught more than 10 m from the nearest nettle host. A good correlation of the vector's density on nettle and sticky traps was only observed with traps within a distance of one meter to the host plant.

To monitor the occurrence of *H. obsoletus* at a particular site, sticky traps should be setup in a grid, or several host stands should be swept with a few sweeps each. If information on the course of the vector's flight activity is required, exposure of sticky traps close to host plant bushes or intensive sweeping of densely populated stands is advisable. In this case, trapping should start when 90% of the required degree-days for adult emergence are reached and continue for at least 10 weeks. To collect a maximum number of vectors with the least effort, sampling should start when 500 degree-days are accumulated from the beginning of the flight activity (three to four weeks after first emergence) and should continue for three weeks. The data presented here fit to the situation in northern vineyards. The approach may require refined parameters for the degree-day calculation for other winegrowing regions.

Key words: Bois noir, *Hyalesthes obsoletus*, monitoring, degree-day model, IPM, epidemiology

Validation and practical use of previously developed habitat models of *Hyalesthes obsoletus*, vector of bois noir

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Abstract: Besides emerging evidence of new Stolbur phytoplasma vectors, *H. obsoletus* is still considered the main vector of bois noir in Baden region, SW-Germany. Recently, habitat models were developed to study the habitat requirements of the planthopper vector. In this study, we address the question of how robust and applicable these developed models are, particularly to new invasive species, such as *Scaphoideus titanus*, which is expected in Baden region in the near future.
For model validation we used datasets from i) a biomonitoring dataset of *H. obsoletus* with presence/absence records of four different years in Baden region; and ii) data derived from a long-term biomonitoring network of *S. titanus* in the Libournais region, France. Depending on the dataset and the available predictor variables, the habitat model with highest AUC was used for prediction. All statistical models are based on logistic regressions. We highlight different potential applications, such as insect dynamics and model transferability to new regions and different pest insects. Results demonstrate the practical use of the previously developed habitat models for current and future pest management.

Key words: insect pest, habitat models, bois noir, planthopper, leafhopper, insect vector, prediction, logistic regression, biomonitoring, pest management, *Scaphoideus titanus*, model transfer, *Hyalesthes obsoletus*

Temporal dynamics of *Scaphoideus titanus* populations: from annual occurrence patterns to changing climate suitability assessments

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Abstract: A previously published model based on a time-varying distributed delay with attrition is used to simulate, at three different temporal scales (one, five and fifty-two years), the dynamics of the invasive Grape leafhopper *Scaphoideus titanus* in vineyards located in Southern and Western Switzerland. The model was parameterized with laboratory and field data. Driven by daily temperature maxima and minima and grapevine plant phenology it satisfactorily represents annual and multiannual occupancy patterns and hence, is concluded to have satisfactory predictive and explanatory capabilities. The simulations representing canopy occupancy by non-diapausing eggs, nymphs and emerging adults are particularly useful for tactical purposes including the timing of monitoring operations and insecticide applications. The simulations representing canopy occupancies by diapausing eggs, non-diapausing eggs, nymphs and adults are useful for strategic purposes. Growers and extensionists should be aware that rather stable occupancies are maintained once an area suitable for development is invaded and no management operations are undertaken. The simulations by the validated model representing long-term dynamics could be useful for strategic purposes, policy design and research work. Namely, the model produces an index that represents the suitability of a region for colonization by *S. titanus*. Preliminary analyses show that autocorrelations exist in some time series of this index. This affects the development of models regressing the suitability index on time. Nevertheless, the index tends to increase when plotted against time during the past 52 years. If verified in future work, extensionists and policy makers could take note of a future invasion and prepare growers for dealing with a new pest. The increase of the index is seen as a climate change effect that may motivate scientists to evaluate the prospects for other pests.

Key words: simulation, suitability index, temporal scales, institutions, decision support

Can differences in feeding behaviour between *Scaphoideus titanus* males and females be related to phytoplasma transmission efficiency?

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Abstract: The leafhopper *Scaphoideus titanus* (Hemiptera: Cicadellidae) is a vector of the phytoplasma causing the Flavescence dorée of grapevine, which is one of the most economically threatening diseases of European vineyards. In plant disease solely transmitted by insects, pathogen transmission occurs during the feeding behaviour, therefore quantifying the different feeding activities is a key to understand the disease transmission process. Feeding behaviour of piercing-sucking insects can be studied using the electrical penetration graph technique (EPG). This technique has been popularized by Tjallingi's in the 80's and further works especially on aphids. By connecting the insect and the plant in an electrical circuit it is possible to monitor electrical resistance fluctuations during probing. These voltage fluctuations occur in a number of distinctive patterns called waveforms that have been correlated to different behaviours according to the stylets position into the leaf and to feeding activity (salivation, puncture, ingestion, etc…).

We have adapted this technique to *S. titanus* in order to investigate if differences in the feeding behaviour between non infected males and females could explain different ability in phytoplasma transmission. EPG waveforms representing probing activities were obtained from adult *S. titanus* probing in Cabernet Sauvignon cultivar. Three waveforms: salivation, phloem and xylem ingestion were characterized in both sexes by comparing them to previously published on others Hemipteran species.

The first interesting result is that xylem ingestion occurred in both sexes, while *S. titanu*s is always described as a phloem feeder. Interestingly, males exhibited more frequent and longer activity in phloem. The number, mean and total durations of each type of waveform differed significantly depending on the sex. Feeding behaviour differences affect the ability to acquire and then to inoculate phytoplasma and may partly explain the higher rates of transmission of Flavescence dorée phytoplasma that were obtained in the laboratory with males.

Key words: electropenetrography, vector, phloem, xylem

Notes on distribution of *Scaphoideus titanus* and "flavescence dorée" phytoplasmas in Tuscany

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Abstract: The first detection of *Scaphoideus titanus* Ball in Tuscany (Italy) dates back to 1998 at Bonascola, a suburb of Carrara city, while the first identification of "flavescence dorée" phytoplasmas (FD) in the same region was in 2003 in a vineyard located at Montignoso in Massa Carrara province. In the last decade, the monitoring of the vector and of the phytoplasma was conducted in an ever more careful way by the Regional Plant Health Service and some connected technical and scientific institutions. This highlighted a rather broad distribution of the leafhopper, not recorded till now only in the south-western provinces of Livorno and Grosseto, and on the contrary, a presence of the FD, at epidemic risk levels, merely in some wine-growing areas of the Massa Carrara and Lucca provinces.
In order to deepen the knowledge on Auchenorrhyncha fauna associated with grapevine yellows in Tuscany, in the years 2007-2012, surveys were conducted in several vineyards of the "Chianti Classico" area. In forty-five vineyards located in the territories of Castellina in Chianti, Radda in Chianti e Castelnuovo Berardenga (Siena), one to three monitoring stations, characterized by agronomic and cultural parameters, were set up with yellow sticky traps exposed from the second half of June to the middle of September. Overall, the stations amounted to 69 in 2007 and 2008, 65 in 2009 and 64 in 2010 and 2011. During 2009-2012 similar surveys were conducted in 31 wine farms located at Panzano, Greve in Chianti (Florence); in this case the monitoring stations were 213 in 2009, 212 in 2010 and 2011 and 194 in 2012. The surveys pointed out an increase in the *S. titanus* population density in the monitored areas, despite the mandatory treatments against the leafhopper. The percentage of affected stations in the Sienese area increased progressively from 25% in 2007 to settle at around 60% in 2009-2012; in the Florentine districts the affected stations moved from 95.78% in 2009 to 98.97% in 2012. Confirming historical findings, distribution of *S. titanus* seemed mainly influenced by microclimatic factors and by the origin of the propagation materials. This growing trend of the cicadellid spreading was not followed by an increasing presence of FD.
In the context of the European project Euphresco GRAFDEPI "Epidemiological studies on reservoir hosts and potential vectors of grapevine flavescence dorée and validation of different diagnostic procedures", in 2012, surveys were carried out mainly in Massa Carrara province. In this wine growing area, a vineyard already monitored and found infected by FD in 2009, was chosen as an appropriate case study. This agro-ecosystem, covering about one hectare and consisting of five local and two international varieties, has been characterized in its agronomical and environmental parameters, and extensively sampled. Surveys, including the assessment of the Auchenorrhyncha vectors of grapevine yellows, are still in progress, however molecular studies carried out so far have revealed how, in the face of a fairly modest population of *S. titanus*, a very high percentage of plants has been, and is now, infected by FD. Molecular characterization of the FD strains obtained from 2009 and 2012 samples on the 16Sr gene showed that all strains had the typical profile described for FD-C. However the RFLP characterization on the SecY gene highlighted, with some enzymes, a polymorphism, typically reported in FD-D.
This finding is significant since it shows the possibility to early identify the appearance of new FD strains and allows to better managing FD before it becomes epidemically relevant.

Key words: grapevine, yellow diseases, vectors, epidemiology

Current research activities on *Scaphoideus titanus* and Grapevine flavescence dorée phytoplasma in Austria

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Abstract: The Nearctic leafhopper *Scaphoideus titanus,* one of the main arthropod vectors of Grapevine Flavescence dorée phytoplasma (FD) was found 2004 for the first time in Austrian vineyards in Styria. Since then it has spread and is now established in parts of Styria and Burgenland. FD was first detected in 2009 in single grapevines and some wild plant species in Styria.
As a consequence annual systematic monitoring surveys about the occurrence of both pests are carried out in the south-eastern part of Austria by the Austrian Agency for Health and Food Safety (AGES) in cooperation with local authorities of the Federal Provinces of Styria and Burgenland. Management measures to reduce the risk of further spread include both the testing and uprooting of symptomatic grapevine plants and the compulsory treatment against *S. titanus,* which resulted in a retardation of the spread and a reduction in the population size of the vector.

Despite these encouraging results new FD infested grapevines and new sites with *S. titanus* were found.

In order to contribute to the understanding of the epidemiology of FD and to find new control options against *S. titanus* for the organic vine growers in Austria, AGES is currently involved in different research projects. An overview on the research projects in the field will be given and the scientific findings of single work packages from the different research projects will be reported:

- The research project GRAFDEPI (ERA-NET EUPHRESCO II) looks at potential insect vector species of FD and reservoir host plants. In field studies the insect community of wild plant species growing next to vineyards where FD was detected was investigated. Additionally, transmission trials were performed with *S. titanus* from FD infected wild host plants to grapevines.

- In the VitisCLIM project (Austrian Climate Research Programme) different modelling methods were used to assess the future potential establishment of the vector in Europe, to test the effect of different pest management options on the local spread of the vector and the disease and on the economic impact.

- The VineMan.org research project (ERA-Net CORE-Oragnic II) aims at finding innovative solutions for the improved control of the main pests and diseases in organic viticulture. Some of the organic vine growers in Austria are already confronted with *S. titanus* and FD control and research is needed for alternative control possibilities. Therefore, the pathogenicity of an entomopathogenic fungus species against *S. titanus* larvae was examined in laboratory tests.

New results from the research projects will be presented and their role in the epidemiology of FD or for the management of *S. titanus* will be discussed.

Key words: Flavescence dorée, *Scaphoideus titanus*, epidemiology, IPM

Potential of the entomopathogenic fungus *Beauveria bassiana* as an endophyte in grapevine *Vitis vinifera* plants

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Abstract: Fungal entomopathogens are important antagonists of arthropod pests and have attracted increased attention as biocontrol agents in integrated pest management programs. In addition to colonizing arthropods, evidence has accumulated that some entomopathogenic fungi like *Beauveria bassiana* (Bals.) Vuill. (Ascomycota: Hypocreales) can endophytically colonize a wide array of plant species. For a couple of crop plants it has been proved that endophytic *B. bassiana* can provide a systemic protection against damage by various insect pests or might trigger induced systemic resistance mechanisms against plant pathogens. Currently, it is unknown whether *B. bassiana* can exist as an endophyte in grapevine, *Vitis vinifera* (L.) plants and still maintains its antagonistic potential against insect pests.

In the present study, greenhouse experiments were conducted to verify endophytic establishment of the entomopathogenic fungus *B. bassiana* in grapevine plants after inoculation. Therefore, a commercialized *B. bassiana* strain (ATCC 74040) was applied as a conidial suspension or as the formulated product Naturalis® on the upper and lower leaf surfaces of potted grapevine plants. To determine if endophytic colonization of grapevine leaves by *B. bassiana* was successful, leaf disks of surface sterilized control and inoculated plants were obtained and placed on a selective medium. Verification of endophytic establishment of *B. bassiana* was achieved by the amplification of strain-specific microsatellite markers or a nested PCR protocol. The antagonistic activity of endophytic *B. bassiana* against putative target pest insects like the vine mealybug *Planococcus ficus* was assessed using surface sterilized leaves for a bioassay. Possible effects of endophytic *B. bassiana* on the feeding preference of black vine weevil *Otiorhynchus sulcatus* choosing between control and inoculated plants were examined through choice assays. Furthermore, the protective potential against grapevine downy mildew *Plasmopara viticola* was investigated in greenhouse experiments.

Endophytic survival of *B. bassiana* inside leaf tissues was evident at least 28 days after inoculation, irrespective of the inoculum used. A significant effect of endophytic *B. bassiana* on growth and on mortality of *P. ficus* one week after the initial settlement of vine mealybug crawlers was evident. Adult *O. sulcatus* chose significantly more often the control plants as a host plant compared to grapevine plants with endophytic *B. bassiana.* A slight but not significant effect on the disease severity of downy mildew could be observed if plants were treated with *B. bassiana* 3 and 7 days before an inoculation with *P. viticola*.

Endophytic establishment of an entomopathogenic fungus such as *B. bassiana* in grapevine plants would represent an alternative and sustainable plant protection strategy, with the potential of reducing pesticide applications in viticulture.

Key words: *Beauveria bassiana*, entomopathogenic fungi, endophytic colonization

Arthropods as bio-indicators in vineyard agroecosystem

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Abstract: In the last few decades the viticulture has undergone remarkable transformations caused by agricultural intensification and land abandonment, which result in an overall loss of habitat heterogeneity and biodiversity. Vineyards form a very peculiar landscape in Southern Switzerland and are characterized by a remarkable number vineyard layout types. The study aimed to investigate the factors shaping the arthropod (spider and ground beetles) assemblages in vineyard agroecosystem and to define indicators species responding to environmental and anthropogenic stressors. We considered three groups of explanatory variables (management, topography and landscape) influencing distribution and composition of arthropod communities. The study was conducted in 2011, in 48 vineyards representative of the wine growing area of the Canton Ticino. We applied multivariate analyses (such as Variation partitioning, Redundancy analysis, Multivariate regression tree and Indicator Value analysis) to identify indicator species predictive for the selected explanatory variables. The results showed that: 1) 246 species of spiders and 89 of ground beetles were identified, dominant species show various microclimatic preferences; 2) communities are mainly affected by environmental and management factors that can promote xerophilous species relevant in conservation, 3) 38 spider indicator species and 23 beetles indicator species were selected and show distinct ecological needs. In synthesis our study indicate that spider and ground beetle communities living in vineyards in Southern Switzerland are characterized by species typical of rich meadows, open habitats and bushy xerothermic. Such diversification was confirmed by the ecological features of the indicator species. This study highlight that terraced vineyards, which include vegetated slopes, represent interesting areas for the conservation of the biodiversity of spiders and ground beetles at the regional level.

Key words: Araneae, Coleoptera Carabidae, beta diversity, management, environmental indicators, indicator species, conservation

Cold Climate Wine Grape Cultivars: A "New" Crop in the Northeast and Upper Midwest Regions of the USA

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Abstract: Cold climate wine grape production is a rapidly emerging "new" crop in the diversification of agriculture in northern states offering significant value-added and agri-tourism economic opportunities. In the past, commercial wine grape production was not recommended in the colder regions of the USA because of problems with winter survival of the vines. However, cold climate wine grape cultivars such as those developed by the University of Minnesota breeding program and a private breeder from Wisconsin are now available commercially. These wine grape cultivars survive -34^{0}C to -37^{0}C winter temperatures are being planted on newly created farms or as an alternative crop on existing farms. In 2004, a national project for grape cultivar and clone evaluation (USDA NE-1020) was initiated in the USA. The justification, objectives and participants of NE-1020 can be viewed at: http://www.nimss.umd.edu/homepages/outline.cfm?trackID=4034. The goals of this national project include: (1) Evaluate the viticulture characteristics and wine quality potential of clones of economically significant cultivars throughout the USA; (2) Characterize the viticultural and wine quality potential of emerging cultivars based on regional needs; and (3) Conduct explorations within and outside of the USA for new or lesser known cultivars that may have economic potential for the US wine industry. Part of NE-1020 research has been focused on evaluating cultivars for cold regions of the country. In addition, in 2011, another project (Northern Grapes Project) was funded by the USDA Specialty Crop Research Initiative program to conduct research and extension/outreach on cold climate wine grapes. The Northern Grapes Project has involved 30 Research and Extension professionals in viticulture, enology, and economics/marketing across 12 institutions in the upper Midwestern and Northeastern region of the USA plus 20 cooperating winery/grower associations. Cornell University is the lead institution; the other institutions along with project goals can be viewed at http://northerngrapesproject.org/. There are many multi-disciplinary studies involved in the project including those which are: addressing varietal performance and the resulting fruit and wine flavor attributes in different climates within the participating states; applying appropriate viticultural practices to achieve consistent fruit characteristics for winemaking; applying winemaking practices to the unique fruit composition of cold climate varieties to produce distinctive, high quality wines that consumers like and purchase; studying consumer preferences and individual/regional marketing strategies that will increase sales and growth of wines made from cold climate cultivars. In 2012, it was estimated that the economic impact of cold climate grape production across the 12 states involved in the project was $34.8 million USD, and wineries that used cold climate cultivars had an economic impact of $194.5 million USD (Gartner and Tuck, 2013). In addition, the economic impact of tourists visiting wineries was conservatively estimated at $113.3 million USD. The overall goal of the project is to increase and sustain profitability of wineries and vineyards growing cold climate wine grape cultivars. The University of Vermont is a participant in both the NE-1020 project and the Northern Grapes Project. The Vermont research vineyard site which was planted in 2007 represents the coldest winter and coolest growing season conditions of any of the NE-1020 sites in the eastern USA and includes the cultivars: Frontenac, La Crescent, St. Croix, Marquette, Prairie Star. The Vermont Cold Climate Grape Program includes education to grape growers through meetings, IPM Updates, one-on-one interactions, and a website where information is posted (http://pss.uvm.edu/grape/). An overview of the two USDA projects and the research/educational program developed for grape growers in Vermont will be presented along with information on specific cold climate wine grape cultivars.

Key words: cold climate wine grape cultivars, interspecific wine grape hybrids, *Vitis riparia*-based wine grape cultivars

Ladybirds in Tuscan vineyards (Coleoptera Coccinellidae)

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Abstract: The ladybird (Coccinellidae) population of three vineyards situated in the Province of Pisa (Ceppaiano, Poggio al Casone and La Serra) was investigated in 2012. Notoriously, ladybirds feed on a wide variety of preys in vineyard and are an important and well-represented group among predators in this agro-ecosystem. Their main victims are aphids, scales and mites, though they can include mycophagous species, which exert predation at times.
Experimental fields were plowed or grassy and differently managed for the control of the grapevine moth *Lobesia botrana* (Denis & Schiffermüller): conventional management with plowed soil at Ceppaiano, pheromone mating disruption (MD) and grassy ground at Poggio al Casone and no sprayings and plowed soil at La Serra. Two Malaise traps were installed in each vineyard from May to October 2012 and checked bimonthly. Traps captured 4057 specimens of ladybirds belonging to 38 species, 24 of which were present in all the plots. Most of the collected specimens were aphidophagous (almost 80%), 8,50% coccidophagous, 8,11% mycophagous and 2,86% were acarophagous. The aphidophagous *Hippodamia* (*Hippodamia*) *variegata* Goeze, *Propylea quatuordecimpunctata* (Linnaeus), *Scymnus* (*Scymnus*) *frontalis* (Fabricius), *Scymnus* (*Scymnus*) *interruptus* (Goeze) and *Platynaspis luteorubra* (Goeze) were the most representative species. *Nephus* (*Bipunctatus*) *bisignatus* (Boheman) was the dominant species among the coccidophagous ladybirds, with over 46% of specimens collected. The mycophagous species *Tytthaspis sedecimpunctata* (Linnaeus) (82,67%) and *Psyllobora vigintiduopunctata* (Linnaeus) (17,33%), both feeding on Erysiphaceae, and the acarophagous *Stethorus pusillus* (Herbst) and *Stethorus gilvifrons* (Mulsant), principally feeding on Tetranychidae, were well represented in the studied environments. Though captured in very low number, the aleyrodiphagous *Clitostethus arcuatus* (Rossi) was found everywhere. Noteworthy is the presence of the exotic aphidopagous ladybird *Harmonia axyridis* (Pallas) in the vineyards of Ceppaiano and La Serra.
In Ceppaiano vineyard (OP insecticides and plowed soil) the three most common species were *Propylea quatuordecimpunctata*, *P. luteorubra* and *H. variegata*. The first and the third species often occur on shrubs and plants between 50 and 200 cm from the ground, while *P. luteorubra* is a myrmecophilous species living on lower growing plants and grasses. The majority of the specimens (over 56%) were collected at Poggio al Casone (MD and grassy ground). In this vineyard the most represented species are *Scymnus frontalis*, *S. interruptus* and *Hippodamia variegata*, which live on low growing plants, shrubs, weeds and grasses. At La Serra vineyard (no sprayings and plowed soil) many specimens of the mycophagous ladybird *Tytthaspis sedecimpunctata* were captured, so being the most represented species in this site.

Key words: Ladybirds, vineyards, Malaise trap, pheromones, IPM

Response of vine mealybug populations to cover crop management in vineyards

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Abstract: The influence of different cover crop management systems on the development of the vine mealybug, *Planococcus ficus* Signoret (Hemiptera: Pseudococcidae), was evaluated in a commercial vineyard (cv. Carignano) in north-western Sardinia within an ongoing multi-year project. In this paper, preliminary results of the first year of observations are reported.
The field trial was arranged in a randomized block design, comparing traditional tillage and three different cover crops: self-regenerating (legume-grass mixture), grass (*Dactylis glomerata* L.) and legume (*Medicago* and *Trifolium* spp. mixture). In each treatment, replicated four times, some life parameters of the vine mealybug (survival, development time from egg to ovipositing female and fecundity) and the nitrogen content of grapevines, measured by a Spad meter, were recorded.
During the first year of the experiment, the ground cover management systems affected the vegetative growth of grapevines but did not influenced the life parameters of the vine mealybug. In fact, the Spad values were significantly higher on tillage and legume cover crop, while grass and self-regenerating soil covers negatively affected the nitrogen concentration on grape leaves. The mealybug development was significantly longer in the self-reseeding ground cover plots, while survival and female fecundity did not vary significantly among treatments.
The results obtained in the first year are not conclusive, because differences in grapevine physiology due to soil management strategies increase in the long-time period, thereby modifications in *P. ficus* population density and life parameters could become clearer in the next years.

Key words: legume cover crop, *Planococcus ficus*, mealybug life parameters, plant nitrogen nutrition

Variation in pesticide hazard from integrated viticulture in Trentino from 2002 to 2012

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Abstract: In the winegrape production system of Trentino IPM guidelines have been applied since 1990. Various pesticide risk indicators have been developed for estimating pesticide impact on human health and the environment as well as the success of a reduced risk policy like IPM.
The present work applied a pesticide risk indicator to estimate change in pesticide risk in the winegrape production system of Trentino between 2002 and 2012. For the purpose, a modified Environmental Impact Quotient (newEIQ), which accounts for all ingredients in the formulation presenting a health or environmental hazard, as identified in the Security Data Sheet was applied. Twelve farms representative of the different areas of the region and accounting for an average area of 55 ha were sampled. Single farm size ranged between 0.2 and 37 ha; some changes in the single farms' size during the contemplated time span were due to sale or expansion of some plots. Compulsory pesticide records kept by the growers were used as a source of the information pertaining to all types of treatments applied at the block level. The records were organized as entries that report the date of treatment, the commercial product and active ingredient, the concentration of a.i. in the formulated product, dose of commercial product in the finish spray solution, the spray volume applied per block, as well as the target pest or the agronomic purpose.
An overall constant improvement in environmental impact of winegrape protection strategies was recognized when linear regression was tested with values of the newEIQ over the 11 years the survey refers to (R^2=0.60). Nevertheless a significant change point (Pettitt test) was identified in year 2008 ($P<0.05$) as a consequence of the ban of formulations with hazard phrases R40 (Carcinogenic; limited evidence) and of the dithiocarbamate fungicides in 2009 and 2010, respectively. In general the improvement appeared to be a consequence of using more selective active ingredients and less due to a reduction in the amount of pesticides applied.

Key words: IPM, viticulture, pesticide risk indicator

Dictyophara europaea an alternative host of Flavescence dorée in Switzerland?

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Abstract: Flavescence dorée is an important grapevine disease known to be transmitted by a unique vector *Scaphoideus titanus* Ball. (Homoptera: Cicadellidae). However, recent observations showed that *Dictyophara europaea* (L.) (Homoptera: Dictyophoridae) could also host FD phytoplasma isolates belonging to the 16SrV-C subgroup and therefore play a role in the transmission of Flavescence dorée in vineyards. A survey conducted in western and southern Switzerland in 2011 and 2012 using sweep nets, yellow sticky traps and a D-vac vacuum insect collector showed that *D. europaea* is widespread and common in xerothermic as well as dry ruderal sites close to viticultural areas. Nonetheless, no insect could be captured inside of vineyards and PCR confirmed that none of the 248 individuals analysed was harbouring Flavescence dorée isolates. Thus, it is concluded that *D. europaea* does not represent a major threat to Swiss vineyards.

Key words: Epidemiology, plant–vector associations, insect vectors, phytoplasma disease, viticulture

Microsatellite analysis of populations of the grapevine moth *Lobesia botrana* (Lepidoptera: Tortricidae)

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Abstract: The grapevine moth *Lobesia botrana* (Den. & Schiff., Lepidoptera: Tortricidae) represents one of the key insect pests in viticulture. This species is present throughout the Palaearctic as well as parts of the Afrotropical and Oriental region and was recently introduced into the US. While *L. botrana* larvae primarily feed on flowers and fruits of grape (*Vitis vinifera*), additional plants from approximately 27 different plant families have been reported as suitable hosts. The native ancestral host plants of *L. botrana* are assumed to be found in the Thymeleaceae family including the flax-leaved daphne *Daphne gnidium*, which is native to the Mediterranean region and might thus indicate the ancestral geographic origin of *L. botrana*. In line with this assumption, adaptation to grapes as a host plant is considered to have happened only relative recently, as intense damage symptoms in vineyards have not been noticed prior to the beginning of the twentieth century.
In this study, we were interested in answering the question whether *L. botrana* populations from different locations in Europe and the Middle East are genetically homogenous indicating that they have just recently spread from a common ancestor population or whether they are genetically differentiated. The later would confirm the hypotheses that *L. botrana* has just recently spread from other host plants being present in the respective geographic areas to grapevine as the favoured host plant. To answer this question, we applied a set of newly developed microsatellite (simple sequence repeats, SSR) markers for this species, which were generated using a high-throughput isolation method based on coupling multiplex microsatellite enrichment and next-generation sequencing on a 454 GS-FLX Titanium platform.
In total, nine SSR markers were considered to be suitable for population genetic studies and were used to assess the genetic structure of individuals from xx European grapevine moth populations. Sampling locations included different vineyards from Italy, Spain, Syria, Israel and Germany. Our microsatellite data revealed the presence of a moderate level of genetic differentiation between the studied populations, which provides a more detailed insight into the evolution and diversification of *L. botrana* populations in Europe and the Middle East.

Key words: *Lobesia botrana*, microsatellite markers, evolution, genetic differentiation

Evaluation of different adaption strategies to climate change in viticulture by using a multi-criteria assessment tool

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Abstract: Climatologists tell us that Earth's climate is changing. It seems clear that a warmer climate is developing in the northern hemisphere, and that the weather will become more variable. Climatic projections suggest that these trends will continue in the coming decades, affecting crop quality, soil moisture, farmer's life style, and generally the overall current management system. In the latest report of the Intergovernmental Panel on Climate Change (IPCC), mean global temperature is estimated to increase between 1.8 and 4.0 °C and changes in rainfall distributions are expected in most of the world, which means a substantial impact on agriculture and food production. As part of this global change, seasonal patterns are being altered to make spring conditions occurring earlier in the year especially in the north hemisphere. Nowadays concerns on possible impact of climate change are increasing worldwide, especially in agriculture. This study is carried out in a study area: Trentino region, located in the north-east of Italy. This paper presents the evaluation of adaptation strategies to face climate change in viticulture in terms of environmental, social, and economic impacts. The evaluated adaptation strategies were: (1) change of variety; (2) switch toward an alternative crop; (3) introduction of anti-hail nets; (4) changes of the irrigation system. The evaluation was carried out with an ex-ante multi-criteria assessment tool: the DEXiPM model. DEXiPM allows the comparison of different systems tanking into consideration several the criteria and indicators, and the simultaneous analysis of the environmental, economic, and social dimensions of sustainability. Environmental and economic data were provided by FEM commercial farm, while the data related to the social dimension were collected by means of a questionnaire. Results are in favor of the alternatives suggesting structural change strategies (introduction of anti-hail nets and changes to the irrigation system) rather than changes of variety and crop strategies. Irrigation system and anti-hail strategies show the highest sustainability values especially with respect to economic and social dimensions (very high and medium levels). Environmental dimension show a medium score for all the strategies except for the change of variety, which gives a low score.

Key words: DSS, vineyard, MASC

Salvia sclarea (Lamiaceae), new host plant of the stolbur vector *Hyalesthes obsoletus* (Hemiptera: Cixiidae)

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Abstract: The planthopper *Hyalesthes obsoletus* is the natural vector of the grapevine yellow disease Bois noir due to Stolbur phytoplasma '*Candidatus* Phytoplasma solani'. This insect is found on a great diversity of plants, mainly on wild plants, and transmits phytoplasma to crops during their feeding probing such as vine, tobacco or tomatoes. In France, lavender (*Lavandula angustifolia*) and lavandin (*Lavandula hybrida*) are also affected by this phytoplasma, and the disease is called lavender decline. These plants are both hosts for the phytoplasma and its insect vector. In 2012, catches of adults were exceptionally important on one of the most tolerant clone of lavandin to lavender decline. It was also find a huge population of stolbur vector on the adjacent plot of clary sage, *Salvia sclarea*.
In order to clarify the potential role of *S. sclarea* as a host plant for *H. obsoletus*, we conducted surveys in fields and laboratory experiments.

The uprooting of clary sage and root examination has highlighted the presence of nymphs feeding on its plant either during autumn and spring. Nymphs harvested have been reared on *S. sclarea* from seedlings in a greenhouse. Nymphs were able to develop until becoming adults, imagoes mated and females oviposited on sage. Eggs obtained gave larvae that developing on sage.

By performing its whole lifecycle on clary sage, we demonstrated for the first time that *S. sclarea* is a host plant of *Hyalesthes obsoletus* and could be a source of stolbur vector. Nevertheless, clary sage host plant status of Stolbur phytoplasma is not so clear. On 30 Q-PCR trials done on *S. sclarea*, 29 were negatives to the phytoplasma, and one uncertain. Further work is ongoing to determine if clary sage could also constitute a source of '*Candidatus* Phytoplasma solani'.

Key words: Bois noir, lavender decline, host plant shift, rearing

Disease evaluation of selected cold climate wine grape cultivars in Vermont, USA

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Abstract: Cold climate wine grape production is a rapidly emerging "new" crop in the diversification of agriculture in Vermont and other northern states offering significant value-added and agri-tourism economic opportunities. In the past, commercial wine grape production was not recommended in the colder regions of the USA because of problems with winter survival of the vines. However, cold climate wine grape cultivars such as those developed by the University of Minnesota breeding program and a private breeder from Wisconsin are now available commercially. These wine grape cultivars survive -34^{0}C to -37^{0}C winter temperatures and are being planted in Vermont on newly created farms or as an alternative crop on existing farms. In addition to cold-hardiness, these interspecific hybrids were bred for disease resistance and potentially may require less overall fungicide use to produce high quality fruit. However, little research has been conducted to determine their relative disease susceptibility and fungicide requirements. The purpose of this research was to compare disease incidence and severity during the 2010-2012 growing seasons among a selection of wine grape cultivars from various sources, including University of Minnesota and Swenson hybrids, planted in the University of Vermont experimental vineyard (44° 28'N 73° 12'W) and managed using an integrated pest management (IPM) approach. Cultivars included: Frontenac, La Crescent, St. Croix, Marquette, Prairie Star, Corot Noir, Vignoles, and Traminette. The first five cultivars are considered cold climate cultivars, whereas Corot Noir, Vignoles, and Traminette are considered "cool" climate cultivars, which were included for comparison. Vines were planted in 2007 using a randomized complete block experimental design of six blocks with four-vine plots of each cultivar per block. The vineyard is part of multi-state USDA research projects (NE-1020 and NIFA-SCRI Northern Grapes Project) to evaluate wine grape cultivars. The vineyard site represents the coldest winter and coolest growing season conditions of any of the NE-1020 sites in the eastern USA. At the beginning of the 2012 growing season, Vignoles and Traminette vines were removed because of viticultural reasons. During each growing season, all cultivars received the same fungicide treatments totaling four to five applications each year. The following fungicides were applied either alone or in combination: mancozeb, mycobutanil, kresoxim-methyl, and captan. At the end of each growing season, disease incidence and severity were determined by examining 20 randomly selected leaves per plot and by visually assessing ten randomly selected fruit clusters per plot. Diseases that were assessed included: powdery mildew (*Erysiphe necator*); downy mildew (*Plasmopara viticola*); black rot (*Guignardia bidwellii*); Phomopsis leaf spot and fruit rot (*Phomopsis viticola*); angular leaf scorch (*Pseudopezicula tetrasporal*); and anthracnose (*Elsinoe ampelina*). Powdery mildew was the most prevalent disease and was observed on the foliage of all cultivars in each year. Frontenac or Prairie Star ranked the highest numerically in percent leaves infected but were not significantly different from some of the other cultivars. No powdery mildew was observed on any fruit in any year. Downy mildew was also observed only on foliage and not on any fruit over the three years of the study. In 2010 and 2011, the highest foliar incidence was observed on Vignoles; in 2012, the highest foliar incidence was observed on La Crescent vines. In contrast, Phomopsis foliar symptoms were not observed in any year but fruit rot symptoms were observed in 2010 and 2012. In 2012, Frontenac had the highest incidence and severity, followed by Marquette. Black rot, angular leaf scorch and anthracnose were either not observed or at very low incidence during the three growing seasons. In summary, differences in disease incidence and severity among the cultivars were observed for some diseases. Future research that incorporates non-sprayed plots and allows for comparison of multiple fungicide programs during a growing season is needed to determine the innate disease resistance/susceptibility of these cultivars and how best to incorporate this knowledge into effective disease management programs that address economic, health, and environmental concerns.

Key words: grape diseases, cold climate wine grape cultivars

Evaluation of natural pesticides in controlling grape berry moths and their side-effects on grapevine fauna

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Abstract: Conventional pesticides should be gradually replaced by non-chemical measures according to the Directive 2009/128/EC. In the framework of the project PURE, a number of microbial and botanical pesticides (i.e. *Bacillus thuringiensis*, azadirachtin, *Beauveria bassiana*, pyrethrins and spinosad) were selected to test their effectiveness against berry moths, in particular *Lobesia botrana*. Their side-effects on other pests and beneficials were also evaluated. Trials were conducted in two experimental vineyards located in Italy (Tuscany and Veneto regions) in 2011 and 2012, following a randomized block design. Additional investigations were carried out in Veneto during 2013. Regarding the efficacy of microbial and botanical pesticides on *L. botrana*, results of trials stressed the high performance of spinosad. *B. thuringiensis* gave satisfactory results in Veneto but not in Tuscany. The remaining compounds were less effective. Leafhoppers were sometimes more abundant in spinosad and pyrethrins treated plots. Spinosad and pyrethrins reduced significantly predatory mite populations compared to other treatments. Implications for IPM in viticulture are discussed.

Key words: *Lobesia botrana*, microbial and botanical insecticides, side-effects of pesticides

Grape phylloxera infestation rate in Switzerland

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Abstract: In the middle of the 19th century grape phylloxera (*Dactulosphaira vitifoliae*) was imported into Europe from North America. Viticulture was nearly broken down due to phylloxera outbreak and other diseases in the late 19th and early 20th century. The American grape vines are mainly susceptible in the leaves but resistant or tolerant in the roots. By contrast, the European grape vine, *Vitis vinifera*, shows the opposite susceptibility and tolerance phenotype. Therefore, the pest was managed successfully by grafting scions of *V. vinifera* grape cultivars on American rootstocks. But producers who are cultivating American-European hybrid cultivars such as Léon Millot ((*V. riparia* x *V. rupestris*) x Goldrieslingor) and Maréchal Foch ((*V. riparia* x *V. rupestris*) x Goldrieslingor) have often high infestation rates with up to 150 galls per leave. We investigated the distribution of grape phylloxera in Switzerland. First results will be presented.

Key words: interspecific hybrid, *Viteus vitifoliae*, *Dactulosphaira vitifoliae*, phylloxera

Experience on Vitimeteo-OiDiag in Southern Germany

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Abstract: In 2010 and 2011, powdery mildew (PM) caused severe problems in a lot of vineyards in Southern Germany. About 200 vineyards planted with susceptible varieties were selected by random evaluated for PM-disease severity. Its growers were questioned on the spray schedules and details about the used spraying technic. They represented a broad spectrum ranging from side jobbers to large estate vineries and from organic to non-organic cultural practice. Overall, different technics were used, ranging from knapsack-sprayer, including additional sprays by helicopters, to the state the art technics. Using data of the nearest representative Vitimeteo-station we counted the number of gap-days (gap-days = number of days, for which OiDiag-rules were passed) differentiated for the two OiDiag-Tools tool-1: gap days before first spray, tool-2: sum of gaps starting after the first spray). In 2010, no gaps could be detected for tool -1 and a high significant correlation to gap-days for tool-2 was found. In 2011, similar results were found for all varieties except Trollinger (=Vernatsch). We suppose that overseen PM in the neighbourhood of the small scattered vineyards caused these problems. Thus, we propose not to use tool-1 until the problems are cleared up but tool-2 proved to be very helpful for the growers.

Key words: Powdery mildew, *Erysiphe necator*, OiDiag, neighbourhood effect

Dogs may help to advice the vine growers to find early symptoms of powdery mildew

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Abstract: Powdery mildew (PM) has caused a lot of problems in Trollinger–vineyards of the Württemberg region. Supposing a problem of an assessment of the overwintering potential of PM in small scattered vineyards, we proposed to use tracking dogs educated to exclusively to sniff PM infected grapes. Thus, we hoped to detect the first symptoms and perhaps the overwintering mycelium in buds. By use of an old, well-educated but retired police dog, we were able show that after only10 weeks of training the dog was able to distinguish between healthy and PM-infected grapes. Due to my own retirement I could not get funding for a project. However, I would offer this idea to colleagues, who are interested in a project with our partners at the University of Hannover, Institut für Tierschutz und Verhalten (Heim-, Labortiere und Pferde). Together, they should proof weather dogs can distinguish different fungus and PM species and develop an education plan for dogs to enable a broad use of tracking dogs in viticulture and agriculture.

Key words: *Erysiphe necator*, tracking dog

A survey on parasitoids of the spotted wing fly, *Drosophila suzukii*, in vineyards and other agroecosystems of Trento province

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Abstract: *Drosophila suzukii* (Matsumura) (Diptera Drosophilidae), is an invasive species native of Eastern and Southeastern Asia. Since its introduction in USA and Europe in 2008, this pest caused hundred thousand dollars worth of damage to small and stone fruits business. Also grapevine has been shown to be attacked by the pest in late season. Observations in vineyards in Northern Italy indicate that *V. vinifera* can become a field host, and soft skinned varieties are the more impacted. The severe damages done by *D. suzukii* are mainly due to the absence of specialized natural enemies, able to control the population outbreaks of the introduced species in the invaded regions. Here we report the results of a survey aimed at determining the presence of indigenous *D. suzukii* parasitoid populations carried out in 2012 and 2013, from May to October, in four locations of Trento Province (Italy). We conducted field and laboratory studies in order to determine the status of biological control agents utilizing *D. suzukii* as a host. Our study sites included a range of commercial soft fruit and natural non-commercial habitats. In each site, sentinel traps were baited with either *D. suzukii* or *Drosophila melanogaster* Meigen (Diptera: Drosophilidae) larvae in different food substrates. In late season 2012, the generalist parasitoid, *Pachycrepoideus vindemiae* (Rondani) (Hymenoptera: Pteromalidae), was collected from both *D. suzukii* and *D. melanogaster* pupae in traps deployed in a selection of these sites. During the first part of season 2013 another species, the larval parasitoid *Leptopilina heterotoma* Thomson (Hymenoptera: Figitidae), hatched from both drosophila's species baited traps. Successive parasitism efficacy tests were set up under controlled conditions confirming the ability of both the species to attack *D. suzukii*. The possible practical implications of this finding for the biological control of *D. suzukii* are discussed.

Key words: Vinegar fly, Pteromalidae, Figitidae, *Leptopilina heterotoma*, *Pachycrepoideus vindemmiae*, small fruit

Viroses – a retrospect and outlook

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Abstract: In viticulture some untreatable diseases are transferred by vectors. This includes viral diseases, which are often difficult to identify in the field. Therefore it is unknown how widespread some viral diseases actually are.
In Europe, only mother plantations are under a regulated control for virus diseases (directive on the marketing of material for the vegetative propagation of the vine). The State Institute of Viticulture and Oenology in Freiburg is one of the institutions that perform these virus tests on graft production. Standardised wood and leaf samples were analysed by ELISA measurement. Collected data of the years 2009-2013 provide a little insight into frequency and distribution of viruses in vine. We showed that the nepoviruses (nematode transmitted polyhedral viruses), especially the Grapevine fanleaf virus (GFLV) (up to 37%), were among the dominating viruses in mother plantations. In Germany GFLV is also transmitted and spread by benthic biotrophic nematodes (*Xiphinema index*), which feed on the root tip cells. GFLV causes yield reduction in vine and neither the vector nor the viruses themselves are currently treatable. A cycle of infection and reinfection between nematodes and grapevine plants remains a constant threat in vineyards. At the moment the spread of GFLV can only be controlled by good soil hygiene; no mother plantations should be build where *X. index* occurs.
Therefore, working on new sustainable strategies is one of the aims to control the grapevine fanleaf disease. The focus is on the early stages of infection and the responses of plants to virus infection. We have previously shown that GFLV infection was able to induce stress related genes (e.g. *PAL*). Experiments were performed to examine whether a viral infection also triggers pathogen response similar to that of fungal pathogens. The expression of various genes was examined in greenhouse grown virus-infected and non-infected roots and leaves of the cultivar Riesling using qRT-PCR. Pathogen-associated genes such as *PR2* and *PR3* were investigated. Since growth deformations are a common symptom of grapevine fanleaf disease a gene which regulates auxin transport (*PIN1*) was also included into the study. In addition, the expression of the corresponding proteins was tested by immunoblot analysis. For the studied genes, the individual response of each plant was very variable independent of a viral infection. No difference in regulation of pathogen response could be determined between non-infected and infected plants. Perhaps in greenhouse other abiotic and biotic stresses superimpose the responses to GFLV. A switch to *in vitro* cultures could be a way to minimise side effects. These results support the field investigation that a formation of viral symptoms very much depends on individual parameters of every plant. Nutrition, water supply and other pathogens influence the individual response.

Key words: *Xiphinema index*, Grapevine fanleaf virus, induced resistance, *Vitis*, plant viroses

Drosophila suzukii (Matsumura) a new pest of grape in Veneto Region (north-east Italy)

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Abstract: The vinegar fly *Drosophila suzukii* (Matsumura) (Diptera Drosophilidae), spotted wing drosophila (SWD), is a highly polyphagous invasive pest endemic to Southeast Asia, which has recently invaded Italian regions. Serious economic losses were reported on soft fruits; furthermore damages were expected in late-maturing cultures, which are not protected by insecticides, such as grape vine. For this reason a monitoring of the presence, ecology and harmfulness of *D. suzukii* on grape growing area was made during the vegetative season on 2012, where red late-ripening grape varieties are cultivated (Verona district, Veneto Region). The SWD adults were monitored using red bottles containing apple vinegar, while the presence of eggs, larvae and pupae was sampled observing the berries at through a stereomicroscope. SWD adults were captured in high hilly condition (500-650 m a.s.l.) from the end of June, in foothills (250-450 m a.s.l.) from middle September and in plain at the end of September. The minimum and maximum of captures per vineyard were 34 and 369 respectively. The relationship between captures and average daily temperatures was studied.
The larvae infestations occurred only in high hilly condition from the grapes ripening to the late vintage.
The damages on berries caused by *D. suzukii* female serrated ovipositor and larvae feeding, were further increased by the activity of native *D. melanogaster* as well as by fungal and bacterial infections. At the harvest, the percentage of infested bunches was higher than 60%, with 1-2 infested berries per bunch on the autochthonous varieties Rondinella and Corvina, while on the international varieties Merlot and Cabernet sauvignon the percentage of infested bunches was lower than 30%, with 0.5 infested berries per bunch. Implications for *D. suzukii* control on grape are discussed.

Key words: spotted wing drosophila, grape, invasive species

The effect of *Drosophila suzukii* attack during grape drying process in Veneto Region (north-east Italy)

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Abstract: In Veneto Region (north-east Italy) the presence and harmfulness of *Drosophila suzukii* (Matsumura) (Diptera Drosophilidae) on grapes was noticed. In the case of dry red wine obtained by drying process, like the renowned Amarone and Recioto wines, the damages caused on berries by *D. Suzukii* female, serrated ovipositor and larvae feeding, can be even more intense, due to the possible increase of pathogens development during the withering process.
In order to evaluate the effects of the *D. suzukii* on grapes during the withering, two autochthonous varieties, Rondinella and Corvina were chosen. For both varieties 100 a hundred apparently healthy bunches were taken from the vineyards at harvest period and stored inside insect proof cage (to prevent further insects attacks). During the withering process the emerged Drosophilidae adults were captured: a total of 632 and 662 fly were counted on Corvina and Rondinella respectively; Corvina showed a higher percentage of *D. suzukii*, 30.1%, against 14.1 % on Rondinella. At the end of the drying process (around a hundred days) the bunches of each variety were ranked in four classes according to the different damages (measured as percentage of berries attacked on the bunches). Afterwards, the main chemical and microbiological parameters for each class were analyzed.
The berries showed a weight loss during withering, which is positively correlated with the intensity of the Drosophilidae attack. The acetic acid bacteria development, expressed as acetic acid amount, showed a high presence in Rondinella only on the more damaged class, whereas in Corvina it increased concurrently with the increasing of the class damage. Both glycerol and glycolic acid to evaluate the presence of *Botrytis cinerea* were sampled. Rondinella showed a moderate attack of *B. cinerea*, and the glycerol/glycolic acid ratio suggests a development of the fungus more in the “noble rot” form than in the “grey mould” one. In Corvina a less intense glycolic acid and glycerol production was observed; these results with the higher acetic acid concentration, suggests the development in Corvina of sour rot instead of *Botrytis*. This different evolution of the micro flora observed on Corvina during withering, could be related to a different susceptibility of the varieties, but also to the higher percentage of *D. suzukii*. A spotted wing drosophila management in the storage house during the drying process is discussed.

Key words: spotted wing drosophila, grape, drying process

Efficacy of microbial and botanical insecticides against *Scaphoides titanus* Ball in different experimental conditions

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Abstract: The Flavescence dorée (FD) is a Grape Yellow Disease causing severe damage in European vineyards. *Candidatus* Phytoplasma vitis, the causal agent of the disease, is transmitted from grapevine to grapevine by the leafhopper *Scaphoideus titanus* Ball (Homoptera: Cicadellidae). In the grape-growing areas where FD is present, insecticide treatments against the vector are compulsory. The Directive 2009/128/EC, establishing a framework for Community action to achieve the sustainable use of pesticides, encouraging the use of alternatives to chemical insecticides.
In this work we studied the efficacy of microbial and botanical pesticides against *Scaphoides titanus* Ball in different experimental conditions. The activity of azadirachtin 10g/L (Neemazal T/S®, CBC Europe), *Beauveria bassiana* 7.16 g/L (Naturalis®, Intrachem), pyrethrum 12,91 g/L (Pyganic®, CBC Europe) and spinosad 480 g/L (Laser™, Bayer Crop Science) was tested against young stages of the vector under field (on 2011, 2012), and semi-field (on 2013) conditions. The same products were tested against adults in semi field condition during 2011.
In semi–field experiments the effect of modes of exposure was considered. Insects were exposed to insecticides through residual exposure and through topical plus residual exposure.
In the field condition, Naturalis® and Laser™ showed an efficacy against young stage higher than 40%, while the other insecticides obtained a lower efficacy. The results obtained in the semi-field trials confirmed the efficacy of Naturalis® and Laser™ on *S. titanus*. Generally for all insecticides, the effect was higher in topical plus residual exposure compare to residual exposure only. Implication for *S. titanus* control of the use of microbial and botanical insecticides are discussed.

Key words: *Scaphoideus titanus*, microbial and botanical insecticides, Integrated Pest Management

Factors affecting the parasitoid complex of *Phyllocnistis vitegenella* Clemens in vineyards of Southern Switzerland

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Abstract: This poster presents the results of a survey conducted between 2011 and 2012, studying the abundance, distribution and parasitism rate of a micromoth, *Phyllocnistis vitegenella* Clemens (Lepidoptera: Gracillariidae), a new pest of grapevine in Canton Ticino and the response of the natural enemies following of his arrival. Male flight activity of *P. vitegenella* was monitored in 2011 using pheromone-baited traps in 22 vineyards. The micromoth was present in all sites and showed three evident generations only in the region of Mendrisiotto, in the South, were the leafminer has been first detected. In 2012, 50 infested leaves of *P. vitegenella* were collected 3 times from June to August in 18 vineyards, and the parasites were reared under laboratory conditions. Eleven species of parasitoids of the micromoth were observed, and parasitism rates ranged from 5 to 33 %. The most dominant parasitoids were the Eulophidae *Chrysocharis nephereus* (Walker) and *Minotetrastichus frontalis* (Nees), which were responsible for 86 % of the parasitism cases. The influence of environmental and management factors on parasitism rates was investigated by model selection techniques. As possible explanatory variables we considered topographic variables, rough land use categories within 500 m from the sampling sites, more fine-grained land use categories within 200 m distance from the sampling sites, and vineyard management characteristics, such as mowing frequency, fungicide or insecticide treatments and fertilization. Besides an influence of the latitude as probable consequence of the colonization dynamic of *P. vitegenella*, first results highlight also the importance of both land use and management variables. This confirms the importance of using an integrated approach for the understanding of the potential of biological control of indigenous parasitoids of grapevine pests.

Key words: vineyard, pest, leafminer, parasitism, biological control

Resistance to copper in *Lysobacter capsici* AZ78: a starting point for the development of a new sustainable management of *Plasmopara viticola*?

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Abstract: Little is known about the biology of members of the bacterial genus *Lysobacter* although it encompasses species with high potential in plant protection. In this work, we investigated on biological features of *L. capsici* AZ78 a strain capable to control of *Plasmopara viticola*, the causal agent of grapevine downy mildew. Interestingly, it has been assessed that AZ78 resists copper ions and its resistance to this metal is probably due to the presence of genes coding for copper oxidase (*copA*) and copper exporting P_{IB}-type ATPases (*ctpA*). Resistance to copper allowed *L. capsici* AZ78 to be combined with a low-dose of a copper-based fungicide, leading to more effective control of grapevine downy mildew. Furthermore, *L. capsici* AZ78 persists in the phyllosphere of grapevine plants and tolerates environmental stresses such as starvation, freezing, mild heat shock and UV light irradiation. These biological traits suggest that *L. capsici* AZ78 could be a suitable candidate for developing a new biofungicide to be used in combination with copper to control grapevine downy mildew.

Key words: *Lysobacter capsici*, *Plasmopara viticola*, copper, environmental stress

Aphidophagous insects in differently managed vineyards

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Abstract: Aphids are an important food resource for many predator and parasitoid insects. Syrphidae (Diptera), Coccinellidae (Coleoptera) and Braconidae Aphidiinae (Hymenoptera) are among the most important aphidophagous insects, together with some lacewings, gall midges and ground-dwelling spiders. In this study we investigate the community of the above mentioned taxa, by using malaise traps, in three differently managed vineyards with regard to the Grapevine Moth control and classified as MD (Mating Disruption vineyard), O (Organic vineyard) and C (Conventional vineyard). Each experimental plot was surveyed on the base of the vegetation surrounding the traps along the production season. From the data analysis it is possible to infer that the populations tend to spread in the environment (in space and time) in a manner that is consistent with the trophic resources available. Syrphidae and Coccinellidae result the most abundant groups, each one with over than 4,000 specimens captured. Syrphidae and Braconidae Aphidiinae are mainly present in the first part of the grape production season, Coccinellidae seem to play an important role all season long. Population of Braconidae Aphidinae and Coccinellidae benefit of the herbaceous layer surrounding the trap sites, though Coccinellidae seem linked to the presence of bushes too. Syrphidae are less influenced by the vegetation surroundings the traps. This is probably due to their greater flight ability in comparison with the other considered taxa.

Key words: Biodiversity, *Vitis vinifera*, predators, parasitoids, IPM

Vineyard landscape and natural pest control services in Bordeaux area

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Abstract: Agricultural intensification is recognised as one of the main drivers of biodiversity loss in agroecosystems. Increasing the reliance on ecosystem services has been recently suggested as a key step towards ecological intensification of cropping systems. Natural pest control by parasitoids and generalist predators is one of the major ecosystem services. Landscape context is known to affect pest and their natural enemies in most agroecosystems. However, this relationship remains poorly studied in vineyard landscapes. The aim of the present study was to examine the mechanisms between landscape characteristics, several major vine pests (grapevine moths and phytophagous mites), and their biological control by different natural enemies (birds, rodents, parasitoids). Pest population dynamics and natural pest control services (parasitism rates and predation) were monitored in 20 vineyards selected along a landscape complexity gradient in Bordeaux area. Our results revealed a positive relationship between landscape complexity and the grapevine moths (mainly *Lobesia botrana*) parasitism rates at a large scale (1 km radius). Predation by birds at the field edge increased with the proportion of semi-natural habitats in the surrounding environment (250 m radius). Predatory mites dynamics were mainly affected by within-field variables. Our study demonstrated that natural pest control services are determined by processes acting at multiple spatial scales and depending on species characteristics (e.g., body size, dispersal ability). These results provide guidelines for designing innovative pest management strategies at the landscape scale and will be completed by future research.

Key words: natural pest control; ecosystem services; landscape complexity; biodiversity; vineyard

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