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EDITORIAL

La réunion du groupe de travail OILB Lutte Intégrée en Viticulture s'est tenue à Gödöllö - Hongrie, organisée par une participante au groupe de la première heure, Erzebet Voïgt, que nous tenons tous à remercier chaleureusement.
Créé en 1974, ce groupe d'une trentaine de personnes comptait surtout des entomologistes. Au fil des années il s'est peu à peu étoffé, s'ouvrant en particulier aux mycologues. Actuellement il rassemble l'ensemble de la filière Recherche-Développement européenne impliquée dans la protection phytosanitaire du vignoble. Environ une centaine de personnes partagent leur activité dans six sous-groupes.

Le présent document mis en forme par Philippe Blaise, que nous remercions également très vivement, rassemble les travaux présentés lors de la réunion qui a eu lieu du 4 au 6 mars 1997. Au cours de la première matinée, un historique de la viticulture et de l'oenologie en Hongrie a été présenté, suivi d'un tour d'horizon sur la situation économique de la filière viti-vinicole après la privatisation. Enfin le point sur la protection intégrée du vignoble a terminé cette première demi-journée.
Ensuite les 6 sous-groupes (Maladies fongiques et bactériennes, Tordeuses de la grappe et insectes broyeurs, Acariens et insectes piqueurs, Mise en pratique de la protection intégrée, Maladies physiologiques, Entretien du sol / EWRS) se sont réunis pour exposer leurs travaux et leurs projets. La réunion s'est terminée par une séance plénière où les différents sous-groupes ont fait la synthèse de leurs activités.

Deux constats très positifs, fruits des réunions précédentes sont à faire :

- Les recherches initiées sur l'épidémiologie des maladies et des ravageurs permettent déjà d'initier des modèles, d'aménager la prophylaxie, de débusquer de nouveaux auxiliaires etc.
- Les directives pour la production intégrée en viticulture ont été publiées à la fin de 1996. Elles doivent servir de cadre pour l'élaboration de directives régionales, adaptées à la spécificité des productions régionales et à leur contexte socio-économique.

Concernant la vie des sous-groupes :

- Il faut rappeler que l'entretien du sol fonctionne avec EWRS compte-tenu que les participants appartiennent généralement aux deux organisations.
- Le sous-groupe "Maladies physiologiques" est maintenu malgré une activité restreinte. En effet, la dissolution pourrait entraîner à terme la disparition de cette discipline dans le groupe, ce qui pourrait n'être que préjudiciable.
- Enfin, nous allons tenter de redonner vie au sous-groupe "Effets secondaires" qui ne fonctionne plus depuis plusieurs années. K.J. Schirra de Neustadt a pris en charge son animation. Nous lui souhaitons de réussir dans cette tâche.

La prochaine réunion du groupe, organisée par Laura Dalla Montà devrait avoir lieu en Italie dans les vignobles du Chianti.

Bernadette DUBOS

The original papers have been reviewed by

Paolo Cortesi
Laura Dalla Montà
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Michael Maixner
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Studies on the germination of *Plasmopara viticola* oospores with a floating disc test

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A sensitive floating disc method was developed to detect the production of very low number of zoospores. Theoretically, the floating disc test can demonstrate the presence of 2 to 3 germinated oospores per sample.
The germination of oospores was studied over a 1 to 3 year peiod, at three sites in Rheinhessen and several other growing districts. Leaves with oilspots were collected in the autumn and crushed in a household blender to a peat moss-like mass. A 2 cm layer of this material was spread on the surface of loamy soil in plastic boxes and placed in the vineyards. Each year, 5 to 7 ml samples were taken at regular intervals from March to September. Controls consisting of sterilized crushed leaf material were treated in the same way in order to determine the rate of contamination by zoosporangia from the secondary cycle of the disease.
From 1994 to 1996, oospores required 7 to 8 days for germination in March, decreasing to 8 hours near budburst. At all of the sites studied, in all years, even after the cold dry and extended winter of 1995/1996, germination reached a high level at pheno-stage "three leaves unfolded". In 1994 and 1996, germination persisted from budburst until the second decade of June, in Rheinhessen. In 1995, however, after a fairly dry period at the beginning of May, for 20 days the germination of oospores required an incubation of 3 to 4 days. At the beginning of June, during a rainy period, the oospores recovered their germination potential. At this time, severe primary infection occurred in the vineyards. In 1996, in the more humid region of Baden, four distinct periods of high germination rates alternating with low rates of germination were observed from budburst to the pea-size berry stage. Germination continued as late as mid-July.
From these findings, it is clear that in Germany oospores are fairly well adapted to the local phenology of the grapevines. Dry periods with higher temperatures may interrupt their potential for rapid germination. However, oospores seem to be able to recover to a certain extent during the month of May, if wet weather returns. Although the germination rate decreases steadily toward the end of May each year, the presence of active oospores must be expected even during the postbloom period in wet years. Surprisingly, the date of primary infections observed in the vineyard was often much later than expected from the germination activity of oospores. There was no significant difference in the germination behavior of oospores between vineyard sites with severe or moderate incidence of downy mildew. It is possible that rain conditions, drop size and wind speed, are more important in primary infection than the actual germination rate of oospores.

Reduction of fungicide applications for control of grape downy mildew (*Plasmopara viticola* Berk. et Curt.) Berl. et De Toni by use of a radio forecasting system

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Introduction

The radio forecast system, addVANTAGE 3.10, (formerly known as Agroexpert) of ADCON Telemetry GMBH, A-3400 Klosterneuburg, is in use in the viticultural regions of Romania, Austria and North America. A study was undertaken to determine if this system could also be useful in a northern grape growing region, the district Moselle-Saar-Ruwer, Germany, where the infection pressure, caused by downy mildew, is also high in some years.

Material and methods

In 1995, a year of high infection pressure, field experiments were conducted in four vineyards in the region of Bernkastel-Kues. Two of the sites were located on steep slopes of the upper terrace of the Moselle in Kues (Fiershkapelle) and in the village Wolf. The third experiment in Wehlen was carried out in a vineyard on a gentle slope in the middle terrace of the Moselle beneath a forest. A fourth experiment was carried out in a vineyard in the plain on the lower terrace of the Moselle in Kues, in an area called Terrassen. All trials consisted of three treatment regimes: untreated, treatment timed as directed by the addVANTAGE 3.10 program and treatment every fortnight in the conventional manner according to the persistence of the fungicide. An electronic sensor for measuring the temperature and leaf wetness was installed between the grapes in each treatment group. Nearby, a radio transmitter with an integrated rain gauge and a solar panel was set upon a pipe at a height of about 3 meters. In addition to the four radio transmitters in Kues, Wehlen and Wolf, a fifth transmitter was used as a relay station on the hills of the middle Moselle above Graach-Schaferei to relay signals to a central computer at the Institute. For control of *Plasmopara viticola* and Oidium, the fungicides Aktuan SC, 0.05% (200 g/l Cymoxanil and 333 g/l Dithianon) and Topas (100 g/l Penconazol) were used. All product were applied with an engine driven portable sprayer in a low volume four-fold concentration.

Results and discussion

<u>Meteorological conditions</u>

The total rainfall of 466.5 mm (long-term average: 248.4 mm) was extraordinarily high in the period from January to April. Because of the wet winter and spring, conditions were favorable for the development of downy mildew. As a result, the infection pressure of *P. viticola* was, in 1995, higher than in previous years. Rainfall totals at the four location were similar between May and August, between 232 and 252 mm (long-term average in Bernkastel-Kues: 276.5 mm).

Epidemiology

In 1995, the germination of the winter spores probably occurred on May 17 and 18, after rainfall of 10 mm. After an incubation period of 14 days to 3 weeks, the moisture conditions favored an outbreak which was first observed on June 6. First symptoms were observed on a young grapevine near the trial in Wehlen in a vineyard which had not previously been sprayed.

Prognostic system

On June 6, the forecast system recommended spraying susceptible varieties in Kues (Fierskapelle) 1 day before symptoms of downy mildew were first observed on leaves in Wehlen. On June 5, the incubation period had come to an end in Wehlen, as well as Wolf. In the vineyard, in Kues (Terrassen) only 22% of the incubation period had passed.

All four vineyards were sprayed on June 6. After 11 mm of rainfall, a spray was called for on June 26. An additional spray was called for June 17, in Terrassen, because of greater humidity in the valley.

The vineyards at Fierkapelle and Wolf, both on steep slopes, only required three fungicide applications, whereas the vineyards in Terrassen and Wehlen required four. This indicates that location on a steep slope was less favorable for disease.

In the conventional treatment group, vineyards were sprayed five times. The radio forecast system worked perfectly except in the Wehlen vineyard. Some factors which may have contributed to the problems experienced in this site were the fact that the sensor was placed near the forest instead of in the middle of the parcel and there was an abnormally high infection pressure due to an unsprayed vineyard nearby.

Conclusions

The absence or insignificance of infection in Kues and Wolf, in the summer of 1995, despite a moderately strong infection pressure by *P. viticola*, indicates that the addVANTAGE 3.10 system worked perfectly well. The Adcon Telemetry system can be recommended for the grape growing region Moselle-Saar-Ruwer, although experiments with helicopter sprays are still needed.

Primary infection occurrence in grapevine downy mildew

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Introduction

In most Italian grape growing regions, fungicides are first applied for the control of downy mildew when the requirements of the three-tens rule have been fulfilled. This rule requires 10 cm shoot length (i.e. Baggiolini's stage F), 10°C minimum air temperature, and at least 10 mm rainfall in 24 to 48 hours. Since only a few oilspots appear at first, may people feel that this rule is too strict. In order to better understand the occurrence of primary infections and thus develop new strategies, the germination dynamics of *Plasmopara viticola* oospores have been studied since 1991. Oilspot development was assessed, from 1993 to 1995, in an area with a high-incidence of downy mildew.

Material and methods

All experiments were carried out in a Merlot vineyard located in the Treviso province (northeastern Italy). Leaf areas with oospores were identified in the autumn. These leaves overwintered on the soil surface in the vineyard. Germination of about 1000 oospores was assayed every 15 days from January to June on water-agar in Petri plates incubated both at 20°C and outdoors. The number of germinated oospores was recorded daily in order to calculate the germination percentage (G), minimum and median germination time (TminG/TmedG). Plants were observed for symptoms every 2 to 3 days on a 4500 m^2 unsprayed plot. The plot was reduced to 1500 m^2 for subsequent oilspot surveys.

Results and discussion

The dynamics of oospore germination over the period from 1991 to 1993 have previously been discussed (Serra and Borgo, 1995). In the spring, oospore germination was principally increased by during periods of low temperature and heavy rainfall. Relationships between overwintering conditions and germination trends were more difficult to find.

Outdoor germination trials provide more interesting information in that they are closer to natural germination conditions. Oospore germination began when the mean temperature approached 10°C. Once conditions for germination were reached, a subsequent decrease in temperature did not stop germination but only lengthened the time required. Under outdoor conditions, the time require for germination was longer early in the season and shortened later to be similar to that recorded in the 20°C trials. The average time required was 5 to 6 days with 3 days as a minimum.

These results provide the criteria for re-examination of the three-tens rule. A temperature of 10°C can be considered as a mean instead of a minimum (in April 1991, germination occurred at a lower temperature). Temperature is seldom a limiting factor if the grapevine is receptive, although temperatures below the seasonal mean can slow germination. The soil must remain wet long enough for macrosporangial formation. Because this never occurred in less than 3 days, oospore germination and infection of the plants is improbable when only 10 mm of rain has fallen over a 2 day period. On the other hand, less than 10 mm could be enough for infection of grapevines if macrosporangia are present and a shower occurs. Factors such as

type of soil, vineyard exposure, and climate are very important. Under experimental condition of mean rainfall 1173 mm/year, high moisture, low wind, stony soil in a vineyard lying in a plain, the three-tens rule worked all but 2 years: 1991 and 1996 (Tab. 1). In these years, shoot development was irregular, i.e. on May 2, 1996, only 30% of shoots were receptive (10 cm or more). Chances of infection were diminished.
The germination percentages decreased in April and May, except in 1991. The results of germination assays are reported in Table 1. Given the germination percentage, the rate of primary infection was expected to be high with rapid spread of disease. Instead, disease development was very slow (Fig. 1). The opposite occurred in 1995, when germination percentages were low and disease spread was very rapid. This trend can be explained by the

Table 1. Three-ten rule reliability and oospore germination results related to first infective rain.

YEAR	Stage F	3-10 rule	Infective rain	Symptom appearance	Germin. assay	G (%)*	TminG (days)*	TmedG (days)*
1991	08-May	09-May	15-May	29-May	10-May	9	6	11
1992	04-May	07-June	7/10-June	16-June	05-June	0.2	7	9
1993	06-May	03-June	03-June	10-June	04-June	0	-	-
1994	02-May	05-May	05-May	16-May	06-May	2.3	5	9
1995	07-May	10-May	10-May	24-May	12-May	0.8	3	4
1996	02-May	02-May	10/12-May	20-May	10-May	0.4	7	8

* Oospores incubated outdoor.

length of time require for germination which was the lowest in 1995 and about the highest in 1991 (Tab. 1).
In 1993, two oilspots and two clusters infection were observed on June 10 and the number of oilspots remained low (about 15) until the end of June. In 1994, two oilspots were observed on May 16. The number increased to 11 by May 26, but more than 200 were observed on May 30. In 1995, two oilspots were observed in May 24, 10 in the next two days and about 73 by the end of May. All oilspots were considered to be primary infections considering climatic conditions, sporulation and distribution of early symptoms. Indeed, there were very few oilspots. Further increase in number was: slow in 1993, first slow then more rapid in 1994, very rapid in 1995. Although oospore germination was very low, waves of primary infection occurred increasingly with light continuous rain. Soil remained wet for a longer period, allowing more oospores to germinate.

Conclusions

It is still difficult to forecast the rate of primary infection based on oospore germination dynamics. There is no explanation for low oospore germination during receptive stages. Nevertheless, the rate of primary infection can be high depending on climatic conditions beginning from bud burst. The three-tens rule is reliable in areas of high mildew incidence and can be a satisfactory guide to time fungicide application even if the first oilspots are few. Attempts to postpone the first spray to when primary infection was higher or after the appearance of symptoms were effective only in years unfavorable to primary infection development (Serra *et al.*, 1996). A better understanding of downy mildew epidemiology is necessary to further improve control strategies.

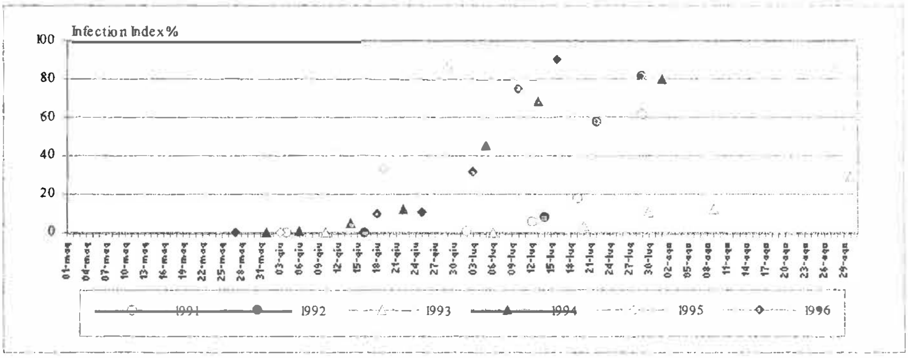

Figure 1. Disease development on clusters (cv Merlot)

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Primary infections of *Plasmopara viticola*: should we revise our ideas about the quantitative relevance of oospores?

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Introduction

According to current knowledge, epidemics of *Plasmopara viticola* are initiated by a few primary infections issued from overwintering oospores, which lead to many secondary infections responsible for the explosive character of the disease. This scheme is also the one used for the modeling of *P. viticola* epidemics as well as in all forecasting systems in use (Blaise, 1991). Although the observed pattern of epidemic development in the field usually tends to confirm this hypothesis, the occurrences of epidemic situations which cannot be explained (e.g. Hill, 1994) led us to reconsider the relative importance of primary vs. secondary infections.
If late infections can be assumed to be secondary, i.e. issued from already existing lesions, for early infections two scenarios are possible: 1)very few primary infections followed by numerous secondary infections, corresponding to a disease with a high Rc (multiplication rate *sensu* Van der Plank, 1963), or 2) numerous primary infections followed by comparatively few secondary infections, i.e. a disease with a low Rc. To clarify which scenario occurs in the field, we need to be able to distinguish primary from secondary infections.
Considering that *P. viticola* is heterothallic (Grünzel, 1961), that it overwinters only as oospore, i.e. after sexual recombination, and that secondary infection come from asexual spores, genetically different lesions must originate from different primary lesions, while genetically identical lesions are issued from the same primary lesion. The distinction between primary and secondary lesions can thus be made by genetical analysis.
As a first step to clarify the quantitative role of oospores in the development of grapevine downy mildew epidemics, the analysis of the initial phase of an epidemic done with molecular genetic methods is presented here.

Material and methods

From the beginning of May 1996 a non-treated vineyard near the Lake Zurich, planted with Riesling-Sylvaner grapevines, was observed once a week for *P. viticola* lesions and sporangia were collected from each new sporulating lesion. The isolates obtained were multiplied separately on Riesling-Sylvaner seedlings in the greenhouse and then stored at -20° C.
The DNA was extracted from ground frozen sporangia with a slightly shortened version of the Total-DNA CTAB Mini-Prep-Extraction from Zolan and Pukkila (1986). Random amplified polymorphic DNA (RAPD) profiles were generated with five primers. Sixteen polymorphic markers were used to discriminate the different isolates.

Results and discussion

Lesions were observed from June 12 to June 24. Sporangia were collected from all new lesions. On July 2, the new lesions were too numerous to all be sampled, and only three isolates were collected randomly. From the 62 lesions which appeared in the first three weeks, 43 isolates were successfully multiplied in the greenhouse, so that enough DNA material was available for the genetic analysis (Tab. 1). The RAPD polymorphism revealed that at least 33 different genotypes were present in the collected samples, leading to the conclusion that at least 33 out of 43 lesions originated from oospores i.e. were primary infections. Taking into account the size of the trial vineyard, this corresponds to 600-800 primary lesions/ha, which is clearly beyond the number of 50 primary infections per ha assumed in some forecasting models (Hill, 1990).

If, as these results suggest, oospores represent the main source of inoculum over a long period, this could explain why the existing downy mildew models realistically simulate epidemics most of the time but sometimes fail to predict some heavy infections.

Table 1. Results of the sampling and analysis of a *P. viticola* epidemic in a non-treated vineyard. Columns 2-5 correspond to the four sampling dates, column 6 is the cumulated total over the four samplings.

	12.6	18.6	24.6	2.7	Total
New lesions observed	24	16	22	many	-
New lesions analyzed	19	11	10	3	43
New genotypes	18	8	5	2	33
found once	17	7	3	1	23
found twice	1	1	2	1	10

Conclusions

Although further quantitative studies have to be conducted, these first results suggest that the ratio between primary and secondary lesions may be much higher than has been thought until now. We conclude that the quantitative role of oospores in downy mildew epidemics of grapevine has to be reconsidered.

Acknowledgments

We would like to thank the Wädenswil research station for providing the trial vineyard, and W. Siegfried for his help in the sampling. This work was supported by the Swiss National Foundation for Scientific Research grant 31-39848.93

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A model describing the influence of *Plasmopara viticola* on the yield of grapevine

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Introduction

Field results suggest that *Plasmopara viticola* epidemics remaining at a low severity level do not reduce yield of grapevine (*Vitis vinifera*) quantitatively or qualitatively (Jermini *et al.* 1994). Existing forecasting models lead to spray recommendations based on predictions of disease events, but unrelated to the risk of loss. Coupling a physiological model of grapevine with a simulation model of downy mildew epidemics should allow quantification of the risk of damage from the disease at any time of the season (Blaise *et al.* 1996). A progress report of the development of such a model and comparison of simulation results with field data are presented here.

Material and methods

The models

The models have been described in detail elsewhere (Blaise *et al.*, 1990; Wermelinger *et al.*, 1991, Blaise *et al.*, 1996). Briefly, the **epidemic model** is driven by hourly values of temperature, relative humidity, precipitation and leaf wetness, and is composed of two parts: i) a mechanistic model based on the asexual life cycle of *P. viticola*; ii) an analytical model driven by the first one and based on a progeny/parent ratio model (Blaise *et al.*, 1992) which describes the epidemic quantitatively. The **grapevine model** is a dynamic crop growth model for dry matter assimilation and allocation in grapevine using the metabolic-pool approach (Gutierrez *et al.*, 1979) to allocate photosynthates to the different organs (leaves, fruits, shoots and roots). It is driven by daily values of solar radiation and temperature (day degrees over 10°C). The **interactions** between the **models** are bi-directional: i) infections on clusters produce a direct reduction of yield, while those on leaves reduce the photosynthetically-active leaf area by a factor proportional to the diseased area; the photosynthetic rate of the diseased leaf area is reduced differently for incubating, sporulating and dead lesions. ii) influence of the host on the pathogen occurs through the available colonizable area. Because the leaves are modeled as cohorts of the same age class, the ontogenic resistance of the grapevine can also be taken into account. Unfortunately, a straightforward connection at the trophic level can not be made because the carbohydrate demand of the pathogen is unknown.

Field data & Simulation requirements

Experiments were conducted and weather data collected from 1988 to 1991 and from 1994 to 1996 in treated and untreated vineyards in southern Switzerland. The details on the vineyard and the experiments have been described earlier (Blaise *et al.*, 1996). Date of bud burst was determined by field observation and not simulated by the model.

Results and discussion

The simulated development of grapevine leaf area was similar to field data not only in the course of the individual seasons but it followed also the yearly variations (exemplified for 1995 and 1996 in Fig.1). In the current version of the model, yield is expressed as fruit dry mass, which does not allow to distinguish yield quality from yield quality. However, relating the sugar contents in the non-treated and treated plot, and comparing it to the proportion of the simulated fruit dry mass in the non-treated plot to this value in the treated plot reveals that the simulated fruit dry mass is a good indicator of the influence of the disease on this quality parameter (Tab. 1). On the other hand, building the same ratio for the yield quantity shows that, although the trend is well rendered by the simulated dry mass, other parameters have to be taken into account for the correct simulation of the yield quantity. Simulations of epidemic development accurately reflected field results in the first and in the explosive phase but not in the final phase (only 1995 shown, Fig. 2).

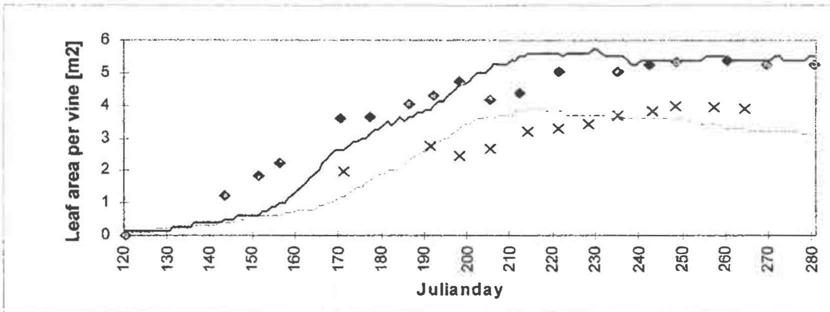

Figure 1. Development of grapevine leaf area in a treated vineyard. Results from the simulation in 1995 (- -) and 1996 (—) and corresponding field data (1995: ×, 1996: ◆).

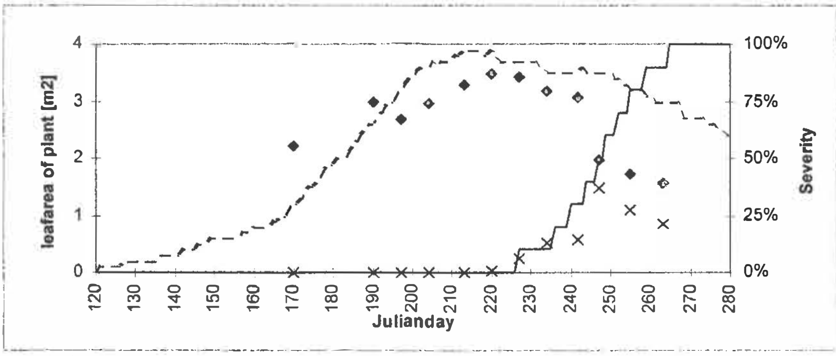

Figure 2. Disease severity of *P. viticola* and grapevine leaf area in a non treated vineyard in 1995. Results from the simulation (severity: solid line, leaf area: dotted line) and corresponding field data (severity: x, leaf area: ◆).

Conclusions

The main benefit of the coupled model is to provides the possibility to express the influence of the parasite on carbohydrate production of the plant. This enables us to relate a certain disease level at a given time to a corresponding yield reduction at a later time. The simulation results indicate the need to improve the model for yield estimation, which has now been taken in account.

Table 1. Ratio of yield parameters and simulated fruit dry mass between the non-treated and the treated plots in seven different years.

Year	1988	1989	1990	1991	1994	1995	1996
Yield quantity	-	94%	130%	94%	67%	84%	114%
sugar components	-	**90%**	**98%**	**101%**	**90%**	**92%**	**95%**
Simulated fruit dry mass	34%	91%	100%	100%	89%	97%	99%

Acknowledgments

We thank Brion K. Duffy for critical reading of the manuscript. This work was supported by the Swiss National Foundation for Scientific Research grant 31-39848.93.

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Effect of foliar sprays of phosphates and carbonates on grape vine powdery mildew.

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Introduction

In ecological pest management systems, powdery mildew of grape caused by *Uncinula necator* is mostly controlled by routine sulfur sprays and in Germany 6-10 routine treatments are currently applied. Thus investigations on alternative methods for disease control are required in order to reduce sulfur residues on grapes and to decrease side-effects on predatory mites. The effect of inorganic salts, such as phosphates and carbonates, in suppressing powdery mildew is described in the literature (Punja and Grogan, 1982; Horst *et al.*, 1992; Reuveni and Reuveni, 1994; Reh and Schlösser, 1995). The purpose of this investigation was to study the efficacy of K_2HPO_4 and $NaHCO_3$ on oïdium in greenhouse and field experiments, their mode of action and some ecotoxicological and enological aspects.

Material and Methods

In 1995, field experiments using Müller-Thurgau grapevines were performed in three commercial vineyards in the region of Rheinhessen. Seven foliar sprays of 0.75 % K_2HPO_4 and 1.0 % $NaHCO_3$ were applied under high, medium and low infection pressure. Greenhouse experiments with Müller-Thurgau cuttings were conducted at SLFA Neustadt. Conidia were removed using a pencil and placed on glass slides and grapevine leaf discs in order to study germination. Slides were placed in petri dishes on wet filter papers, leaf discs were placed in petri dishes on water agar and both were incubated at 22° C. 24 h after inoculation, prints of leaf discs were done by adhesive tape and fixed on glass slides. Germination and mycelial growth were assessed by microscopic observation. Scanning electron-microscope observations were aimed at determining the structure of germinating conidia and the dispersion of the foliar sprays.

Results and discussion

Foliar sprays of 0.75 % K_2HPO_4 and 1.0 % $NaHCO_3$ were able to inhibit powdery mildew development to a satisfactory degree only in the case of low infection pressure. In a field experiment under high infection pressure, disease severity rating was 8,2 (on a 0-10 scale) on non-treated control clusters and 5.9 and 5.3 on clusters treated with O.75 % K_2HPO_4 and 1.0 % $NaHCO_3$, respectively. In field experiments as well as in greenhouse experiments, the efficiency of K_2HPO_4 and $NaHCO_3$ sprays could be improved by addition of 0.1 % sulfur. The efficiency of both salts could partly be explained by the inhibitory effect on conidia germination (Tab. 1) which was corroborated by electron-microscope observations. A curative effect on mycelium growth could not be observed. Foliar sprays of K_2HPO_4 and $NaHCO_3$ had no influence on predatory mites. No negative effects on fermentation of musts could be observed.

Table 1: Germination rate (%) of conidia on slides and leaf discs 24 h after inoculation. (values = mean value of 10 replications)

	conc. (%)	germination rate (%) on slides	germination rate (%) on leaf discs
H_2O		20,97	28,29
K_2HPO_4	0,75	13,03	13,98
$NaHCO_3$	1	10,41	11,18
K_2HPO_4 + sulfur	0,75 + 0,3	5,58	8,27
$NaHCO_3$ + sulfur	1,0 + 0,3	4,81	8,28
Sulfur	0,3	10,01	9,44
Topas	0,015	12,38	12,08

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First indications for a race specific resistance against *Plasmopara viticola*

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Introduction

In Germany and Switzerland, the use of grapevine varieties resistant to downy and powdery mildew is rapidly increasing. Some new varieties (for example Regent and Johanniter) are classified as *Vitis vinifera*, because their habit and the vine-quality are similar to the European varieties. Some of these hybrid varieties, normally considered to be field resistant, were heavily infected by downy mildew (*Plasmopara viticola*) in vineyards at the end of the growing season in 1994 (Wildeck, Germany), in 1995 (Oberwil, Switzerland) and in 1996 (Oppenheim, Germany). Isolates from these vineyards were evaluted by laboratory tests. The tests should show if specific interaction between vine varieties and isolates (specific adaptation) could be the cause of this phenomenon.

Materials and methods

Grape varieties and fungus isolates

Two populations from seriously diseased Johanniter-grapevines in Germany in 1994 (isolate We02) and from Regent-vines in Switzerland in 1995 (We04) were isolated. Isolates We01 and We03 were obtained from the highly susceptible European variety Trollinger in 1994 and 1995. We01 spread very slowly in the field and grew poorly under laboratory conditions. We03 was selected because of its extreme spread despite fungicide treatments. A supposed resistance to fungicides could not be confirmed. The isolates were propagated on Trollinger leaves. Only young sporangia (max. two days old) were used.

Test procedure

Fifteen leaf disks (diameter 3 cm) were inoculated with 0.007 ml/cm² of a 50000 sporangia/ml suspension (350 sporangia/cm²) and were incubated as floating disks upside down on water at 20°C under a 16/8 h day/night photoperiod. During the first 20 hours, the disks were kept at 100 % relative humidity. Then they were dried and incubated at 70 % r.h. for 10 days. After 3 days with 100 % r.h., when the maximum of sporulation was reached, the percentage of leaf area with sporangiophores was assessed visually. In test no. 1, isolates We01 and We02 were evaluated. Test no. 2 was carried out with isolates We02, We03 and We04. Four temporal replications of the complete test were carried out.

Results and discussion

For one variety (Johanniter), a constant ranking of disease incidence of fungus isolates and vine varieties was found (= horizontal resistance). LI *et al.* described similar results (1986) using monosporocystic clones. Grünzel (1960) did not find any variation between isolates from different vineyards. Regent showed a significant difference from constant ranking in combination with isolate We04 (= partial vertical resistance). Therefore, adaptation of the parasite could be the reason for the resistance breakdown of Regent.

Mean values of disease incidence (% leaf area infected) in experiment 1			
isolate	vine variety		
	Trollinger	Johanniter	mean
We01	23,3	14,5	18,9
We02	57,8	36,8	47,3
means	40,5	25,6	33,1

Mean values of disease incidence in experiment 2 (expected values in brackets)				
isolate	vine variety			
	Trollinger	Johanniter	Regent	mean (mean effect)
We02	38,5 (34,1)	20,2 (20,0)	14,5 (19,1)*	24,4 (-2,7)
We03	40,3 (42,0)	29,8 (27,9)	26,8 (27,0)	32,3 (+5,2)
We04	31,5 (34,3)	18,0 (20,2)	24,2 (19,3)*	24,6 (-2,5)
mean (mean effect)	36,8 (+9,7)	22,7 (-4,4)	21,8 (-5,3)	27,1

* = significant difference from expected mean value

Conclusions

Resistance in *Vitis* to downy mildew (*P. viticola*) is normally assumed to be inherited polygenically. But, in most cases, the real inheritance of resistance is unknown. Diehl (1988) calculated a heridity (h_e^2) up to 0.39 for resistance against *P. viticola*. This indicates that in some cases resistance could be inherited oligogenetically. Polygenic resistance is always horizontal (non-race specific) while oligogenic resistance can be race-specific (vertical) (Robinson, 1976; Vanderplank, 1968). The frequency of vertical genes (matching genes) rapidly increases in the parasite population if a threshold is exceeded which depends on the costs of virulence (Geiger et al. 1980). In this case a breakdown of resistance occurs. To date, the genotype of Regent has been very rare in the European *V. vinifera* population. Under these circumstances specific, resistance breaking races of *P. viticola* should be few at the beginning of the season but increasing in Regent vineyards at the end of season. An increasing use of the resistance genes of Regent could result in a high frequency of specific fungus genotypes even at the beginning of the season. This could end in a total loss of resistance. Therefore Regent should only be used very carefully in further breeding.

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Prediction of bud infection by *Uncinula necator*

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From 1990-96, epidemiological studies on *Uncinula necator* were carried out in three untreated vineyards in Rheinhessen (Germany). Both the occurrence of Oidium flag shoots and the progress of the disease were monitored. Between 1990 and 1994, severe Oidium attacks lead to a complete loss of the crop in the experimental plots. In 1995, despite rather cool and wet conditions during the prebloom period, the epidemic was severe. In 1996, however, the disease progress was much retarded. Unexpectedly, the number of flags also decreased at a rate of up to 90% from 1995 to 1996.
Since cultural measures including spraying were not changed, the observed differences in disease levels could be due to climatic factors. To elucidate the impact of climate on disease progress during the prebloom period, simulations were calculated with the model OISTAR.

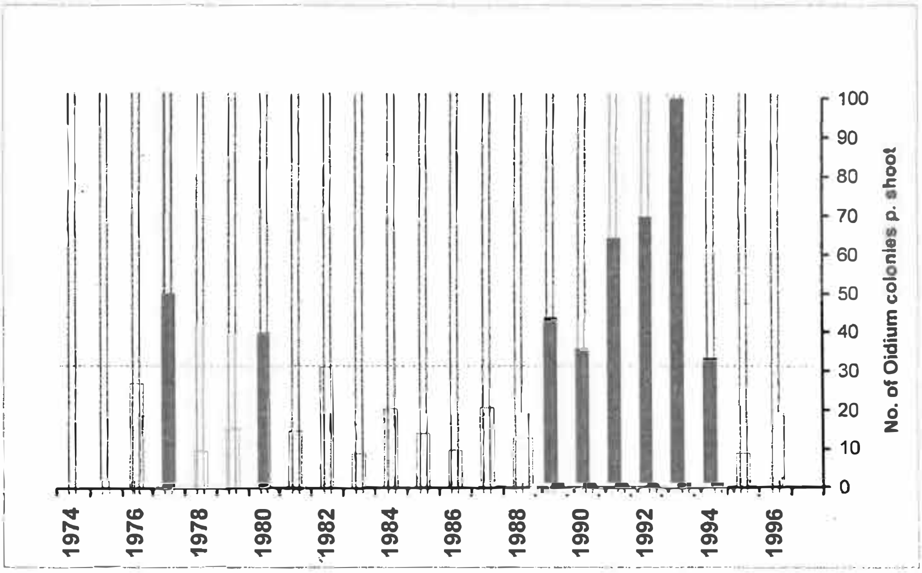

Figure 1. Simulation of the Oidium disease pressure for the phenological stage "5 days before bloom" at Oppenheim.

This model describes the Oidium epidemic on leaves of cv. Mueller-Thurgau, starting from primary inoculum emerging from infected winter buds. Parameters were daily mean temperature, daily rainfall and daily leaf wetness duration. Disease pressure was estimated in terms of the number of Oidium colonies per shoot. From spray trials, it is known that the infection of winterbuds on the nodes 1-10 (basipetal) of the new bursted shoots takes place between bud burst and the beginning of bloom. Figure 1 shows the simulation of the disease pressure five days before the beginning of bloom for the Oppenheim site from 1976-1996. For each year, the simulator was started with a constant primary inoculum of 10 flag shoots per 100 vines.

Figure 1 indicates the potential infection pressure from winterbuds on the potential fruit canes for the following year. In 1995 the infection pressure was comparatively low during the preflower period, which could explain the reduction of flags in spring 1996. The same applies for the years 1978-88, a period exhibiting a quasi-absence of the disease in regularly sprayed vineyards. Further studies are required to determine to what extent other factors such as overwintering conditions and hyperparasitism affect the frequency of Oidium flag shoots the following year.

Cleistothecia of *Uncinula necator* are an additional source of inoculum in Italian vineyards

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Introduction

Mycelium of *Uncinula necator* overwintering in dormant infected buds (Pearson and Gärtel, 1985), has been considered the principal source of primary inoculum for grape powdery mildew in Europe, whereas cleistothecia have been shown to be the sole source of primary inoculum in New York (USA) where flag shoots have not been observed (Pearson and Gadoury, 1987). Our objectives were to determine a) the possible role of cleistothecia in epidemics of grape powdery mildew in Tuscany where these epidemics are often severe and b) to quantify the density and viability of cleistothecia on leaves, on bark, and in the soil.

Material and Methods

Bark, leaves overwintering on the ground and soil were collected in early spring in three commercial vineyards in the Florence and Siena provinces of Tuscany for three years. The Corti di Sotto vineyard (Florence), planted with cultivar Sangiovese is 1 ha, and is isolated by surrounding forests. The Santa Cristina vineyard (Florence), planted with cultivar Chardonnay, is located in a large vine growing area. The Fornace vineyard (Siena) is 0.7 ha, planted with cultivar Sangiovese, and surrounded by olive orchards. For each vineyard, bark was collected from the upper trunk of three vines (or fewer where specified), which were cordon-trained and spur-pruned, from each of five locations that were evenly-spaced along the diagonals of the vineyard. Soil on the surface (1-2 cm deep) and leaves overwintering on the ground were collected from the same locations. Samples were air-dried in the laboratory at room temperature. Density and viability (Cortesi *et al.*, 1995) of cleistothecia from bark, leaves and soil were determined.

Results

A higher density of cleistothecia was found on leaves overwintering on the ground than on bark. However, the percentage of viable cleistothecia was higher on bark. No viable cleistothecia were recovered from soil. The estimated density of viable cleistothecia on bark was higher in Fornace vineyard in 1995 (47000 / kg of dry bark) than in Corti and Santa Cristina, where over the three years density of viable cleistothecia was always $\leq$ 1000 / kg of dry bark. Density of viable cleistothecia on fallen leaves was higher in 1996 when 7000 and 11000 viable cleistothecia / kg were found in Fornace and Santa Cristina, respectively. *U. necator* overwintered as mycelium in dormant infected buds only in Santa Cristina, where 20 and 92 flag shoots / ha were detected before bloom in 1994 and 1995, respectively. Disease incidence and severity increased similarly at Corti, Fornace, and at Santa Cristina, although powdery mildew epidemics started from ascospores only in Corti and Fornace, while flag shoots were present at Santa Cristina. Cleistothecia were formed in autumn in both 1994 and

1995, and dispersal started in late-September mid-October, with the maximum number trapped in funnels during the second half of October.

Conclusion

Cleistothecia appear to function as the sole source of primary inoculum for grape powdery mildew in some Italian vineyards, and to serve as an additional source of inoculum where the pathogen also overwinters in infected buds. The role of cleistothecia in the epidemiology of grape powdery mildew appears similar to that recently reported from North America and Australia (Pearson and Gadoury, 1987; Stapelton *et al.*, 1988, Magarey *et al.*, 1997).

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In vitro investigations on the efficacy of botryticides

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Introduction

The goal of the present study was to determine the efficacy of two new fungicides, Botrylon and Scala, against *Botrytis cinerea*. The current extent of the resistance of *B. cinerea* to the dicarboximide fungicides, Ronilan, Rovral, and Sumisclex, was also investigated. Results of these investigations are important for the development of recommendation for applications for control in practice. Previous studies (Holtz, 1979 and 1983) showed that dicarboximide resistant strains of *B. cinerea* are widespread in German viticulture. The efficacy of treatment with dicarboximide fungicides has diminished since about the year 1980.

Material and methods

Laboratory investigations were carried out using the Petri dish diffusion test described by Gartel (1967). For this test, 0.9 cm diameter filter paper disks were soaked in the following fungicide concentrations: 1/125, 1/25, 1/5, undilute and five-fold of the recommended concentration for practice. The soaked filter paper disks were place on 15 cm Petri plates of potato dextrose agar so that the active ingredient could diffuse into the agar. The agar surface was then inoculated with a suspension of conidiospores. The germination of conidia and growth of mycelia were then recorded. Rovral 0.075% (500g/kg Iprodione as WP), Botrylon 0.125g/kg (250g/kg Carbendazim + 250 g/kg Diethofencarb as WP), Scala 0.125% (400g/l Pyrimethanil as SC) and Switch 0.06% (375 g/kg Cyprodinil + 250 g/kg Fludiozonil as WG, CGD 20450 F) of Novatis (Ciba-Geigy & Sandoz were tested. Switch is not registered for application in German viticulture. Euparen WG 0.2% (515 g/kg Dichlofluanide as WG) was used as a contact botryticide in comparison to the above mentioned products.

Results and discussion

Investigation into the resistance to new fungicides was begun in 1994, when five strains of *B. cinerea* were tested against Botrylon and Rovral. This was the year that Botrylon was registered for application in viticulture in Germany. All strains tested were sensitive to Botrylon. In 1995, 19 strains were tested against Scala, Rovral Botrylon, and Euparen using the diffusion test. Only one strain was resistant to Botrylon. The results of our tests on the fungicide, Scala, are not presented here because a potato dextrose agar medium was used and this is not in accordance with the FRAC [methods for monitoring fungicide resistance of the international group of national associations of manufacturerers of agrochemical products of EPPO (Birchmore and Forster, 1996)]. In 1996, the results of resistance tests on Scala seemed to be too high in comparison with the performance of the product in the field. Scala should be retested on synthetic media in line with the FRAC guidelines. In 1995, in the diffusion test using Scala, none of the strains tested demonstrated resistance, whereas, in the test using Rovral, 8 of the 19 strains tested (42%) were resistant.

In 1996, 24 strains were tested on potato dextrose agar. This was the first year that Switch was tested. The development of resistance to dicarboximides that has been observed in the field since they were introduced in 1975 was corroborated by the fact that 50% of the isolates tested were resistant to Rovral. Sporadic resistance to Botrylon was observed. In agreement with other investigators, no cross-resistance between fungicide groups was observed.

Conclusions

Given the level of resistance observed in tests using dicarboximides, Ronilan WG, Sumisclex WG, it is recommended that these fungicides be used only once in a growing season. In 1994, when Botrylon was introduced, no resistant isolates were found. The fact that the first slightly resistant strain was isolated in 1995 indicates that this fungicide should also only be applied once in a growing season. In the field, Scala has proven to be effective and no incidents of resistance have been reported. No resistant strains were found in diffusion tests on potato dextrose agar, in 1995. In that the Frac guidelines require the use of a special synthetic medium for testing the anilino-pyrimidine fungicide, Scala, no information can be given on the presence of resistant strains in the German vineyards. With regards to these guidelines, our results of laboratory trials were not representative for Scala in 1995 and 1996. The detection of three resistant strains in our tests using Switch agrees approximately with the results of investigations of other groups working in Switzerland.

Table 1: Percentage of 24 isolates of *Botrytis cinerea* from the Moselle region sensitive and resistant to fungicides in 1996.

Behaviour of the strains in the diffusion tests (% of the tested isolates)				
Botryticide	**Sensitive**	**predominant sensitive**	**predominant resistant**	**resistant**
Rovral	50	0	21	29
Botrylon	75	8	13	4
Switch *)	88	0	12	0

*) not registered in Germany

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Quelques différences mises en évidence dans le comportement des cépages sensibles et tolérants à l'eutypiose.

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Introduction

Il est maintenant bien établi qu'il existe chez la vigne des cépages sensibles à l'Eutypiose et des cépages tolérants. Connaître le déterminisme de ces différences de sensibilité entre les cépages nous semble être un objectif essentiel pour progresser dans l'amélioration de la lutte à l'égard de cette maladie. Quelques pistes de recherche relatives aux différentes étapes des relations qui s'instaurent entre le champignon parasite et la vigne ont été suivies pour contribuer à atteindre cet objectif.

Matériel et méthodes

Matériel végétal
Quatre cépages ont été choisis comme modèle : 2 sensibles (Cabernet Sauvignon, Ugni blanc) et 2 tolérants (Merlot et Sémillon).
Matériel fongique
Les suspensions de spores d'*Eutypa lata* pour l'étude de la phase de contamination ont été obtenues à partir de périthèces prélevés sur des ceps morts de Cabernet Sauvignon.
Le mycélium utilisé pour l'étude de la phase infectieuse provient d'une souche productrice de phénoloxydases.
Méthodes
Pour l'étude de la phase de contamination, la taille est effectuée à 3 périodes. Des lots de 20 bois taillés sont contaminés par une suspension de spores titrant 10^5/ml successivement le jour de la taille, puis tous les 7 jours pendant 60 jours.
Les bois sont ensuite prélevés 14 jours après inoculation. Les pourcentages de réussite de la contamination sont évalués au laboratoire. Des colorations spécifiques permettent d'observer les mécanismes histologiques de défense de la plante.
Quant à l'étude de la phase infectieuse plusieurs méthodes sont utilisées.

- Des bûchettes de bois sain calibrées sont inoculées par du mycélium d'*E. lata*. Chaque mois et cela pendant 18 mois, les pertes de masse des 3 constituants majeurs du bois (cellulose, hémicelluloses, lignine) sont quantifiées par le procédé Fibertec.
- Parallèlement, le mode de dégradation du bois est observé en microscopie électronique à transmission.
- Des boutures de vigne sont inoculées par *E. lata*.

Sept mois après l'inoculation, le bois situé en avant de la nécrose est prélevé, et les composés phénoliques en sont extraits. Ensuite, le pouvoir inhibiteur vis à vis d'*E. lata,* des composés extraits est mesuré *in vitro* et l'analyse de ceux-ci est procédé en chromatographie liquide haute performance.

Résultats

L'étude de la phase de contamination, première étape des relations hôte-parasite ne permet pas d'apporter d'informations discriminantes. Néanmoins de nombreuses connaissances ont été acquises sur la durée et l'intensité de la réceptivité des plaies de taille, les mécanismes de défense non spécifiques mis en oeuvre par la plante, en réaction au stress généré par la taille ou la contamination par un micro-organisme parasite ou saprophyte, et le rôle de la microflore saprophyte.

L'étude de la phase infectieuse est plus prometteuse.

- La cinétique de dégradation des 3 principaux constituants des cellules ligneuses (cellulose, hémicellulose et lignine) montre que la lignine est dégradée beaucoup plus vite chez le cépage sensible que chez le cépage tolérant. L'observation en microscopie électronique à transmission ne montre pas de différence dans l'arrangement des constituants au sein des structures cellulaires laissant ainsi présager que la différence observée a probablement pour origine une constitution différente des lignines.
- L'analyse quantitative et qualitative des composés phénoliques du bois situé en avant de la nécrose brune montre, chez les deux types de cépage, une accumulation de composés phénoliques qui existaient déjà dans le bois sain. Des différences apparaissent entre les cépages :
    - Le pouvoir inhibiteur des extraits phénoliques du bois situé en avant de la nécrose est plus important chez les cépages tolérants que chez les cépages sensibles.
    - L'analyse des composé phénoliques en chromatographie liquide haute performance montre l'existence d'un composé spécifique aux cépages sensibles, et d'un composé spécifique aux cépages tolérants. A l'heure actuelle, ces composés n'ont pas encore été identifiés.

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Studies on ascospore discharge in *Pseudopezicula tracheiphila* (Müll.-Thurg.) Korf & Zhuang, the cause of rotbrenner

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Introduction

The fungus *Pseudopezicula tracheiphila* causes a leaf scorch disease on grapes. This disease is generally confined to certain areas, but in recent years rotbrenner is steadily increasing in German and European vineyards. The control of the disease generally requires regular applications of fungicides. In viticultural practice the first treatment is usually applied at growth stage ES 13, when two to three leaves are unfolded with no regards to the biology of the fungus. To obtain further information on the epidemiology of *Pseudopezicula tracheiphila* in order to develop a forecasting system for integrated disease control, studies on ascospore discharge were conducted over three years in Frankonia, a viticultural region in Germany. In 1995, a spraying programme was carried out to ascertain the date of primary infection and the main infection period.

Material and methods

Ascospores were detected with a Burkhard spore trap and weather data (temperature, rainfall, relative humidity, leaf wetness) were recorded at ten minutes intervals by a data logger. Six plots were sprayed at weekly intervals with Polyram Combi (0.2 %) from growth stage 13 to the preflowering stage. Further on, fungicide trials were done to detect the properties of the fungicide compounds Kresoxim-methyl and Difenoconazol. The need for fungicide application was determined using information on ascospore discharge, weather conditions and grape development. Assessments of disease frequency and severity were carried out at regular intervals from the preflowering stage (ES 57) until the beginning of berry touch (ES 77).

Results and discussion

Large amounts of ascospores were trapped after the rainfall events in mid April at the stage of bud burst (Fig.1). The release of ascospores was not influenced by daylight. It always occured after and sometimes during rainfall events. The amount as well as the intensity of rainfall influenced ascospore discharge whereas temperature did not seem to play an important role. The main infection period in 1995 occured at growth stage 17-19. Because of the long latent period of three to four weeks, higher amounts of leave necrosis were observed at the beginning of berry touch, in the middle of July. At this growth stage the grapevine can easily compensate defoliation caused by rotbrenner. So in 1995, rotbrenner caused no losses of yield and quality on grapes. The graduated application of Polyram Combi showed that the grapevine is susceptible after the fifth leave is unfolded (Tab.1). Ascospore discharge at growth stages 13 to 15 did not cause any infection although the weather conditions during this period were favorable to the infection process. Therefore, the first application of fungicides is recommended after a rainfall event when ES 15 is reached. The subsequent treatment depends on plant growth and rainfall. After bloom, the control of rotbrenner can be combined with sprays against downy mildew.

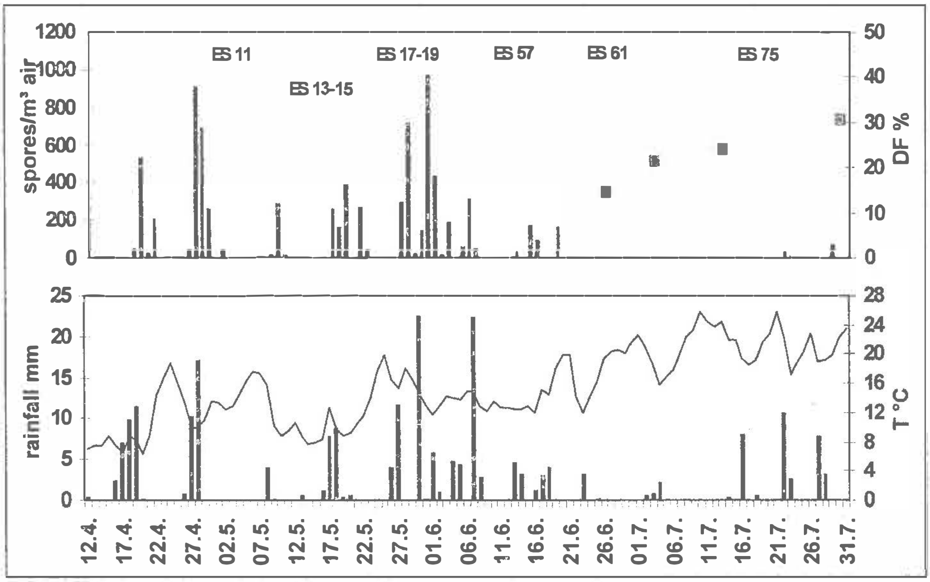

Figure 1: Weather data (lower graph), ascospore discharge and disease frequency of rotbrenner at Veitshöchheim in 1995.

Table 1: Disease frequency of rotbrenner in the plots of the spraying programme. Statistical differences based on Mann-Whitney (p= 0.05).

Date of first fungicide treatment	Sampling dates: 24/6 (ES 61)		4/7 (ES 67)		14/7 (ES 71)		10/8 (ES 77)	
12/06	40.0	a	55.7	a	55.9	a	61.1	a
06/06	46.1	a	58.6	a	56.1	a	61.1	a
29/05	1.9	b	14.4	b	18.8	b	22.0	b
22/05	0.71	b	1.4	c	4.4	c	6.9	c
15/05	0	b	0.4	c	2.2	c	2.8	c
08/05	0	b	0	c	1.7	c	2.3	c

The results of the fungicide trials showed that the use of a fungicide with high protectant activity and persistance can reduce the number of treatments against rotbrenner. In 1995, a single application of Kresoxim-methyl at the growth stage 17/18 before the rainfall events at the end of May (Fig.1) would have been sufficient to control the disease. Difenoconazol allows treatments as late as two days after a rain event, depending on weather and soil condition of the vineyard.

Maîtrise de l'Esca et respect de l'environnement

(Programme du contrat E.E.C. FAIR CT-95-0654)

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L'Esca est une maladie cryptogamique qui existe depuis très longtemps et qui sévit dans tous les pays où la culture de la vigne existe. Il s'agit d'une de ses plus graves affections puisqu'elle s'attaque à la charpente de la souche dont elle provoque la mort à plus ou moins court terme. En dépit de cette connaissance fort ancienne, cette maladie, qui a été peu étudiée en raison de la découverte fortuite au début du XXe siècle de l'efficacité de l'arsénite de sodium, fut attribuée à deux champignons basidiomycètes, *Stereum hirsutum* et *Phellinus igniarius*, jusqu'à nos jours.

Durant les années 80, les recherches sur cette maladie ont repris en France en raison d'un éventuel retrait de l'arsénite de sodium, du fait de sa toxicité non seulement pour l'Homme mais aussi pour l'Environnement. Les études ont porté sur l'identification et sur le mode d'action des microrganismes qui sont associés à la maladie (Larignon, 1991). Cet auteur montrait que l'Esca était en fait une maladie complexe à laquelle étaient associés cinq champignons qui se répartissaient en deux séquences : une séquence primaire où intervenaient *Phaeoacremonium aleophilum*, *Phaeoacremonium chlamydosporum*, ou *Eutypa lata*, qui sont isolés dans une nécrose brune et dure, et une séquence secondaire où sont impliqués les champignons basidiomycètes responsables de la dégradation du bois, caractéristique de la maladie.

La présence de ces différents champignons dans les ceps a été confirmée dans différents vignobles : Portugal, Californie, Italie (Mugnai *et al.*, 1996).

En dépit de l'amélioration des connaissances sur l'identification des champignons associés à la maladie, les différents travaux engagés dans les années 80 n'ont cependant pas permis de montrer la relation qui peut exister entre les microrganismes, mise en évidence dans le bois, et la symptomatologie observée au vignoble (forme apoplectique, forme lente). D'autre part, aucune étude n'a été réalisée concernant la biologie de ces champignons et l'épidémiologie de la maladie.

Afin de rechercher une méthode de lutte plus respectueuse pour l'environnement, il nous semble nécessaire d'une part d'améliorer les connaissances envers cette maladie et d'autre part de comprendre le mode d'action de l'arsénite de sodium. Ce travail fait l'objet du programme européen "Maîtrise de l'esca et respect de l'environnement".

Les participants

Coordinateur : le groupe LVMH (M. Boulay)
Pays contractants :
- Italie : Université de Milan, Institut de Pathologie Végétale (M. Bisiach)
- Suisse : Université de Neuchâtel, Institut de Chimie (M. Tabacchi)

- France : LVMH Recherche (M. Boulay)
INRA de Montpellier, Station de recherches Viticoles (M. Péros)
INRA de Bordeaux, Station de Pathologie végétale (Mme Dubos).

Le Programme

1- Identifier les champignons impliqués dans le syndrome de l'Esca en relation avec la symptomatologie induite au vignoble au niveau de la végétation herbacée et dans le bois

- enquêtes réalisées dans les vignobles français et italiens qui serviront de supports à l'identification des parasites inféodés et fourniront une approche pour l'étude de l'expression des symptômes et de leur évolution sur différents cépages, sous différentes conditions climatiques.

2- Créer des outils pour comprendre et suivre le développement épidémique de la maladie par une approche de la variabilité génétique des champignons impliqués (étude par RAPD) et de celle de leur pouvoir pathogène sur différents cépages (biotests, toxines).

3- Faire des essais préliminaires pour préparer de nouvelles méthodes de traitement plus respectueuses de l'environnement. Ce dernier objectif est centré sur deux solutions potentielles:

- L'une chimique, en étudiant le rôle de l'arsénite de sodium au niveau du bois de vigne afin de trouver un substitut plus neutre pour l'environnement.
- L'autre biotechnologique, en étudiant l'efficacité de promoteurs auto ou hétérologues au niveau des principales barrières de défense des bois de vigne que sont les rayons parenchymateux et les limites d'un cerne.

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Further evidence for the activity of phosetyl Al (Aliette® Ca) and phosphorous acid on fungi involved in "Esca" disease

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Introduction

The control of black measles "Esca" disease of grape is rather difficult and relies on cultural practices such as pruning methods, removing infected woody portions, taking away dried up grapevines and using protective wood sealants. These practices are recommended but not sufficient to ensure an effective control of the disease. Trials based on the application of triazoles by means of either injector pole or syringes showed, under certain infection conditions a statistically significant reduction of Esca severity: the infection was not stopped, but a prolonged and/or better "productivity" of the plants was generally achieved over several years (Bisiach *et al.*, 1995). Recently, phosetyl Al Ca (Aliette® Ca) applied by syringe in the field on infected grapevines at first foliar symptom appearance was given promising results. Positive indications have been also provided through studies carried out under controlled conditions (Di Marco, 1995; Mazzullo *et al.*, 1996).
The aim of this study was to investigate the relationships among fungicide, host and pathogens involved in Esca disease under laboratory conditions and, consequently, possible field applications. In particular, phosphorous acid - into which phosetyl Al is transformed rapidly - stilbenes (*trans*-resveratrol and *trans*-pterostilbene) and an extemporaneous mixture of phosphorous acid and stilbene were tested. Moreover, field applications on infected vines by syringe were carried out in order to assess the effects on disease severity.

Material and methods

Laboratory trials. Tests were carried out on the following fungi: *Phaeoacremonium aleophilum*, *P. chlamydosporum*, *Libertella sp.*, *Phellinus igniarius*, and *Stereum hirsutum*. They were isolated from various grape cultivars, from different grape growing areas and maintained on PDA at room temperature. Different concentrations of stilbenes (*trans*-resveratrol at 10, 100, 500, 1000 ppm and *trans*-pterostilbene 1, 10, 100 ppm) were preliminary tested by dilution in sterile distilled water and 2% ethanol; each dilution was added to agar, which was then inoculated with the above fungi. Afterwards resveratrol at 300 ppm, pterostilbene at 10 ppm and an extemporaneous mixture of stilbene and phosphorous acid (300 ppm) were compared. Disks, 6 mm in diameter, were cut from the margin of the colonies and placed, mycelium downwards, in each Petri dish. Five replicates per concentration were set up. All plates were incubated at 25°C in the dark. Colony diameter was measured daily and inhibition of the radial growth expressed in % of the untreated control was calculated.
Further *in vitro* investigations were carried out using wood decay resistance test. This test took place inside decay chambers (square glass bottles) containing PDA colonized by the fungus where grapevine wood blocks (some treated with phosphorous acid) were placed. Blocks were first incubated at 40°C for two weeks.

Field trials. Trials were carried out in four Emilia Romagna vineyards planted with cvs. Sangiovese, Riesling and Lambrusco, 12 - 18 years old, assessing each growing season the incidence of the disease before harvest. Disease severity on single grapevines was evaluated using an arbitrary 0 - 5 scale of different degrees of foliar necrosis: 0 = 0%; 1 = 5 - 25%; 2 = 25 - 50%; 3 = 50 - 75%; 4 = 75 - 100%; 5 = dried up plants. The following year, phosetyl Al Ca, specially formulated (undiluted) for wood injections was applied using specially designed syringes (two per plant) driven inside the trunk by means of a cordless drill. The application took place at a rate of 2 g of a. i. per plant. Incidence and disease severity were assessed each year.

Results and discussion

Trials showed *in vitro* activity of phosphorous acid on *Libertella sp.* and *P. chlamydosporum*. Stilbenes generally reduced mycelial growth, especially pterostilbene; on the other hand, low rates of resveratrol stimulated *P. aleophilum* and *P. chlamydosporum*. The mixture of phosphorous acid and stilbenes was generally more effective than the single compound. Similar positive results were not achieved with *Phellinus igniarius* (tab. 1). Wood decay tests are still ongoing: the activity of phosphorous acid on *Libertella* but not against *P. igniarius* seems to be confirmed.

Interesting results are being obtained in 2 - 5 years field trials whereby both a significant reduction of foliar symptom severity and an increase in the percentage of plants showing this reduction have been generally achieved on treated grapevines.

Table 1. *In vitro* average degree of mycelial growth inhibition by phosphorous acid and stilbenes. For each treatment, columns correspond to the time of assessment: the left resp. the right column concerns the first resp. the second part of the test.

	Treatment									
Esca pathogen	Resveratrol		Pterostilbene		Phosp. Ac.		Ph. ac. + resv.		Ph. ac.+pteros.	
P. aleophilum	- *	+*	++	+	- -	++	++++	++	++++	++++
P. chlamydosporum	+	+	++	++	++	++	+++	++	++	+++
Libertella sp.	+	+	++	++	++++	+++	+++++	+++++	+++++	+++++
S. hirsutum	n. e.	n. e.	++	+	n. e.	n. e.	++	+	+++	++++
P. igniarius	n. e.	n. e.	n. e.	n. e.	n. e.	n. e.	n. e.	n. e.	n. e.	n. e.

*Average degree of mycelial growth inhibition +: 20%; ++: 40%; +++: 60%; ++++: 80%; +++++: 100%; - : a stimulation of mycelial growth was observed; n. e. = no effect.

Conclusions

Laboratory trials pointed out a very interesting superior activity of phosphorous acid against some fungi involved in Esca disease when applied with stilbenes directly. This seems to be due to the inability of some pathogens to metabolize resveratrol in the presence of phosphorous acid. Several TLC analysis carried out on agar-media strenghten this hypothesis. Moreover, field applications generally showed a reduction in symptom severity and in some cases this reduction was significant, however in depth investigations are needed.

Further experiments will assess effects of phosetyl Al treated wood *in vivo* on grapevine stilbenes, using potted plants grown under controlled conditions and appropriately inoculated.

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Qualité des mesures agrométéorologiques et utilisation de modèles predictifs

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L'utilisation depuis quelques années par les agriculteurs de systèmes de calcul automatique des risques parasitaires nécessite d'utiliser des données climatiques mesurées en temps réel sur le terrain. Il ne faut pas cependant sous-estimer les risques d'erreurs associés à la mesure des paramètres climatiques, qui est assurée par les capteurs (même normalisés) des stations agroclimatiques disponibles dans le commerce. Pour cette raison, il est indispensable de contrôler la qualité des données mesurées. Or, si l'achat d'une station agroclimatique est un pas facilement franchi par les utilisateurs, ceux-ci se trouvent rapidement démunis dès lors qu'il s'agit d'assurer la maintenance du matériel (bon fonctionnement des capteurs, de la batterie alimentée par un panneau solaire, etc.).

Parmi les démarches permettant de contrôler la validité des valeurs climatiques mesurées par une station, la plus simple, consiste à avoir un regard critique sur les valeurs enregistrées. Pour cela, nous proposons de comparer les diverses mesures provenant de stations situées dans une même région et donc exposées à des conditions climatiques assez voisines. Le logiciel Phytomet offre cette possibilité aux utilisateurs, à condition d'être reliés à un réseau de stations agroclimatiques automatiques

Ce logiciel permet :

- d'assurer une représentation graphique des paramètres mesurés par les capteurs d'une station, par exemple l'évolution des températures horaires ou journalières, de l'humidité relative, des précipitations, de l'humectation et enfin de suivre l'évolution de la tension de batterie
- d'identifier d'éventuelles aberrations de fonctionnement (par ex : chutes de tension de batterie, absence d'enregistrement de précipitations due à un bouchage du pluviomètre, dérives des températures due à une oxydation de la sonde (Fig.1), humidité relative supérieure à 100%, etc...).

Sur l'écran il est possible de comparer les valeurs issues de plusieurs sites, d'un paramètre donné puis éventuellement de corriger les erreurs en substituant aux données aberrantes éliminées, celles d'une station proche.

Le logiciel Phytomet utilise un micro calculateur de type PC nécessitant une place de 150 kilo octets, équipé d'un écran VGA ou SVGA couleur et d'une version MS-DOS (4.0 minimum) ou de MS-Windows 95. Toutes les procédures sont écrites en Turbo Pascal (Borland international).

En conclusion, il nous semble que le travail en réseau soit une bonne condition de la mise en œuvre des outils prédictifs utilisant des données climatiques.

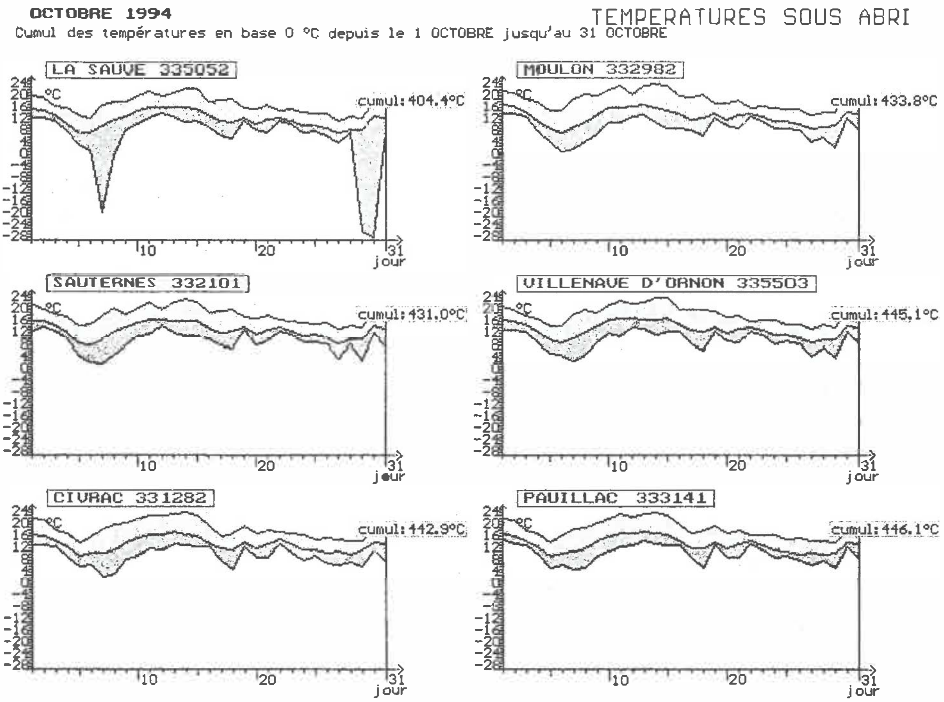

Figure 1. Comparaison des températures minimales, moyennes et maximales, enregistrées durant un mois par six postes agrométéologiques automatiques dans le vignoble bordelais (sortie graphique sur l'écran à l'aide de Phytomet). Sur le site de la Sauve, un dysfonctionnement de la sonde de température est aisément repérable (7,29,30 Oct.) sur les valeurs minimums. Un contrôle sur place a montré une oxydation anormale des contacts électriques de la sonde de température.

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Induced resistance of grapevine - Perspectives of biological control of grapevine diseases

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Introduction

To date in viticultural practice, there has not been any strategy available to control the most important fungal diseases of grapevine by natural resources and natural regulation mechanisms. Considering the aim of the IOBC, it is essential to focus scientific, experimental and practical efforts on the requirements mentioned above. To achieve biological control of the most important fungal diseases of grapevine, induced resistance is one possible approach (Ryals *et al.* 1996, Kessmann *et al.* 1997). Pathogens induce a defense response in host plants that protect against challenge by the same or another infectious agent. The response to challenge infection is systemically spread throughout the plant. When we started our work on SAR in *Vitis vinifera,* we proposed the following hypothesis:

- The *Euvitis* species are all closely related and carry the same genes involved in generating a response to a pathogen attack.
- Due to the coevolution with *Plasmopara viticola* and *Uncinula necator,* the kinetics of defense mechanisms of the American species follow a different course from those of *Vitis vinifera*.
- In European cultivars, the response is delayed and the pathogen overcomes the defense mechanisms.

Material and methods

Cell suspension cultures of *V. vinifera* cv. Pinot noir clone FR 54-86 were established and used as a model system for the investigation of the host response mechanisms. Induction studies on plants were performed on cuttings and leaf disks of *V. vinifera* Pinot noir clone FR 54-86 and *V. rupestris* cv. Gloire. From the cell cultures, elicited by yeast extract, cDNA of enzymes of the phenylpropanoid pathway, probably involved in the liginification process, were cloned and sequenced. Additionally cDNA´s from pathogenesis related proteins were cloned from elicited cell cultures. Transcripts of the enzymes and the pathogenesis related proteins were detected by Northern blot hybridization. The induced resistance was proofed by induction of plants and leaf disks with yeast and subsequent inoculation with *P. viticola* or *U. necator. Pseudomonas syringae* pv. *syringae*, *Botrytis cinerea* and salicylic acid were used as inductors.

Results and discussion

The inducible phenylpropanoid-pathway plays a major role in active defense reactions of the host against fungal challenge (Nicholson *et al.* 1992, Matern 1991). This pathway provides phenolic metabolites of two types (Hahlbrock *et al.* 1989). The first group are the stilbenes and may be active as antimycotics. The second have been collectively addressed as "lignin like" compounds and protect the host cells after incorporation into the cell wall. The latter compounds are based primarily on coumaric and ferulic acid esterified to cell wall polysaccharides. The biosynthesis of ester, triggered locally by pathogen invasion causes drastic change in the rigidity and digestibility of the cell wall. The formation of papillae around the infection site is one of the possible defense mechanism. The formation of the cell-wall bound esters and lignins depends on coumaroyl-, feruloyl- and sinapoyl-CoA substrates. The caffeoyl-CoA 3-O-methyltransferase is responsible for the methylation of cinnamic acid precursors. A grapevine caffeoyl-CoA 3-O-methyltransferase were cloned and sequenced (Busam *et al.* 1997b). Elicitors such as yeast extract and pathogens induce the expression of this enzyme. We reported the molecular and biochemical characterization of the induction of the enzyme by fungal elicitors at the last IOBC-meeting. Recently, we detected an autofluorescence of the cell walls around the infection site of *U. necator* when using a 450-490 nm excite-filter, a beam splitter 510 nm and a suppression-filter LP 520 nm. We now have evidence that cell-wall reinforcement is induced by pathogens and is involved in the defense reaction in *Vitis*.

Another pathogen inducible reaction in plant hosts is the expression of pathogenesis-related proteins, the PRP's. It is known that PRP's are involved in induced resistance and furthermore, some are correlated with SAR. Some PRP's encode for different classes of chitinases which can be differentially regulated upon infection by pathogens. Two chitinases from cell suspension culture of *V. vinifera* cultivar Pinot noir, were cloned and characterized. The cloned cDNAs encoded for basic class I and class III chitinase showing a high sequence similarity to the chitinases of other plants (Busam *et al.* 1997a). The transcript abundance of the two *Vitis* chitinases were measured in response to *P. viticola* infection in leaves of susceptible *V. vinifera* cultivar Pinot noir and resistant *V. rupestris* plants. We observed different induction kinetics between compatible and incompatible interaction and additionally the systemic induction of class III chitinase mRNA in the compatible interaction.

Leaves of the susceptible *V. vinifera* cultivar Pinot noir were locally inoculated with 2.5 x 10^4 spores per ml. The infected leaves and the corresponding uninoculated leaves of the upper insertion site were harvested. C1 and C8 were leaves of uninoculated healthy control plants harvested 1 and 8 days after the beginning of the experiment respectively. Total RNA was extracted and RNA gel blots were probed with ^{32}P-labeled class III chitinase cDNA probe. Class III chitinase mRNA in leaves of grapevine accumulated upon pathogen infection in the locally infected leaves and the systemically induced leaves.
In a biotest we corroborated the induced resistance in *V. vinifera.* Leaf disks from *V. vinifera* cv. Müller-Thurgau were inoculated with *B. cinerea* by a suspension of 450 conidia in a droplet of 10 µl. The disks were incubated on agar-plates at 24°C. After development of local lesions with a diameter of 5 mm, we inoculated a challenge pathogen on the leaf disks on the side opposite to the lesion. For challenge infection we used a droplet of 10 µl with 150 sporangia of *P. viticola.* Sporulation on induced and uninoculated disks was assessed.

On leaves without induction, the challenge infection resulted in a strong sporulation of *P. viticola* whereas on induced leaves sporulation was weak. In further experiments *U. necator* was used as challenge pathogen with similar results. Using *P. syringae* pathovar *syringae* strain DS20 as inductor on whole plants, we observed a slight systemic effect after challenge infection by *P. viticola.*

Conclusions

- The susceptible *V. vinifera* cultivars seem to be able to respond to pathogen infection with the induction of systemic acquired resistance.
- Precursors of lignin-biosynthesis were induced by fungal elicitors.
- Cell-wall reinforcement by apposition of esterified ferulic acid around the infection site seems to be a defense reaction of *Vitis*.
- The expression of class I and class III chitinase after elicitation is a further last response to pathogens.

These findings indicate that induced resistance may have potential for the biological control of powdery and downy mildew of grapes.

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Some questions about primary infection and sporulation of downy mildew

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Downy mildew, caused by *Plasmopara viticola* is one of the most important fungal diseases in viticulture. Due to its economic importance it is one of the best known plant pathogens. Its epidemic behavior was described by many authors, e.g. Müller-Thurgau (1911), Arens (1929a, 1929b), Müller and Sleumer (1934), Blaeser und Weltzien (1978), and Lalancette *et al* (1988a, 1988b). Some studies have been conducted on the epidemic behavior of related fungi like *Pseudoperonospora humuli* by Arens (1929c), Rhoyle and Thomas (1972), Rhoyle (1973), Kremheller (1979), Kraus (1983) and Dolinar and Zolnir (1994), *Bremia lactucae* by Schulz (1937), Verhoeff (1969) and Scherm and van Bruggen (1992, 1993, 1994, 1995), *Pseudoperonospora cubensis* by Bedlan (1987) and *Pseudoperonospora destructor* by Hildebrand and Sutton (1981) and Bashi and Aylor (1983). Observing the important similarities between epidemics of these downy mildew fungi, we propose a universal structure for an infection model for downy mildew on different plants.
This universal structure was transformed into a computer model which is driven by a database containing values for the influence of temperature, relative humidity, rainfall, leaf wetness and

Universal structure for downy mildew infection models

Macrosporangia formation	=>	discharge death	=>	primary infection	=>	incubation

(hibernation as oospores, *Plasmopara viticola,* sometimes *Pseudoperonospora humuli*)
start of the secondary cycle

Sporangia formation	=>	discharge death	=>	infection	=>	incubation

(several downy mildew pathogens)
start of the next cycle

light at the different stages of the infection process. With this database the program can be adapted to different downy mildew fungi.
Comparing the enviromental impact with the epidemics of these different fungi and adapting the universal structure for an infection model we found some open questions in primary infection and sporulation of Grapevine downy mildew.

P. viticola overwinters as oospores. Zoospores from macrosporangia are the primary inoculum in most viticultural areas, but not all vineyards show primary infections. In Southern Austria, for example, vineyards on organic soils which are influenced by the water table show primary infections while no primary infection occur on the light stony soils in the same villages. In the laboratory, macrosporangia are formed within 6 hours by oospores on a moist surface, which would correspond to a wet soil surface in the field,. This. Wet soil surfaces can result from rainfall followed by a period of leaf wetness or high relative humidity. Comparing different systems used by European viticulture advisory services to predict Grapevine downy mildew

primary infections it can be seen that they are mostly looking for a rain period of 24 hours or more before assuming the occurence of primary infection. Therefore, we have to take a longer, approximately 16-24 hours, period of wet soil surface for macrosporangia formation in the field. The zoospores inside the macrosporangia can be dispersed by splashing rain. Released zoospores need water to survive. Therefore, the infection process must be completed within one period of leaf wetness.
In order to adapt this step by step model for Grapevine downy mildew primary infection into practice three questions must be answered:

1. What are the best parameters to assess wet soil conditions, leaf wetness or high relative humidity?
2. What is the minimum period for macrosporangia formation (something between 6 hours and 24 hours)?
3. What is meant by the expression "splashing rain"?

Sporulation of downy mildew takes place at night during periods of high relative humidity. Grapevine downy mildew models look for a steady period of high relative humidity during the night. Models for P. *destructor* look for the total period of high relative humidity during the night. We know less about the influence of fluctuating relative humidity during the night. What is ist influence? In the field we are often faced whith the situation where the relative humidity is below 95% and the leaves are wet. Can sporangia be formed during nights with wet leaves without a relative humidity higher than 92%?
Sporangia of downy mildew fungi can be dispersed by rain or by air. Dry distribution can only take place if sporangia are dry. How much rain is needed to disperse the sporangia?
Spore production for artificial inoculation in the laboratory is limited by the survival of the oilspots. How often can an oilspot produce sporangia in the field?

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Modeling development rate for predicting *Lobesia botrana* (Den. & Schiff.) population dynamics

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Résumé

L'exigence d'un usage véritablement raisonné des insecticides en viticulture est au centre des enjeux de la protection intégrée du vignoble. Des connaissances approfondies sur la biologie des ravageurs, sur les méthodes qui permettent d'en évaluer les populations et sur les outils de prévision de leurs dynamiques sont indispensables de nos jours.
C'est dans ce cadre que nous développons des recherches sur la modélisation de la dynamique des populations de l'Eudémis de la vigne (*Lobesia botrana*). Pour prévoir les variations quantitatives saisonnières de cet insecte nous avons formulé un nouveau modèle mathématique basé sur des équations aux dérivées partielles. Dans ce modèle, la vitesse de développement des différents stades de l'insecte (oeufs, larves et chrysalides), la mortalité et la fécondité sont prises en compte. Nous présenterons ici l'analyse de la vitesse de développement des oeufs, des cinq stades larvaires et des chrysalides placés dans des conditions de températures constantes, de 10°C à 34°C. Les résultats ont été ajustés à l'aide de cinq équations qui sont comparées entre elles. Le modèle de Logan (Eq. 10) est celui qui présente le meilleur ajustement aux données biologiques.

Introduction

The grape berry moth, *L. botrana* Dennis and Schiffermüller, has been a serious pest of vineyards in Europe since 1890. Crucial to the problem of managing this pest is the timing of development which depends on the climate and especially on the temperature. Several studies on the development of *L. botrana* have been conducted (Götz 1941, Gabel and Mocko 1984) but they show inconsistent results for understanding the phenology of this species and to build growth models for its management. The aim of this study was to quantify the effect of constant temperatures on the developmental times of *L. botrana* eggs, larvae and pupae and to describe these relationships using different models. The accuracy of these adjustments is compared.

Material and methods

Insects were provided from our laboratory colony maintained following a method earlier described (Stockel *et al.*, 1989). All measurements were made in growth chambers : 4 Platinous® S Series chambers (registered trademark of TABAI ESPEC CORP.) with temperature, relative humidity (RH) and photoperiod control. *L. botrana* development was studied at constant temperatures ranging from 10°C to 34°C by 2°C increments, with 65% RH and under a 16:8 (L:D) photoperiod.
Egg, larvae and pupae development were studied using methods described earlier (Brière and Pracros, 1997). Means of developmental times (*Days*) and developmental rates ($V=1/Days$) were determined for each temperature.

Results and discussion

We compared five rate models : a linear model, a third degree polynomial model (Harcourt and Yee, 1982), two models by Logan (1976), and one by Lactin *et al.* (1995). These choices were made after a preliminary screening of several functions available in the literature.

For all stages, the relationship of developmental rate to temperature is nonlinear, has an asymmetrical form and is composed of three parts. First at low temperatures where the rate of development increases with nonlinearity from the point of zero development, second where the developmental rate becomes proportional to the temperature and a third nonlinear one which begins from an optimal temperature (i.e. the temperature associated with the fastest rate) up to lethal temperature.

The model of Logan (Eq. 10) provides the best fit to our data sets for estimating the rates of development for each stage of *L. botrana* at constant temperatures. The estimated parameters are listed in tab. 1.

Table 1. Parameters estimated for the model of Logan (1976, Eq. 10).

α	0.23367	0.35642	0.60678	0.508	0.87809	0.237	0.1523
ρ	-0.2757	-0.260059	-0.2137	-0.195	-0.16	-0.215	-0.25
k	230.75	209.2775	108.0436	67.05	71.59	70.65	235
T_{opt}	32.01	34.103	37.4719	37.18	37.48	37.18	36.16
Δ_T	0.842	1.97463	6.07027	4.34	6.32	4.58	1.77
R^2	0.999475	0.998336	0.9996	0.99913	0.996868	0.9987	0.99983

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Etude méthodologique de la répartition spatiale de l'eudémis (*Lobesia botrana* Den. et Schiff.). Intérêts pour l'échantillonnage et la modélisation.

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Summary

Methodological study of the grape berry moth's (*Lobesia botrana* Den. and Schiff.) spatial distribution. Sampling and modeling interests.
Studies on *L. botrana* spatial distribution were started in 1996 to provide sampling methods. On the first generation, exhaustive data were collected in two vineyard plots. A geostatistical analysis method was used and preliminary results with semi-variogram calculations are now discussed.

Introduction

Dans le cadre de la lutte intégrée en vignoble, des études de dynamique de populations de l'eudémis et de modélisation quantitative (voir communication de J. F. Brière) sont en cours. C'est pour cette raison qu'un travail a débuté en 1996 sur la description de la répartition spatiale des oeufs, des larves et des dégâts qu'elles réalisent en vue de mettre au point des méthodes d'échantillonnage pour la validation du modèle et l'évaluation pratique des risques.
Après un exposé des méthodes d'étude de la répartition spatiale, nous présenterons quelques résultats préliminaires sur les dégâts de première génération.

Matériels et méthodes

Il existe peu d'études sur la répartition spatiale de l'eudémis. Aussi nous avons tenté de réaliser des observations assez fines. Pour cela, deux zones de vignoble ont été choisies, l'une en Sauternais sur cépage sauvignon (nommée zone 1) et l'autre dans le Palatinat (Allemagne) sur cépage riesling (nommée zone 2). Toutes deux font partie d'une parcelle d'au moins 3 ha. Elles sont constituées de 4 rangs de 80 ceps et sont situées à distance des bordures de parcelles.
De manière exhaustive, nous avons observé les grappes de chaque cep en conservant leur position sur les rameaux. Les observations ont porté sur les glomérules et les larves, lors du maximum de densité larvaire. Par ailleurs, des notations sur la phénologie des plantes ont été réalisées pendant la période de ponte.
Pour réaliser une description de la répartition spatiale nous avons employé une méthode d'analyse relative à la théorie des variables régionalisées. Développée par Matheron (1970) dans le cadre de la recherche minière, cette théorie a été appliquée en recherche forestière, mais aussi dans des études d'épidémiologie. Thioulouse *et al.* (1985) considèrent d'ailleurs qu'elle est la seule solution pour analyser les différentes échelles d'hétérogénéité de la répartition des individus d'une population naturelle.
Une variable est dite régionalisée lorsque les valeurs qu'elle prend ne dépendent que de sa position dans l'espace. Elle est caractéristique d'un phénomène qui présente une certaine structure ou régionalisation. Le modèle de répartition est identifié, en pratique, grâce au calcul du demi-variogramme empirique $\gamma(h)$. Il représente une variabilité moyenne pour des couples

de points distants de h dans l'espace échantillonné. L'analyse du graphe de γ(h) en fonction de h est basée sur son comportement au voisinage de l'origine, au voisinage de l'infini, mais elle prend aussi en compte la présence d'un seuil.
Les variogrammes ont été réalisés avec le logiciel VARIOWIN (Pannatier, 1996).

Résultats et discussion

Pour les 2 zones étudiées, les variogrammes directionnels standardisés sur le nombre total de glomérules par cep ont des comportements différents. Dans la zone 1 (figure 1a), la variabilité moyenne du nombre de glomérules pour les couples de ceps est constante quelle que soit la distance entre les ceps. La répartition des glomérules peut donc être aléatoire ou uniforme. Dans la zone 2 (figure 1b), l'allure globale du variogramme est de type linéaire (malgré des oscillations), ce qui suggère la présence d'un gradient de densité de glomérules dans le sens des rangs. De plus, le comportement des variogrammes à l'origine nous fait penser à l'existence d'une structure à une échelle inférieure au cep ou dépendante de la répartition des grappes.
L'étude de la structure dans des directions différentes de celle des rangs n'a pu être réalisée en raison du nombre insuffisant de rangs.

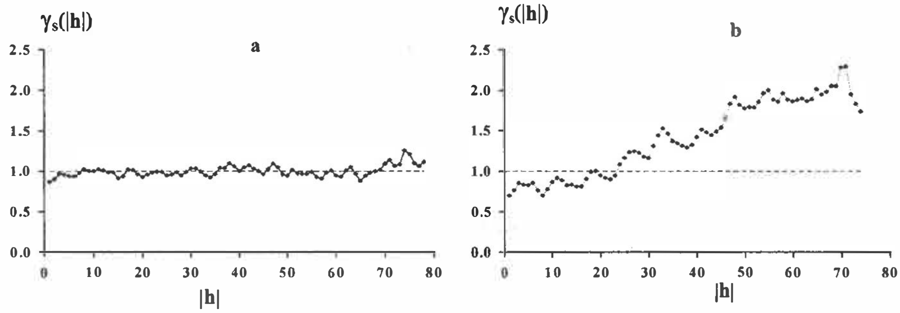

Figure 1. Demi-variogrammes directionnels standards calculés sur le nombre de glomérules par cep dans les zones 1 (a) et 2 (b)

Conclusions

Les résultats montrent l'existence de plusieurs types de répartition spatiale des dégâts et de structures à plusieurs échelles. Mais, il est souhaitable de poursuivre ces observations sur les prochaines années, afin de pouvoir mettre en évidence un modèle de répartition et étudier son isotropie. Nous essaierons aussi de détecter des dépendances spatiales à des distances inférieures à l'inter-cep. De plus, d'autres traitements statistiques seront nécessaires pour compléter les analyses. Nous avons choisi, pour cela, d'employer des indices d'agrégation et d'autocorrélation appliqués à différentes échelles (Chessel, 1978) et intégrés dans des procédures de Monte-Carlo (Badenhausser, 1993).

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Etude de la nuisibilité des tordeuses de la grappe et réflexion sur le seuil de tolérance

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La lutte intégrée au vignoble contre les tordeuses de la grappe : Eudémis (*Lobesia botrana* Den. et Schiff.) et Cochylis (*Eupoecilia ambiguella* Hb.) nécessite une connaissance approfondie de leur nuisibilité réelle. Cette connaissance est indispensable pour préciser un seuil de tolérance économique pertinent : niveau de population à partir duquel une intervention phytosanitaire est économiquement justifiée. La nuisibilité de ces insectes est décomposée en nuisibilité directe et indirecte. La première correspond à la perte quantitative de récolte due à la seule activité larvaire (pertes de fleurs ou de baies par morsures). La nuisibilté indirecte traduit l'infection des dégâts larvaires par *Botrytis cinerea* (champignon pathogène responsable de la Pourriture grise). Les conséquences des attaques larvaires sont alors amplifiées par les pertes quantitatives et qualitatives (oenologiques) à la vendange dues au champignon. La notion d'un seuil de tolérance unique est discutable car différents éléments conditionnent la nuisibilité de ces ravageurs que nous allons détailler.

1 - Adaptation du seuil à la génération de l'insecte.

En première génération, la nuisibilité a fait l'objet d'études approfondies par l'O.I.L.B. (Roehrich, 1978). Les attaques à la floraison n'aggravent pas la Pourriture grise à la vendange. La nuisibilité est donc uniquement directe. En général, 2 glomérules par grappe (70 à 100 chenilles pour 100 grappes) peuvent être tolérés. Pavan et Girolami (1986) confirment ce résultat pour les raisins de cuve produits dans le nord-est de l'Italie. Ils tolèrent une attaque sur 50 p. cent des grappes puisque la plus grande partie des grappes attaquées ne comporte alors qu'une chenille par grappe. En revanche, le seuil est très inférieur pour les générations estivales (2ème ou 3ème) dont la nuisibilité est surtout indirecte.

2 - Des seuils différents suivant l'espèce considérée : Eudémis ou Cochylis.

En première génération, il ne semble pas nécessaire de distinguer les 2 espèces. Cependant, pour la génération suivante, l'effet des attaques larvaires sur la Pourriture grise diffère selon l'espèce (Fermaud et Giboulot, 1993). Rappelons que, quand les deux espèces coexistent, un synchronisme étroit est toujours constaté en 2ème génération.

Ainsi, nous avons montré (tab. 1) que la sévérité d'attaque par *B. cinerea* est augmentée plus par la Cochylis que par l'Eudémis, et ce dès la véraison. Ce résultat incite donc à préconiser un seuil de tolérance en deuxième génération supérieur pour l'Eudémis.

3 - Des seuils en fonction de la climatologie.

En 2ème génération, l'effet favorisant des chenilles d'eudémis sur la Pourriture grise peut varier fortement suivant les années et les régions. Nos expériences récentes dans le Bordelais confirment cette variabilité et mettent en cause les conditions climatiques estivales (Fermaud

et Giboulot, 1996). Ainsi, en situation chaude et particulièrement sèche (1988, 1989, 1995), et en absence de fongicide anti-botrytis, on peut tolérer des niveaux élevés de population, tels 50 chenilles pour 100 grappes, sans incidence sur la Pourriture grise.
C'est aussi le cas pour les larves de 3ème génération. En situation sèche (Bordeaux : 1988, 1989, 1995), le taux final de Pourriture grise reste faible (inférieur à 3 p. cent), même en présence de chenilles. Cependant, en situation pluvieuse en fin de saison (1993, 1994), une seule chenille par grappe induit entre 5 et 10 p. cent de grains pourris supplémentaires.

4 - Seuils de tolérance et cépage.

En première génération, rappelons le cas particulier des cépages sensibles à la pourriture pédonculaire (Riesling) et des situations de coulure ou de très faible production, où il convient d'abaisser nettement le seuil précédemment cité.
Pour les générations estivales, l'influence du cépage est à considérer pour 2 raisons.

- Premièrement, les cépages sont de sensibilités différentes à la Pourriture grise. Des essais sont donc nécessaires pour mieux mesurer l'interfèrence de cette sensibilité avec la nuisibilité indirecte de l'insecte.
- Deuxièmement, les cépages présentent une sensibilité propre aux attaques larvaires d'eudémis (Fermaud, 1997). Les 5 principaux cépages étudiés se classent ainsi par sensibilité décroissante : Sémillon, Cabernet-franc, Cabernet-sauvignon, Sauvignon et Merlot. Il est enfin important de souligner que ce classement est commun à la 2ème et à la 3ème génération d'eudémis.

Tableau 1 : Sévérité moyenne d'attaque de *B. cinerea* au sein des grappes(Essai *in natura*, sans traitement anti-*Botrytis* spécifique, sur grappes de Sauvignon au stade "Fermeture de la grappe" artificiellement infestées avec 10 chenilles d'élevage par grappe).

	1991		1992	
	Véraison	Récolte	Véraison	Récolte
Cochylis	4.7 % A	13.8 % A	13.4 % A	20.7 % A
Eudémis	3.2 % B	5.2 % B	8.1 % B	14.8 % A
Témoin	1.0 % C	4.1 % B	1.2 % C	3.4 % B

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Dissipation des résidus du fenoxycarbe et du flufénoxuron sur raisin de table

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Introduction

On a étudié la courbe de dissipation de ces insecticides employés dans la lutte contre la 3ème génération de la tordeuse de la grappe (*Lobesia botrana*), puisqu'ils sont parfois appliqués à des moments très proches de la récolte.

Matériel et méthodes

Les essais ont été réalisés au mois d'août 1996 en une seule application avec trois répétitions:

matière active	*concentration m.a. %*	*dose*	*consommation bouillie*	*g.m.a./Ha*	*Spécialité Commerciale*
fenoxycarbe	25	40 g/Hl	730 l/Ha	73	Insegar
flufénoxuron	10	75 cc/Hl	730 l/Ha	55	Cascade

On a effectué un prélèvement d'échantillons juste après l'application (T) ainsi que 3, 7, 14 et 21 jours après l'application (T+3, T+7, T+14, T+21). Les résultats obtenus sont les suivants:

Resultats

	Résidus moyens (mg/kg)					*Résidus maximaux(mg/kg)*				
Pesticide	*T*	*T+3*	*T+7*	*T+14*	*T+21*	*T*	*T+3*	*T+7*	*T+14*	*T+21*
fenoxycarbe	3,0	1,94	1,63	0,84	0,94	3,28	2,24	1,78	0,89	1,02
flufénoxuron	1,32	0,50	0,55	0,46	0,36	2,75	0,60	0,63	0,56	0,48

Discussion et conclusions

Si l'on compare ces résultats avec les LMR (teneurs maximales en résidus) des pays européens, on peut constater que beaucoup d'entre eux ne s'en soucient pas et même qu'il pourrait y avoir des problèmes dans certains pays où la législation est bien établie.

Pays	*fenoxycarbe*	*Flufénoxuron*
Espagne	1 ppm.	0,1 ppm.
Italie	0,2 ppm.	0,1 ppm.
France	0,05 ppm.	0,05 ppm.
Suisse	0,3 ppm.	---
Allemagne	0,2 ppm.	---
Pays Bas	0,05* ppm.	---

- Le fenoxycarbe, avec le délai d'emploi avant récolte de 21 jours fixé en Espagne, aurait posé des problèmes dans les autres pays européens. En Italie (LMR: 0,2 ppm.), ce délai est de 45 jours. Il serait très difficile de déterminer un délai d'emploi avant récolte raisonnable pour la France et les Pays-Bas (LMR: 0,05 ppm).
- Bien que dans cet essai on n'ait déterminé les résidus seulement jusqu'à 21 jours après l'application du produit, et étant donné la grande stabilité qu'on observe avec les résidus du flufénoxuron, comme c'est généralement le cas chez les azylurées, le délai d'emploi avant récolte fixé en Espagne et en France (28 jours), serait insuffisant pour respecter leurs LMR respectives (0,10 ppm et 0,05 ppm).

En conséquence, après confirmation de ces résultats provisoires (un seul essai), il serait opportun d'harmoniser les LMR, de préférence à l'échelle européenne, en les adaptant à des niveaux conformes avec la bonne pratique agricole (BPA), si cela est possible du point de vue toxicologique. Dans le cas contraire, les résidus de ces pesticides pourraient poser des problèmes de légalité sur certain marchés.

Essai sur l'efficacité du "Spinosad" dans la lutte contre la tordeuse de la grappe (*Lobesia botrana*)

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Introduction

Dans le cadre de la recherche de produits biologiques pour lutter contre la Tordeuse de la grappe, on a essayé une formulation dont les matières actives sont des substances dérivées du *Saccharopolyspora spinosa* (spinosad: mélange de spinosyn A et spinosyn D). Ce neurotoxique agit sur la larve par contact et ingestion.

Matériel et méthodes

On a éprouvé l'efficacité, à différentes doses, de la spécialité XDE 105, formulée par Dow Elanco, en comparaison avec un produit biotechnique (tébufénozide) et un produit organo-phosphoré (méthyl parathion microencapsulé).

Les traitements ont été réalisés sur la 2ème et la 3ème génération au début des éclosions (le méthyl parathion a été appliqué une semaine plus tard), avec un volume de bouillie de 600 l/ha, selon les variantes suivantes:

Variante	*matière active*	*concentration en m.a.*	*dose g.m.a./ha*		*specialité commerciale*
			2ème gen.	*3ème gen.*	
I	tébufénozide	240 g/l	86,4	86,4	Mimic
II	"spinosad"	480 g/l	288	72	---
III	"spinosad"	480 g/l	144	144	---
IV	méthyl parathion microencapsulé	240 g/l	360	360	Penncap
V	témoin non traité				

Résultats et discussion

Les efficacités par rapport aux témoins (37% et 41% de grappes attaquées en 2ème et 3ème génération respectivement et 119 et 83 pénétrations/100 grappes), ont été les suivants:

Variante	*2ème génération*		*3ème generation*	
	% grappes attaquées	*pénétr./100 grappes*	*% grappes attaquées*	*pénétr./100 grappes*
I	70	83	91	95
II	90	97	97	98
III	78	97	92	96
IV	67	84	97	99

Le spinosad a montré une efficacité comparable au tébufénozide et au méthyl parathion microencapsulé, même à la dose la plus basse (0,025% du produit formulé, équivalent à 72g.m.a./ha.); il serait par conséquent nécessaire d'étudier son efficacité à doses plus basses afin de déterminer la dose minimale efficace.

Variante	*nombre moyen acariens/15 feuilles*
I	21,0
II	18,0
III	13,3
IV	12,0
V	32,3

On a étudié les effets secondaires éventuels de ce produit sur phytoséïdes (31 jours après la dernière application). On a seulement trouvé *Typhlodromus phialatus* (58%) et *Euseius stipulatus* (42%). Bien qu'il n'existe pas de différences significatives entre les variantes, on ne peut écarter pour autant l'existence d'un certain effet déprimant.

Effectiveness of *Bacillus thuringiensis* on the grape vine and grape berry moth (*Lobesia botrana* and *Eupoecilia ambiguella*)

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Introduction

Bacillus thuringiensis (B.t.) is an alternative control agent for the mating disruption method against the grape vine and grape berry moth in integrated and biological viticulture. Problems in practical use exist concerning the timing of application (Wohlfarth and Schruft, 1986) and the permanence of activity in dependence on atmospheric conditions (Weingärtner, 1994). In the last years the grape vine moth *L. botrana* has increased in number in the vineyards of Baden, the southwest viticultural wine area of Germany, so we had to study possible differences concerning the effectiveness of B.t. on both species (Keil, 1995).

Material and methods

We tested the LT_{50} of four B.t.-products in the recommended dosis. 150 µl of B.t. toxin suspension was mixed with 250 mg ground wheat germ in small Eppendorf reaction tubes in adaptation to Pearson and Ward (1987) and Funke *et al.* (1993). Five larval instars L3 were added to this food-B.t.-mixture in 10 ml glass vials. Twenty hours later and every two hours thereafter, the number of living or dead larvae were checked and LT_{50} calculated. Each test was carried out with 20 individuals (five repetitions) at 24 ± 1 °C and 40-50 % relative humidity.

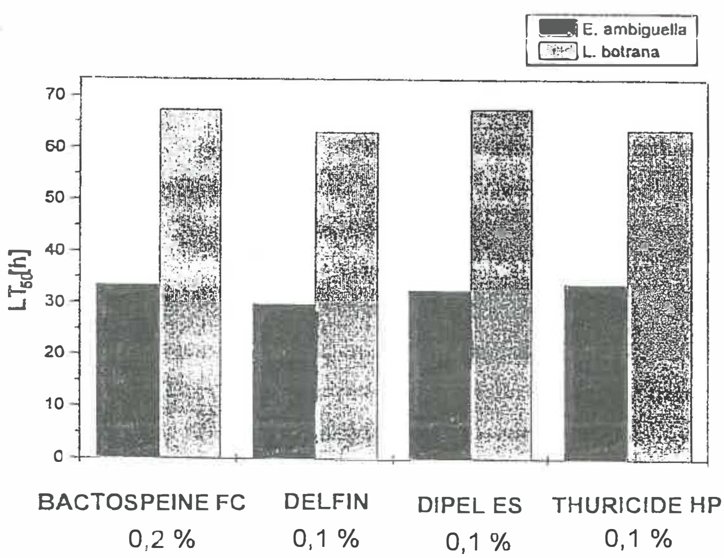

Figure 1. LT_{50} of four B.t.- products for the grape berry moth (*E. ambiguella*) and the vine moth (*L. botrana*)

Results and discussion

Under laboratory conditions we could not find any difference in the effectiveness of the different products, but the LT_{50} of *Lobesia* was double as high as that of *Eupoecilia* (fig.1).
The influence of temperature is very important for B.t. efficacy. Studies at five different temperatures have shown that LT_{50} is shorter and the effect is faster at higher temperatures in contrast to lower ones as it usually is in spring under natural conditions (fig.2). For *E. ambiguella* a LT_{50} stability is given between 20 and 28 °C, but for *L. botrana* at 12 °C no toxic effect is given and a stability was not achieved below 24 °C. These effects are in agreement with the ecological requirements of the grape vine and the grape berry moth which are dependent on atmospheric conditions.
For the practical use of B.t. it is important that larval instars infected with B.t. stop feeding immediately after uptake in order to prevent damages, what we could demonstrate for DELFIN (0,1 %) by counting the excrement pellets during a period of 24 hours (fig.3). The consumption rate per 24 h of L3 for *E. ambiguella* usually gives 18,0 ± 1,43 pellets, for *L. botrana* 25,8 ± 3,22 pellets. After B.t. uptake, the consumption is reduced considerably: the number of pellets per individual was 1,76 ± 0,32 for *E. ambiguella* and 2,48 ± 0,41 for *L. botrana.*

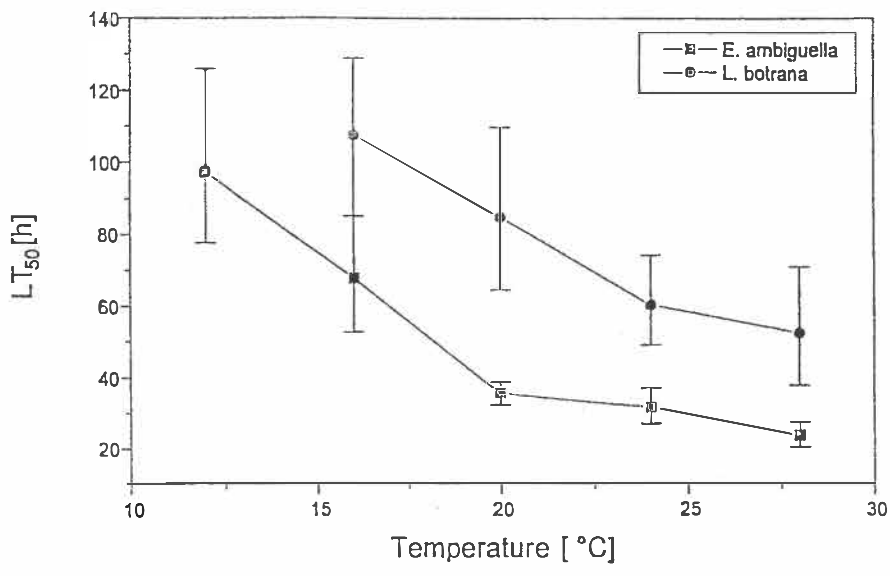

Figure 2. LT_{50} of B.t.- product DELFIN (0,1 %) for the grape berry moth (*E. ambiguella*) and the vine moth (*L. botrana*) at different temperature conditions

Conclusions

Concerning the effectiveness of *Bacillus thuringiensis,* differences in LT_{50} exist for L3 larval instars of the grape vine moth *L. botrana* and the grape berry moth *E. ambiguella.* The reason for this is not clear, but perhaps can be found in the different larval activity of the two species.

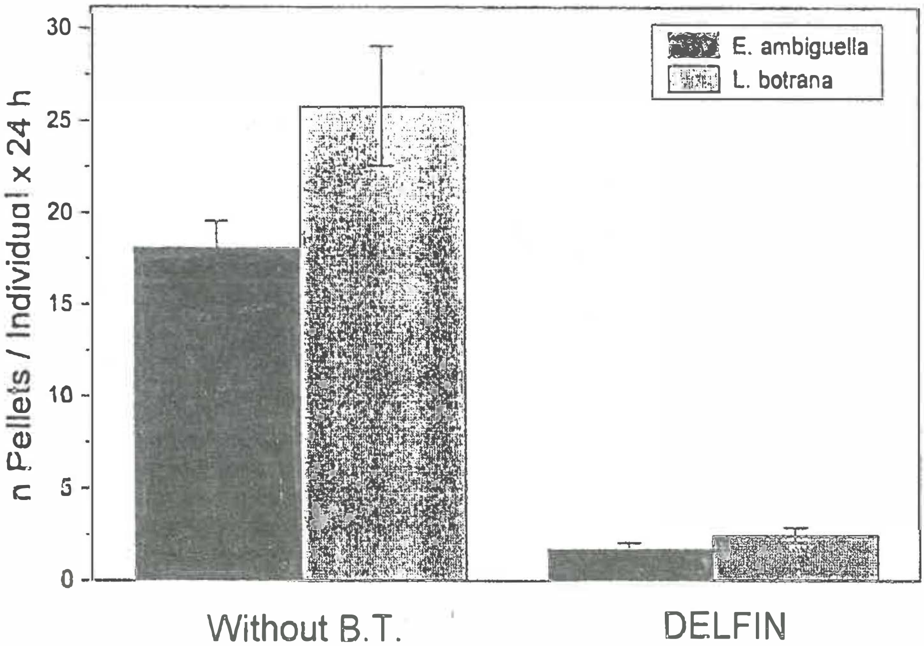

Figure 3. Amount of excrement pellets of *E. ambiguella* and *L. botrana* larval instars (L3) after uptake of food mixed with the B.t.-product DELFIN (0,1 %, corresponding 6 x 10^{10} spore cristals/l) and without the influence of this toxin.

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Occurence of beneficial organisms in pheromone treated vineyards

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Introduction

In 1985, at the SLFA Neustadt investigations started concerning the occurence and potential effects of beneficials on pests in vineyards treated with specific pheromone for mating disruption of *Lobesia botrana* Schiff. and *Eupoecilia ambiguella* Hbn. (Lepidoptera, Tortricidae).

Material and methods

The investigations were carried out in different vineyards located in the viticultural area „Pfalz". The fauna of the grapevine foliage was collected with a suction apparatus (Schütte, 1985) and by beating (Steiner, 1962; Anonymous, 1980). Flower-/grape clusters were also controlled. Trunks were examined by investigating the bark. Further examinations were conducted concerning potential activities of parasitoids on tortricids. Pieces of plastic film fit with *L. botrana* eggs (origin: lab) were exposed on flower/grape clusters. For determining parasitism *L. botrana*-larvae (L4 - L5) were collected from grape clusters. Overwintering pupae of *L. botrana/E. ambiguella* were obtained by installing corrugated cardboard collars around the upper ends of vine trunks and collecting pupae of both tortricids manually. Visual control of the foliage completed the examinations.

Results and discussion

Looking at the results obtained within the upper vine zones there was a striking dominance of *Araneida*, *Hymenoptera*, *Diptera* and *Heteroptera*. Spiders were the most common predators of the upper zones, the net webbing *Araneidae*, *Linyphiidae* and *Theridiidae* predominating. *Diptera* were also quite abundant within the upper zones but none of its predacious groups occurred in remarkable densities. The arthropod fauna of flower-/grape clusters showed predators, in general spiders, inhabiting these zones in very low densities. Spiders were also the beneficials predominating on the trunks, especially *Salticidae*, *Dictynidae*, and *Theridiidae*. Generally other predacious taxa e.g. *Opilionida*, *Planipennia*, *Heteroptera*, *Dermaptera*, and *Coleoptera*, appeared in more or less small numbers.

Parasitoids collected from the upper vine zones belonged to the parasitic wasps sensu lato (*Hymenoptera*, *Apocrita*) and a few members to the dipteran *Tachinidae*. The *Hymenoptera* were classified into groups being „potential parasitoids of *Lepidoptera*" or „being unable" to parasitize *Lepidoptera*. Wasps specialized on *Lepidoptera* were rarely found. Most parasitoids (about 70 %) belonged to taxa being parasitical on *Lepidoptera* - apart from other hosts -. Up to 20 % belonged to wasps not parasitizing any lepidopteran development stage. Some of the collected *Hymenoptera* were species developing hyperparasitically on other parasitoids (e.g. in *Tachinidae*).

In general egg parasitoids of *tortricidae* could only be found exceptionally. Investigations on the larval stages (L4 - L5) of *L. botrana* showed very little parasitic activity. Larval parasitism of *Sparganothis pilleriana* , a common pest in some regions of the „Pfalz", reached about 15

%. The percentage of tortricid pupae parasitized ranged between about 30 % (*Sp. pilleriana*) and over 70 % (*L. botrana*), the percentage of hyperparasitism in some cases being extremely striking (> 30%). Table 1 gives a survey of the parasitoids hatched off lepidopteran pests. The results show the necessity to classify the corresponding beneficials into groups "having the ability" to reduce pests and "being not able" to have an influence on pests in vineyards. The results obtained to date lead to the conclusion that parasitic beneficials have a higher effect on regulating pest populations in vineyards than predators.

Table 1. Parasitoids of *Lepidoptera* in pheromone treated vineyards (investigations conducted within vineyards of the „Pfalz" since 1985). L: Larva, P: Pupa.

	Sparganothis pilleriana		Lobesia botrana		Eupoecilia ambiguella		Peribatodes rhomboidaria		Hyperpara-sitoid
	L	P	L	P	L	P	L	P	(host)
HYMENOPTERA									
BETHYLIDAE									
1 Goniozus clavipennis	X								
ICHNEUMONIDAE									
2 Agrothereutes hospes		X							
3 Agrypon minutum		X							
4 Chorinaeus cristator		X							
5 Diadegma sp.	X								
6 Gelis albipalpus									X
7 Gelis areator									X
8 Gelis sp.									X
9 Theroscopus hemipteron				X					
10 Gregopimpla inquisitor	X								
11 Itoplectis alternans		X		X		X			
12 Itoplectis maculator		X							
13 Pimpla instigator		X							
14 Pimpla turionellae		X							
PTEROMALIDAE									
15 Pteromalus chrysos									(Tachinidae)
16 Cyclogastrella deplanata		X		X		X			
ELASMIDAE									
17 Elasmus albipennis		X							
TORYMIDAE									
18 Monodontomerus aereus		X							
DIPTERA, TACHINIDAE									
19 Eumea linearicornis		X							
20 Eumea mitis		X							
21 Eurysthaea scutellaris		X							
22 Pseudoperichaeta nigrolineata		X							

Acknowledgements

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(*Ichneumonidae*), Dr. Papp, Budapest (*Braconidae*), Dr. Tschorsnig, Stuttgart (*Tachinidae*) and Dr. Vidal, Hannover (*Chalcidoidea*).

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Seasonal and spatial dynamics of *Empoasca vitis* and its egg parasitoids in vineyards in Northern Switzerland

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Introduction

In vineyards of Northern Switzerland the green leafhopper *Empoasca vitis* (Goethe) has locally become a pest of concern to the growers. However, data from several years strongly suggest that population densities causing evident leaf damage usually occur only in plots with open soil (Remund & Boller, 1995). In vineyards with a botanically diverse green cover, population densities are lower and in particular the peak of the second generation is almost completely suppressed. It appears that under these conditions egg parasitoids, of which *Anagrus atomus* Haliday (Hym., *Mymaridae*) is the most important species (Remund & Boller, 1995), are able to effectively control the leafhopper populations.

Since *E. vitis* leafhoppers overwinter as adults, while Mymaridae do so in leafhopper eggs, the density of the Mymaridae population in spring depends on the presence of alternative hosts living on other plants within or near vineyards. We found hedge rose (*Rosa canina*) and blackberry (*Rubus fructicosa*) to be the most important overwintering sites for *A. atomus* (Remund & Boller, 1996). In a plot studied in detail, these plant species were part of a hedge near the vineyard. Trap catches indicated that, in spring, probably two generations of parasitoids developed mainly within the hedge before the adults started to move into the vineyard where they parasitised eggs laid by the first generation of *E. vitis*.

Materials and methods

The seasonal variation in spatial distribution of leafhoppers and parasitoids was studied in Oberhallau in Northern Switzerland. Yellow sticky traps of a size of 8x15 cm (REBELL®, Eidgen. Forschungsanstalt Wädenswil) were exposed approximately 1.2 m above ground in a hedge and in the adjacent vineyard at various distances, up to 325 m from the hedge (5 replicates per distance). The traps were replaced every two weeks.

Results and discussion

Cumulated for the whole season, *Mymaridae* catches were highest in the hedge (mean per trap ± SE = 10.9 ±1.7) and decreased downto 3.9 ± 0.3 at 225 m and more with increasing distance from the hedge. This confirmed results from an earlier experiment by Remund & Boller (1996). Furthermore, population maxima had previously been at distances of 25 m to 75 m farther away from the hedge (Fig. 1). This indicated that the parasitoids dispersed from the hedge into the vineyard, probably beyond the maximum monitored distance of 325 m. Although early in the season, leafhopper catches increased with the distance from the hedge, we did not get clear evidence that the spatial variation in the density of *Mymaridae* could account for the observed spatial variation in leafhopper density (Fig. 1).

Further studies will continue to investigate the influence of botanical and habitat parameters on the dispersal of leafhopper egg parasitoids. Furthermore, we will focus on the relationship between parasitoid dispersal and the population density of *E. vitis*.

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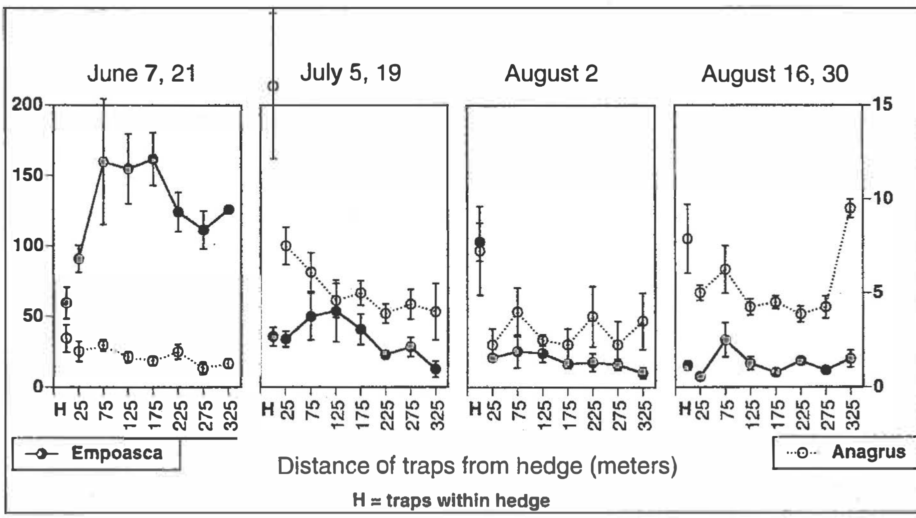

Figure 1. Trap catches of *Empoasca vitis* and its egg parasitoid *Anagrus atomus* in a vineyard with adjacent hedge.

Les effets de la gestion de l'enherbement sur les populations d'acariens Phytoseiidae dans les vignobles de Lombardie

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Introduction

Depuis de nombreuses années on connait l'importance de la végétation qui entoure les vignobles pour ce qui concerne la stabilité écologique de la culture (Boller *et al.*, 1988; Lozzia et Rigamonti, 1990). Cependant, bien que l'on connaisse l'influence exercée par une flore bien diversifiée sur l'accroissement du nombre des espèces d'artropodes (Remund *et al.*, 1989), les données sur le rôle de la végétation à l'intérieur du vignoble sont insuffisantes. Le but de ce travail est l'évaluation de l'importance des travaux culturaux sur la composition floristique et sur les *Phytoseïdae* afin de déterminer le rôle de la végétation herbacée entre les rangs pour la sauvegarde des populations des typhlodromes.

Matériel et méthodes

La recherche a été conduite dans deux vignobles de Lombardie durant l'été 1995. Le premier, nommé "Casaglio", se trouve dans la région viticole de la "Franciacorta". Il est caracterisé par une situation d'abandon complet remontant à deux années avant le début de nos recherches. Le deuxième vignoble, nommé "Gozzi", se trouve dans les "Colli Morenici Mantovani del Garda". L'enherbement y est pratiqué ainsi que tous les travaux culturaux habituels. La structure des communautés herbacées des deux vignobles a été déterminée avec une méthodologie basée sur l'emploi d'un quadrat de 1 m² de superficie jeté sur le terrain un certain nombre de fois. Les observations sur les acariens ont été effectuées en prélevant des échantillons de 25 feuilles pour chacune des espèces herbacées les plus répandues.

Résultats et discussion

La communauté végétale s'est révélée bien plus complexe dans le vignoble Casaglio qui compte 40 espèces par rapport aux 14 espèces du Gozzi. La composition a également été influencée par une présence majoritaire des Dicotylédones (34 espèces), surtout pérennes (23) à Casaglio. Dans le vignoble Gozzi ces valeurs ont été respectivement de 10 et 6 espèces. Enfin, la couverture végétale en conditions naturelles est bien supérieure à celle de la parcelle de vigne cultivée.

Les typhlodromes sont très nombreux sur la végétation herbacée à Casaglio alors qu'ils sont absents à Gozzi, même sur les plantes colonisées dans l'autre vignoble. La plupart des Dicotylédones abritent des populations de typhlodromes plutôt consistantes (tab. 1). Sur les graminées, la présence de *Phytoseïdae* n'a jamais été observée. A Casaglio cinq espèces ont été recueillies: *Typhlodromus pyri*, *Amblyseius andersoni*, *Kampimodromus aberrans*, *Euseius finlandicus* et *Bawus subsoleiger*. Les espèces recueillies sur la culture sont *K. aberrans* et *E. finlandicus* à Casaglio et *T. pyri* et *A. andersoni* à Gozzi. La colonisation est bien plus élevée dans le premier vignoble (fig. 1).

Tableau 1. Distribution des *Phytoseïdae* sur les espèces végétales à Casaglio (Aa= *Amblyseius andersoni*, Bs=*Bawus subsoleiger*, Ef=*Euseius finlandicus*, Ka= *Kampimodromus aberrans*, Tp=*Typhlodromus pyri)*.

Espèces végétales	Acariens par feuille	Espèces des *Phytoseïdae*
Vitis vinifera	1,64	Ef, Ka
Amaranthus retroflexus	0,80	Aa, Tp
Cirsium arvense	1,64	Bs, Ef, Ka, Tp
Sonchus oleraceus	0,76	Aa, Ka
Taraxacum officinale	1,20	Ef, Ka Tp
Lamium purpureum	0,72	Ef
Salvia pratensis	0,28	Ef
Heracleum sphondylium	0,16	Ef
Plantago major	2,16	Aa, Bs, Ef, Tp
Urtica dioica	1,76	Aa, Bs, Ef, Ka

Conclusions

Dans les vignobles abandonnés, les plantes herbacées sont habituellement colonisées par les *Phytoseïdae*. Certaines espèces d'acarien sont aussi celles que l'on retrouve sur la vigne. Un échange de typhlodromes entre la vigne et les plantes herbacées est donc bien probable. Les travaux culturaux usuels modifient la structure de la communauté végétale en faveur des Monocotylédones qui n'abritent pas de *Phytoseïdae*. La lutte antiparasitaire provoque la disparition de ces acariens. Une gestion correcte des travaux culturaux peut donc favoriser la présence des *Phytoseïdae* aussi dans les vignobles cultivés.

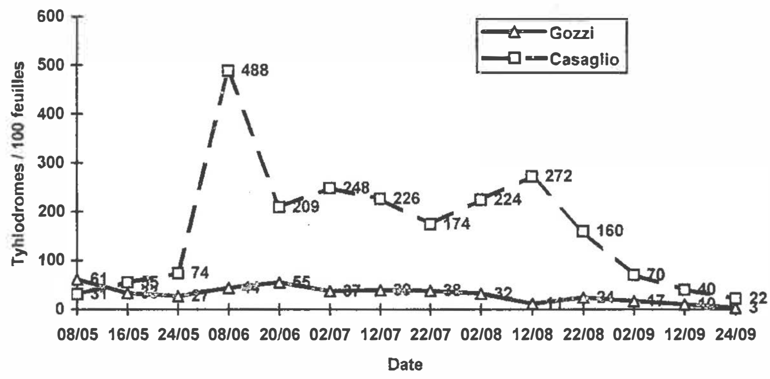

Figure 1. Dynamique des *Phytoseïdae* sur la vigne dans les deux vignobles.

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Insect parasitoids and mite parasites of leafhoppers and planthoppers (Auchenorrhyncha) in vineyards

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Introduction

Three species of Auchenorrhyncha are known as pests in German viticulture. *Empoasca vitis* is widespread and causes leaf injury through feeding on vein-phloem. Recently, we found *E. decipiens*, a second typhlocibid leafhopper very similar to *E. vitis* in several viticultural areas. *Hyalesthes obsoletus*, a cixiid planthopper, is the third species of economic significance. It is the vector of Vergilbungskrankheit (Maixner, 1994), a phytoplasma disease (grapevine yellows) which is widespread and of considerable economic importance in some viticultural areas of Germany. Chemical control of *Empoasca* leafhoppers is difficult due to the lack of appropriate insecticides and the yet unclear relationship between infestation and economic loss. *H. obsoletus,* on the other hand, is widespread on herbaceous plants within, but also outside the vineyards. Therefore, we surveyed vineyards for the occurrence and activity of parasites of leafhoppers and planthoppers with the objective of identifying antagonists that could be useful as natural antagonists of Auchenorrhyncha.

Material and methods

Throughout the growing season, yellow sticky traps (Aeroxon, 13x25 cm^2) were exposed in different vineyards, just above the soil level and within the canopy of grapevines. Traps were removed weekly and hoppers as well as parasitoids were counted. In addition to trap catches, leafhoppers were collected from grapes and weeds by sweep-nets and checked in the laboratory for visible symptoms of parasitation.

Results and discussion

Insect parasitoids

Hymenopteran egg parasitoids of the family Mymaridae are known to be effective antagonists of Typhlocybinae. They were caught on sticky traps throughout the season, but quantitative assessments were started in July when up to 15 parasitoids could be found per trap. We detected no correspondence between the spatial distribution of *Empoasca* and mymarids: Almost 80 % (n=6505) of *Empoasca* spp. but only 20 % of the parasitoids (n=481) were caught in the canopy. Most of the mymarids were found on the lower traps. However, sticky trap catches probably do not represent the abundance of mymarids, which usually forage by walking on the plant surface (Waloff and Jervis, 1985). Furthermore, we did not differentiate between *Anagrus atomus*, the most important egg parasitoid of *Empoasca* (Cerutti *et al.*, 1991) and other mymarids, which may be antagonists of other leafhoppers, including species living on herbaceous plants.
Dryinids (Hymenoptera: Dryinidae) of the genus *Aphelopus* have been described as specific antagonists of *Empoasca* (Jervis, 1980). However, we detected dryinids only occasionally in nymphs and adults of *Empoasca vitis* and various Deltocephalinae. Less than 1 % of the

insects checked were found to be parasitized by these parasitoids.
Parasitic flies of the family Pipunculidae attack both nymphs and adult leafhoppers. Although the genus *Chalarus* is specialized on Typhlocybinae (Jervis, 1980), we found no such parasitoids in *Empoasca.* However, parasitation was high in *Neoaliturus fenestratus*, another widespread leafhopper in vineyards. Thirty four of the 120 leafhoppers of this species (28 %) were parasitized by a yet undetermined pipunculid.

<u>Parasitic mites</u>

Mites are less known as antagonists of Homoptera than insect parasitoids. We detected two genera of prostigmatid mites (Acari: Erythraeidae) parasitizing on leafhoppers, planthoppers, and psyllids. Only the larvae of these mites are parasitic on insects while other stages are predatory (Southcott, 1960). *H. obsoletus* was parasitized by *Leptus* sp., which was the only parasite we found at all on this planthopper, whose soil inhabiting nymphs are protected from attack by the common parasitoids of Auchenorrhyncha. However, the occasional parasitation by *Leptus* does not seem to have a significant influence on the abundance of this vector. More important was the parasitation of Psyllidae and *Empoasca* spp. by a yet undetermined species of the genus *Charletonia.* More than 90 % of 180 individuals collected in a vineyard and the surrounding vegetation were parasitized by these mites. Multiple parasitation of individual leafhoppers by as many as nine mites weakened and occasionally killed the hosts.

Conclusions

Insect parasitoids of three taxonomic groups are parasitizing leafhoppers in German vineyards. However, the parasitation of *Empoasca* leafhoppers by Dryinidae and Pipunculidae is too low for a significant effect on population density. Mymarid egg parasitoids and erythraeid mites are present in considerable numbers, but more information is required about their relationship with the economically important Auchenorrhyncha.

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Habitat requirements of *Hyalesthes obsoletus* Signoret (Auchenorrhyncha: Cixiidae) and approaches to control this planthopper in vineyards

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Introduction

The planthopper *Hyalesthes obsoletus* Signoret is the vector of Vergilbungskrankheit (VK) (Maixner, 1994), a phytoplasma disease of grapevine in Germany that is similar to the Bois noir disease in other European countries. Unlike *Scaphoideus titanus* Ball, the leafhopper vector of Flavescence dorée, the polyphagous *H. obsoletus* feeds on grapevine only erroneously, and prefers herbaceous plants instead. All stages of the planthopper except for the adults live in the soil on the roots of herbaceous hosts. Among these are common vineyard weeds such as bindweed, *Convolvulus arvensis*. This plant is also a natural reservoir for the phytoplasma causing VK. The disease is transmitted by *H. obsoletus* from bindweed and probably other herbaceous plants to grapevine (Maixner *et al.*, 1995). We studied the biology of *H. obsoletus* at the northern border of its geographic range (Hoch and Remane, 1985), where it is restricted to areas with favorable climatic conditions, with the objective to identify possible outsets for the control of the further spread of Vergilbungskrankheit.

Material and methods

Five vineyards were included in this study, that varied with respect to intensity of cultural practice and the composition of weed flora. Host plants of *H. obsoletus* were identified by digging up nymphs from roots. The activity of adult planthoppers was monitored with yellow sticky traps and additional insects were caught by sweep-nets. In order to determine the infestation of the vector populations with the VK phytoplasma, individual planthoppers were tested by a polymerase chain reaction (PCR) procedure (Weber and Maixner, 1998).

Results and discussion

The larval development of *H. obsoletus,* like many cixiid planthoppers, is carried out in the soil where it feeds on roots. The development from third to fifth instar nymphs in spring is accompanied by their ascent to the surface. While the minimal depth of third instar nymphs was 10 cm in mid May, fourth instar nymphs stayed within two and 12 cm below the surface. Nymphs of the fifth instar and young adults were found from the soil surface to a depth of approximately 3 cm. Three new host plants were identified beside *Convolvulus arvensis* (bindweed) and *Urtica dioica*: *Artemisia vulgaris, Senecio erucifolia*, and *Ranunculus bulbosus*. Adults frequently fed on *Solanum nigrum*, while grapevine was used only erroneously.

In 1995, adult planthoppers were caught from mid June to beginning of August. The maximum activity was observed at the beginning of July. Significantly more males than females were caught on sticky traps (1302 versus 385) whereas equal numbers of both sexes were caught by sweep net (620 versus 534). This indicates, that sticky trap catches represent the activity rather than the abundance of adult *H. obsoletus.*

The presence and abundance of *H. obsoletus* is influenced by various factors of the vineyard environment:

Soil type: *H. obsoletus* is not able to dig actively but depends on structured soils with natural cavities. The steep slopes of the river valleys provide numerous cavities for the nymphs, while the clay or loess soils of other viticultural regions are not favorable for larval development.

Host plants: The numbers of sticky trap catches of *H. obsoletus* illustrate the high preference of this species for herbaceous hosts. As many as 2819 (92 %) of the 3075 planthoppers collected in the five vineyards were caught on traps exposed at the weed level, while only 256 vectors were trapped in the canopy. The average number of planthoppers was 89 on traps surrounded by either *C. arvensis* or *R. bulbosus* compared to 17 vectors on traps without a herbaceous host at a distance of 2 m. *C. arvensis* is also the main source for acquisition of VK phytoplasma by the vector. Between 30 % (49 of 166) and 34 % (42 of 123) of the planthoppers were infected by VK in vineyards with a high abundance of bindweed, while only 7 % (11 of 165) carried the phytoplasma in a vineyard with *R. bulbosus* as the prevalent weed. Unlike bindweed, the latter was never found to be infected by VK phytoplasma.

Cultural practice: Open soils without a managed green cover provided a good environment with sufficiently high temperatures for the xerotherm *H. obsoletus*. Plowing had a negative effect on the planthopper population, probably by disturbing its development in the soil.

Conclusions

While the spread of Flavescence dorée in southern Europe can be readily suppressed by applications of insecticides against its vector (Caudwell *et al.*, 1987), the transmission of VK cannot by interrupted by chemical control of *H. obsoletus* because this vector is hidden in the soil, is not restricted to the grapevine, and occurs also outside the vineyards. According to our current state of knowledge, control of bindweed and plowing are the only appropriate means of decreasing the risk of infection in areas which are affected by VK.

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Stochastic model for population development of *Lobesia botrana* (Den. et Schiff.)

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Introduction

We propose a mathematical model for supporting the pest control operation management of *Lobesia botrana* Den. et Schiff. (Lepidoptera Tortricidae) populations. This model takes into account uncertainty in forecasting and is suitable for describing the population dynamics of such lepidoptera; in particular, it permits an estimation of larval attack potential even at the second and third generation. Since such stages are those with the highest attack potential, it is useful to have an estimate of the increase and abundance of population.

Our model also yields estimates of the intensity and infestation times, starting from field data on temperature and abundance of first-generation larvae and chrysalids. Moreover, the model considers a set of biological data concerning stage-specific development rates as function of temperature, mortality rate, adult survival and fecundity.

It is commonly accepted that the development of a cohort of individuals gives rise -other environmental conditions being equal- to a distribution of development times where individuals emerge with a frequency distribution which is well-approximated by known probability distributions (Gamma function or some derivate function of it). Such dispersion in development times is due to the different development rate of individuals. The model takes this variability into account, starting from development rate distribution on individuals belonging to each stage and it can output a development times distribution that is close to that obtained from field data.

The second fundamental aspect of the model is its ability to account for the evolution of a population structured in life stages, thus supplying a faithful representation of the population development and permits a more efficient planning of pest management activities.

Structure of the model

We consider a population made of N age classes (or development classes). If n_1^t, n_2^t, ..., n_N^t represent the number of individuals in class 1, 2, ..., N respectively, at time t, then dn_i^t/dt is the variation ratio of individuals in class i per unit of time at time t; such a ratio is meaningful only when numerosity is high.

We adopted one of the simplest models for describing the evolution of a structured population, the so-called 'box-car' model (Manetsch, 1976; Severini *et al.*, 1990). This model simulates population dynamics as a flux of individuals through a train of boxes, each of them representing a single developmental class. In such a model, the development dynamics are described by a system of ordinary differential equations (Di Cola *et al.*, 1997)

$$\frac{dn_i(t)}{dt} = R_i(t) - R_{i+1} - M_i(t) \qquad i = 1,\ 2,\ \ldots,\ N \qquad (1)$$

where N is the number of age/development classes by which we divide the development interval of the population, R_i (with $R_i(t) = R(s_i, t)$, where $s_i = \sum_{j=1}^{i} \Delta s_j$ is the development stage of the i-th class) represents the input flux to class i from class i-1, R_{i+1} is the output flux -due to aging- from the i-th class and $M_i(t)$ is the output flux from class i which is due to the sum of all mortality factors.

Parameter estimate

The data concerning development rate were extrapolated from works of Baumgärtner and Baronio (1988) and Rapagnani *et al.* (1988); they have been approximated with Logan functions for the egg, larval and chrysalid stages, and with linear regression for the adult stage. The parameters and their dispersions have been estimated using Curve Expert.
Data concerning fecundity and mortality have been supplied by the "Laboratorio di Modellistica" at "Osservatorio delle Malattie delle Piante" of the Emilia Romagna region administration (Briolini, 1996).

Numeric simulation.

As a case study we have considered the spring infestation of *L. botrana* in a vineyard in Emilia Romagna (Italy). In particular, we started from the measurement of a cohort of chrysalids in the first 10 days of May. A simulation has been run on the development over time of this cohort by using the temperatures observed in the vineyard in the following 100 days.
Figure 1 shows the abundance of individuals in the four stages over time, so that the attack potential of second and third larval generation can be appreciated.

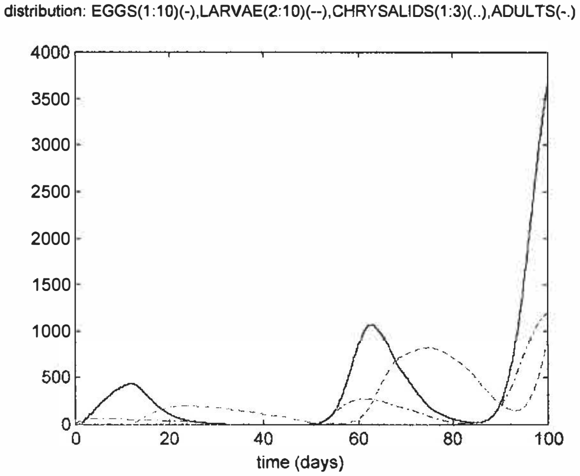

Figure 1. Population dynamics evolution in the four stages of *L. botrana* during a 100-days simulation.

The results obtained from the model, namely the knowledge on phenological events such as the start of the second generation, make it possible to plan optimal pest management activities. The model also suggests at which times pheromone-based traps are to be employed, so as to collect additional data on infestation evolution and thus suggest the timing of chemical control. Moreover, the representation of density dynamics allows pest managers to design a threshold-based control strategy.

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Research on the biology and integrated control system of *Peribatodes rhomboidaria* Den. et Schiff. in Rumanian viticulture

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Introduction

Peribatodes rhomboidaria was first met in 1977 in the Dobrogea region in the Murfatlar vineyard. It became soon a dangerous pest which can destroy 40-50% of the fruit buds at the beginning of the bud burst stage. The investigation was necessary for the development of an integrated control system in Rumanian viticulture

Material and methods

Studies on the biology of *P. rhomboidaria* were carried out at the Murfatlar viticulture station which lays 25 km away from the Black Sea coast during 1994-1996 in vineyards planted with Pinot gris. The various development stages of the pest were evaluated by almost daily observations.
The efficacy tests were carried out on 50 plants for each of the 14 different compounds tested. The application was made once with a Calimax sprayer pump using normal liquid volume of solution. Two days after application, total infestation as well as the amount of surviving larvae was surveyed in each plot.

Result and discussion

a) Biology of *P. rhomboidaria*
During the years 1994-1996, the larvae of the first generation (G1) appeared between September and May 15th.
The flight of the adults of the first generation corresponded mostly with the flowering period of the grapevine and lasted one month while the eggs-laying period lasted 1-2 weeks during this stage.
The emergence of the second larvae generation began between mid June and the beginning of July (after the adults of the first generation had laid their eggs) and lasted until the end of August. In Rumanian vineyards, *P. rhomboidaria* completes 2 generations per year although the most important for the damages is the first one, with winter larvae.
b) Control efficacy
Outbreaks of *P. rhomboidaria* are controlled by the application of insecticides, especially biological insecticides and chitin inhibitors;
In 1996, the results confirmed our previous works: Application of Polytrin 200 EC at 0.1 l/ha, Supersect 10 EC at 0.3 l/ha, Enduro at 0.3 l/ha and Bullock at 0.3 l/ha resulted in respectively 95.4 %, 93%, 90.1 and 88% of larvae mortality.
Treatments with the biological preparations Dipel DS at 1.0 l/ha and Forey (Biobit) at 1.5 l/ha as well as with inhibitor compounds like Alsystin 25 WP at 0.2 kg/ha and Insegar 25 WP at 0.2 kg/ha present the advantage of avoiding excessive chemical pollution in vineyards.
The use of these compounds represent an example of possible integrated control in viticulture in Rumania.

Conclusions

In Rumania, *P. rhomboidaria* finds climatic conditions good enough to complete 2 annual generations. The attack of the winter larvae of the first generation is the most important and can destroy up to 40-50% of the fruit buds in years with favorable development conditions.

In the biological control of *P. rhomboidaria*, very good results were obtained using the biological preparations of Dipel DS at 1.0 l/ha and Forey (Biobit) at 1.5 l/ha. The use of the inhibitor compounds Alsystin 25 WP or Insegar 25 WP at 0.2 kg/ha gave similar results.

For the chemical control of *P. rhomboidaria*, the effcicacy tests carried out during 1994-1996 showed that good results can be obtained with insecticides such as: Decis 2.5 EC at 0.3 l/ha; Polytrin 200 EC at 0.1 l/ha; Supersect 10 EC at 0.3 l/ha; Fury 10 EC at 0.2 l/ha; Enduro at 0.3 l/ha; Bulldock at 0.3 l/ha. However these products should only be used when the observed infestation with larvae is over the economic threshold of 3-5 larvae / 100 vine buds examined.

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Research and development in integrated production in Northern Switzerland

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Integrated Production in viticulture had been developed in German-speaking Switzerland from 1986-1988 in close collaboration with 45 grape growers and has led to the establishment of the ecological bonus-malus system ("Wädenswil model"). IP was officially introduced in practice by the foundation of the first farmers' association VINATURA in April 1989 and now covers some 1900 ha (=75% of the vineyard area in our region).

Whereas Integrated Production is becoming more and more a routine in our part of Switzerland we perceive signs of stagnation. Sustainable production systems are *per definitionem* dynamic processes that should not be slowed down in their evolution by rigid production guidelines. A possible approach is the clear definition of a minimal set of important criteria to be fulfilled wherever IP is practised, completed with a set of additional options addressing the peculiarities of the individual farm and of the region concerned. Such a list of 35 different options has been established by VITISWISS at the national level from which the 6 regional organisations can select their specific mix. Each IP member has to select and to implement a minimum of 7 options to obtain certification.

In order to verify the ecological impact of such options and to develop the scientific basis for future tools, in spring 1994 we decided to focus all IP relevant R&D activities at our research station on a network of 14 pilot IP-farms where prototypes are investigated with the direct participation of the growers.

The present activity program (1994-99) is placing emphasis on preventive (indirect) plant protection and habitat management issues and includes the following aspects:

Soil and habitat management:

- Intensive and extensive management of the green cover to enhance the development of 2 different types of botanical diversification; assessment of physiological parameters ca. 1999.
- Characterisation and management of ecological compensation areas within and outside the experimental vineyards.

Zoology:

- Continuous faunistic monitoring of the 2 soil management systems:
    - ◊ yellow sticky traps ("Ecometer") for *Empoasca*, Thrips and parasitoids of grape moths and *Empoasca*
    - ◊ Monitoring the activity of *Trichogramma* by exposition of grape moth eggs; improvement of exposition technique
- Complete faunistic profile after termination of green cover program

- Prototypes of more effective wasp traps

Phytopathology:

- Improving prognostic tools for *Plasmopora* and *Pseudopezicula:*
    - ◊ operation of warning devices for *Plasmopora*; primary infections
    - ◊ operation of trapping devices for spores of Pseudopezicula

Resistant varieties:

- Small experimental plots with inter-specific varieties.

The possibilities of representing blanket coverage agrometeorological information for plant protection advisory regarding information from weather forecast.

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Areal representation, network density and standards

The efficacy of phytopathological alert services can be increased considerably when blanket coverage information on the development of organism pests dependent on the weather is possible. We have to be aware of the fact that a weather station in a vineyard can only supply data for the site where it is located. Applicability to other sites is only partly possible. In this respect, possibilities for providing a blanket-coverage presentation of agrometeorological variables are to be discussed. When looking for alternatives, it has to be taken into account that considerable differences can occur in meteorological quantities, even over short distances, due to the influence of the canopy. If model results of the forecast system are to provide blanket-coverage representation, then a quantitative estimation of the differences in the microclimate is necessary.

Transfer model of leaf wetness duration

Transfer models can be used to close the gap between measurements under standard conditions and the microclimate situation in the vineyard, as an example a model for wetness-duration can be introduced(Pedro and Gillespie, 1982). A further advantage of this method is that, in addition to the data from a weather station based on standard data set, the weather forecast can also flow into the phytopathological model.

The basis is the calculation of leaf wetting against the heat balance of a leaf, which is combined with the engineering heat transfer theory for a small rigid plate of the same dimensions as the leaves. The energy balance equation takes all the relevant energy transfer terms into consideration. There are two modules in the calculation of leaf-wetness. The first leaf-wetness module is only active during rainless periods. It describes evaporation or dewfall assuming a thin horizontal waterfilm with a maximum of 0.2 mm thickness. The rainfall module simulates the evaporation time of a rain droplet settled on a leaf (Wittich, 1993). The dimensions of the droplets can be found with field experiments. The average value was set to a diameter of 1.5 mm for grapevine leaves. The single values fluctuate between 0.5 mm and 4 mm. The calculations of a rain droplet start in the last hour of rainfall. The shape of the drop is approximated by a small cylinder with an initial height of half the diameter of the drop. The leaf wetness model validation is presented in Fig. 1, where the measured and calculated leaf wetness times are compared for the upper parts of a foliage with free exposed leaves. The good agreement between measurements and calculations provides the basis for running the downy mildew model with estimated wetness duration.

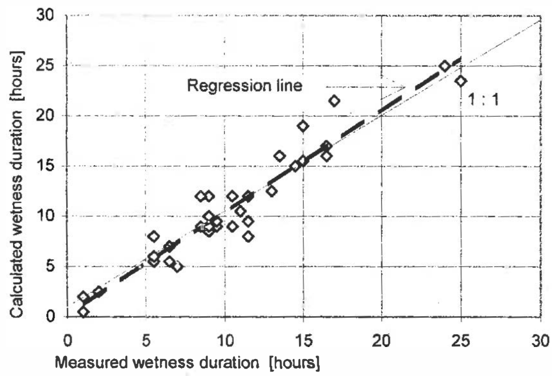

Figure 1. Comparison between calculated and measured leaf wetness duration for the upper parts of a foliage with free exposed leaves in Geisenheim, September 1995. The thin line divides represents the 1:1 ratio; the thick, dashed line is the regression between measured and calculated data.

Precipitation from meteorological radar network

The wetness model also needs information regarding the duration of rain periods. Extensive recording of precipitation is only possible by means of radar, whereby a doppler radar beam scans the atmosphere at the smallest possible angle of elevation. Precipitation occurring in the monitored air masses scatters part of the emitted energy back.

The transit time of the impulses and the direction of the antennae determine the location of the precipitation. The energy scattered back serves as a scale for the intensity of the precipitation. The angle of the radar beam amounts to 1°. Regarding the curve of the globe, the radar beam elevate to a height of 3000 m in a distance of 100 km. Therefore, the accuracy of radar measurements decreases as the distance from the detector increases. Good results are possible up to a distance of 100 km. The measurements can be resolved to an area of 1 km^2. The measurements have to be calibrated with normal rainfall measurements on single points in the area. This procedure can be done automatically. The advantage lies in the timely resolution of the rain intensity that can, for example, be significant for the quantitative determination of primary infection from downy mildew. Fig. 2 shows the total blanket coverage of the total daily precipitation in the viticulture area of Rheinhessen as an example from the last year: more than 20 mm (black and dark grey) fell in the area near Mainz as well as on the deep slopes of Rüdesheim. Heavy rainshowers and thunderstorms were drifting from SW to NE through the area. Rainfall lower than 5 mm was observed only sparsely in the hilly region of Rheinhessen and in the Nahe-valley.

Further investigations

In the next step the leaf wetness model has to be validated with the aim of describing the blanket coverage of the leaf-wetness situation in a viticulture area. Therefore a network with several agrometeorological stations was installed in the area of Rheinhessen to compare the results of calculated and measured leaf wetness. The advantage of the leaf wetness model is the possibility to calculate leaf wetness for the following 5 days. Since 1994 the Deutscher

Wetterdienst has introduced the Deutschland model in the weather forecast. In this model the grid point distances amount to only 13 km. This model supplies weather forecasts for the following 48 hours. Afterwards the European weather forecast model with grid point distances of 50 km was applied. If the validation program is successful, many possibilities for applying the new measurements of rainfall can be expected. For example actual soil moisture for green covered and normal ploughed vineyards can be calculated. It is also possible to apply computer models to estimate the nitrate fluxes in the soil.

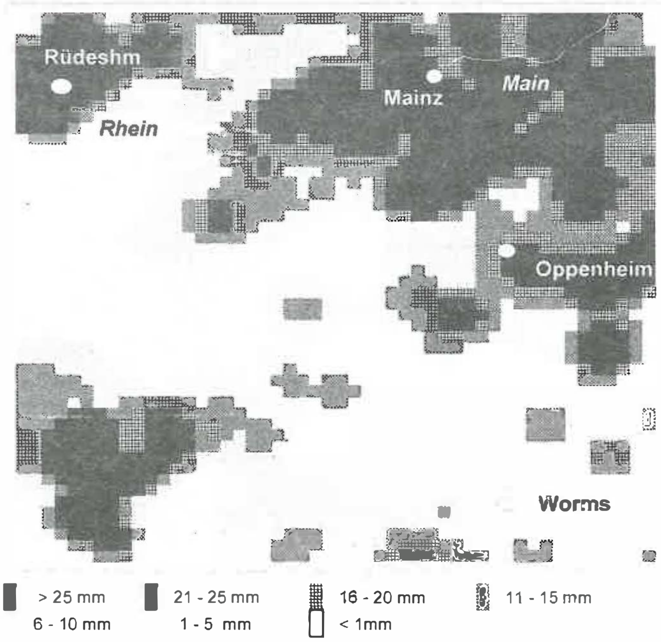

Figure 2. Sum of rainfall on July 29th 1996 in the viticulture area of Rheinhessen (51*51km). For orientation few topographic details are indicated (the Rhine river and some bigger towns) . The radar pixel means a square with 1 km extension and the different hatchings correspond to the different steps of total daily rainfall.

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Comparaison économique de la lutte par confusion avec d'autres méthodes de lutte contre les vers de la grappe (*Lobesia botrana*)

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Introduction

La technique de lutte par confusion contre les vers de la grappe a été appliquée depuis une quinzaine d'années dans divers vignobles européens, tant à titre expérimental, que dans la pratique (Neumann et *al.*, 1993; Stockel et *al.*, 1994).
La bonne efficacité de la lutte obtenue contre eudémis lors de sa première année d'homologation provisoire en Suisse (Charmillot et *al.*, 1997), doublé d'une subvention partielle, rendent aujourd'hui cette méthode biotechnique très attractive aux yeux des viticulteurs.
Considéré comme étant un procédé coûteux , il était intéressant de calculer le coût effectif de cette méthode et de le comparer à celui de la lutte classique, sur la base de l'expérience de 1996 en Valais.

Matériel et méthodes

Les diffuseurs RAK2 du fabricant BASF furent installés à une densité de 500 unités à l'hectare, correspondant à une charge annuelle de 60 g d'attractif /ha.
L'évaluation du coût de la méthode fut réalisée pour une surface totale de 104 hectares, divisée en 5 secteurs de superficie comprise entre 4 et 50 hectares. La topographie, le mode de culture, le degré d'isolation par rapport aux vignes voisines et la nombre d'exploitants varient fortement entre les secteurs, voire à l'intérieur de ceux-ci (Schmid et Emery, 1996).

Résultats

Le nombre d'heures/hectares total varie de 3,4 à 5,8, selon les secteurs considérés, leur topographie et leur mode de culture. La moyenne pondérée par les surface est de 4,1 h/ha, dont les ¾ concernent uniquement la pose des diffuseurs (3 h/ha).
Pour une densité de 500 diffuseurs/ha et à raison d'un salaire horaire de 20FS, nous obtenons en moyenne les frais suivants par hectare:

- diffuseurs Rak$_2$ (500/ha) Fr. 242.-
- installations 3 h Fr. 60.-
- contrôles 1.1 h Fr. 22.-
- **Total Fr. 324.-**

Discussion

A titre de comparaison, le coût de la lutte chimique représente les montants suivants (prix du produit pour une application par saison, sauf pour le Fénoxycarbe qui en exige deux de suite):

- Fenoxycarbe Fr. 144.-
- Chlorpyrifos Fr. 75.-
- Tebufenozide Fr. 115.-
- Bacillus thuringiensis Fr. 90.-
- Tetrachlorvinphos Fr. 85.-
- Parathion Fr. 50.-

Ces valeurs n'intégrant ni les frais d'application, ni les frais de contrôles, ils sont à comparer au coût de mise en place de la lutte par confusion uniquement, soit environ 300.-/ha. Néanmoins, elles restent de 52 à 83% meilleur marché que la confusion, respectivement pour le fenoxycarbe et le parathion. Toutefois, il conviendra de rajouter éventuellement les frais induits par une application spécifique de l'insecticide, ou par un second, voire un troisième traitement annuel contre le ver. Les valeurs précitées se verraient alors doubler, voire tripler.
A moyen terme, les coûts de cette méthode pourraient être réduits, consécutivement à une diminution de la densité des diffuseurs (Charmillot *et al.*, 1995) et à une réduction du temps de contrôle liée à une meilleure connaissance des secteurs, des zones à risque et à l'effet cumulatif de la méthode.

Conclusions

La lutte par confusion sexuelle reste pour l'instant une méthode coûteuse par rapport à la lutte chimique, mais une diminution conséquente du prix est envisageable à court terme.
Mis à part les critères d'ordre financier, la confusion donne aux viticulteurs la liberté d'organiser d'une manière indépendante la protection contre les maladies fongiques et de mieux placer les interventions en fonction du risque. Cette indépendance des traitements "vers de la grappe" permet dans certains cas d'économiser une intervention.
Pareillement à d'autres méthodes spécifiques (*Bacillus thuringiensis*, régulateurs de croissance), la méthode de confusion présente en outre l'avantage de préserver les auxiliaires et éventuellement de réduire la pression d'autres ravageurs (Schmid, 1990).
Tous ces éléments en faveur de cette technique expliquent l'augmentation de la surface placée en confusion; malgré son coût relativement élevé, celle-ci a en effet presque triplé en Valais depuis l'année dernière, passant de 104 à 290 hectares.

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Organisation de la lutte par confusion sexuelle contre l'eudémis (*Lobesia botrana*) dans les vignobles Morceles

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Les résultats de plus de 10 ans de recherche de base et d'expérimentation dans les vignobles ont démontré la fiabilité et l'efficacité de la méthode de lutte par confusion contre l'eudémis (Neumann *et al.*, 1993; Stöckel *et al.*, 1994). Aujourd'hui, des directives et conseils précis ont été formulés afin de permettre son utilisation dans la pratique (Charmillot *et al.*, 1997). Une des contrainte majeure à respecter est de couvrir une surface suffisamment vaste, afin d'éviter une immigration de femelles fécondées.
Pour répondre à cette exigence, les exploitants d'un vignoble aussi morcelé que celui du Valais sont tenus de se regrouper et d'imaginer un système d'organisation en collaboration avec le Service cantonal d'agriculture.
Nous présentons ici la méthode et les résultats de 1996 en deux secteurs valaisans où le morcellement parcellaire est particulièrement fort : Venthône et Leytron.

Les différentes phases de l'organisation sont présentées de façon chronologique:

1. **Evaluation préliminaire des populations :** Des observations effectuées par l'office cantonal de protection des plantes dans le cadre de Vitival (organisation professionnelle pour la production intégrée) nous renseignent sur la répartition des deux espèces de vers de la grappe, eudémis et cochylis, et sur leur taux d'attaque respectifs durant les années qui précèdent la mise en place de la lutte.
2. **Persuader les viticulteurs :** Des séances d'information sont organisées par l'office de protection des plantes. La nécessité d'obtenir l'accord de tous les viticulteurs concernés conduit les responsables des groupements à expliquer brièvement et clairement par courrier la méthode de lutte; à cette occasion, ils peuvent soit leur demander un accord écrit (variante Venthône), soit considérer la non-réponse comme accord tacite (variante Leytron).
3. **Organisation de la lutte :** Des membres de groupe Vitival se chargent d'organiser l'installation des diffuseurs; ils assument également le contrôle de l'efficacité (piégeage de papillons, contrôles larvaires) avec l'assistance de l'office susmentionné.
4. **Gestion de la comptabilité :** Les consortages d'irrigation respectifs gèrent la comptabilité concernant le matériel et les frais de main d'oeuvre (installation des diffuseurs et contrôles); ils s'occupent également de la facturation auprès des viticulteurs. Enfin, ils transmettent les décomptes finaux aux instances officielles pour un éventuel subventionnement (en 1996 : 50 %).
5. **Mise en valeur :** Les résultats des contrôles durant la saison permettent à notre office d'évaluer l'efficacité de la méthode, d'établir ses coûts et de la comparer avec d'autres méthodes de lutte (Schmid et Emery, 1997).

Les évaluations de l'attaque des vers de la grappe en 1996 à Venthône et Leytron dans les vignes placées en confusion ont donné les résultats suivants:

Lieux	**Surfaces (ha)**	**Nbre de propriétaires**	**Attaques larvaires (%)**	
			1ère génération	2ème génération
Venthône	50	183	0,64	0,89
Leytron	15	140	0,05	0,74

En Valais, les résultats obtenus en 1996 sur d'autres surfaces sont tout à fait comparables à ceux présentés ci-dessus; pour un total de 104 ha, seulement 2 ha présentant une mauvaise isolation ont nécessité une intervention curative en deuxième génération (Schmid et Emery, 1996).

Ainsi, moyennant une supervision et une coordination des opération par un organe responsable, la méthode de lutte par confusion est également pratiquable dans des vignobles très morcelés et cela, sans qu'elle n'exige la création de nouvelles structures administratives.

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Pest control of the grapevine in landscape conservation areas

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Introduction

There are more than four thousands ha of vineyards in Hungary within the Landscape Conservation Regions, and in many of these the vinestocks are the plant typical to the landscape. Especially in the case of pest control it must be taken into consideration that conventional insecticides also kill non-target and beneficial organisms of the ecosystem, injuring the biodiversity of the plot. Therefore, only highly selective insecticides should be used in those areas (Voigt, 1991; Voigt, 1992).
Our investigations have been conducted with the aim of developing an environmental friendly pest control method in the Landscape Conservation Region.

Material and methods

The experiments were carried out in Badacsony (North of Lake Balaton, Landscape Conservation Area), in four plots:

number of the observation	1	2	3	treated control (by conventional insecticides)
surface, ha	1,2	1,0	0,8	2,0
cultivar	Sauvignon blanc	B 38	Riesling+Pinot gris	Riesling
training system	high cordon	Sylvoz	horned head	high cordon

The pests investigated during the research period (1991-1994) were:

Lobesia botrana Den. et Schiff. (European Grapevine Moth) (it was the main insect pest found in the research period)
Calepitrimerus vitis Nal. (Grapevine leaf-mite)
Tetranychus urticae Koch. (Two spotted spidermite)

The pests were controlled with selective insecticides and acaricides (a.i.: fenoxycarb (Dalla-Montà and Pavan, 1989; Coscollà *et al.,* 1991.) chitin-synthesis inhibitor, *Bacillus thuringiensis* var. *kurstaki* (Charmillot *et al.,* 1992; Funcke *et al.*, 1992)).
The flight of the grapevine moth species was observed by means of pheromone traps.
The IGR applications were made just after the first peak of the flight of EGVM (in the two generations resp.).
The number of EGVM larvae was counted in 100 grape bunches selected randomly. The mite populations were determined three times a year : May, end of July and early September in each plot respectively (Sárospataki *et al.,* 1991).
EGVM larvae were collected and evaluated in the laboratory to determine their parasitation.

Results and conclusions:

The following trends can be concluded based on four year-period:

1. the population of *L. botrana* was forced under the economical threshold by use of IGR pesticide (Insegar, a.i.: fenoxycarb) either twice in a generation at 0,3 kg/ha or once 0,6 kg/ha,
2. the active ingredient of Dipel (*Bacillus thuringiensis* var. *kurstaki*) dissolves rapidly with UV radiation and at high temperatures (above 20°C), the effectiveness of BT preparations are low in the case of the second generation of the two grapevine moth species which cause damage in July and August,
3. the recolonisation of the beneficial (parasitoids and predators) and non-target organisms of the fauna was very slow in the area treated by selective insecticides. This was more rapid in our Swiss colleagues's observations (Boller and Remund, 1986; Remund *et al.,* 1992.)
4. no parasitoids were noticed in the caterpillars of *L. botrana* collected from the treated plots,
5. sex-pheromone traps can be used for determining the moment at which larvae caused damaged, however the data should be completed with the help of any other available methods (alimentary traps, observations in the field etc.),
6. during the observations the populations of *Calepitrimerus vitis* Nal. and the *Tetranychus urticae* Koch. remained under the economical threshold,
7. the following predatory mite species were determined in the experimental plots: *Amblyseius finlandicus, Paraseiulus subsoleiger, Zetzellia mali.*

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Nouvelles méthodes de protection raisonnée du vignoble. Les étapes de mise en oeuvre

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Plusieurs opérations d'expérimentation/démonstration sont en cours dans les différentes régions françaises pour assurer la promotion d'un mode de protection des vignobles, plus respectueux des équilibres naturels et de la qualité des produits issus de la vigne. Les résultats obtenus sont tangibles et montrent que la mise en application des techniques de lutte raisonnée permet le plus souvent d'économiser des traitements tout en minimisant les prises de risques et en accordant une part plus importante au respect de l'environnement.

L'aspect quantitatif de cette approche (marge de progrès technique, intérêt économique) est maintenant mis en évidence. Au delà de ce premier niveau de résultat en cours actuellement, une réflexion nous conduit à penser que deux interrogations subsistent (schématisées en A et B sur la figure 1) auxquelles il nous semble nécessaire d'apporter des réponses pour, d'une part atteindre l'objectif final qu'est la mise à disposition de ces techniques au plus grand nombre de viticulteurs, et d'autre part, assurer la pérennité de ces techniques :

Niveau A : Force est de constater qu'à ce jour, les surfaces concernées par la lutte raisonnée restent modestes, et que les méthodes de contrôles, nécessitant des observations longues et fastidieuses le plus souvent réalisées par des techniciens, risquent de décourager nombre de viticulteurs. Un transfert de techniques doit être envisagé pour permettre à l'exploitant de réaliser lui-même, par des méthodes simplifiées, la majeure partie des observations nécessaires à la conduite raisonnée de son vignoble.

Niveau B : Sur le plan technique, les outils évoluent, et des marges de progrès restent possibles. Elles sont liées aux travaux d'amélioration en cours conduits par les organismes de recherches sur l'adaptation régionale des seuils de nuisibilité ou de nouveaux modèles de comportement épidémique d'ores et déjà testés sur des réseaux d'évaluation en temps réel. De même, l'expérience acquise dans le domaine des réseaux de stations météorologiques doit nous conduire à proposer des améliorations de fonctionnement par rapport aux schémas existants.

Les champs d'investigations restent considérables ; leur étude et les progrès accomplis doivent être valorisés à l'aval par une exploitation pratique, notamment dans le cadre de la lutte raisonnée. Ceci nécessite la mise en oeuvre de liaisons étroites avec des réseaux d'évaluation ainsi qu'avec les concepteurs des méthodes nouvelles.

A moyen terme, quelles sont les voies d'organisation qui permettront de diffuser plus largement ces techniques de lutte raisonnée ? Trois schémas, d'ores et déjà disponibles pour les viticulteurs, se dessinent à l'heure actuelle :

- L'exploitation individuelle de ces techniques : nécessite un investissement en temps considérable, ne met pas l'utilisateur à l'abri d'échecs possible pour les raisons évoquées ci-dessus et ne concernera, de toute façon qu'une minorité
- La mise en oeuvre de ces méthodes pourrait être sous-traitée à des organismes, publics ou privés, et restituée sous forme de conseils. Si une telle organisation permet d'envisager un développement des surfaces concernées, elle présente l'inconvénient de déresponsabiliser l'utilisateur final, voire lui interdire d'évoluer vers la maîtrise de ces techniques modernes
- La troisième voie, mixte, nous semble la plus intéressante car elle optimise à la fois la formation individuelle et l'amélioration des outils ; elle consiste en une exploitation individuelle, à partir de méthodes simplifiées (transfert des techniques), concertée en temps réel dans le cadre d'un réseau coordonné sur le plan régional.

Seule cette troisième voie nous semble réaliste pour permettre de développer considérablement les surfaces conduites en lutte raisonnée ; elle implique le viticulteur au niveau du contrôle de son vignoble en le déchargeant de nombreuses contraintes de fonctionnement qui représentent une lourde charge pour chaque exploitation, sans le placer en position d'assistanat.
Un tel développement semble possible si l'on veille à intégrer dans l'organisation proposée les deux niveaux de préoccupations évoquées plus haut.

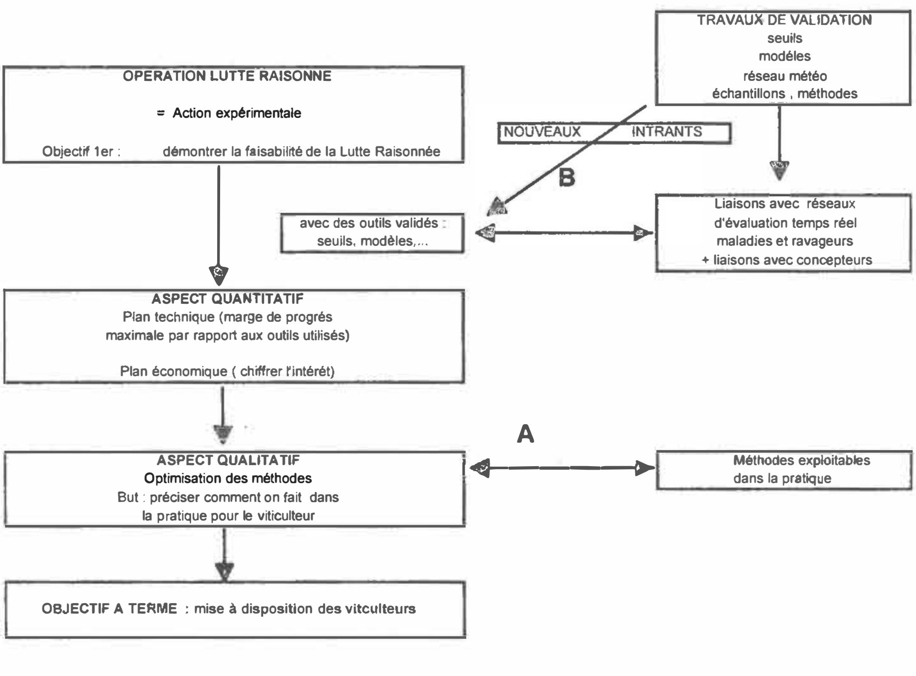

Figure 1. Protection raisonnée du vignoble : étapes et mise en oeuvre

Coûts comparés de la confusion sexuelle et de la lutte insecticide classique dans un vignoble Médocain

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Introduction

Une analyse des coûts ne peut s'arrêter à la seule prise en compte du produit phytosanitaire. Elle doit porter aussi sur les temps de travaux nécessaires à la mise en oeuvre respective des deux types de lutte (y compris les temps d'observation au vignoble) et sur les charges de mécanisation.

Matériel et méthodes

Est mis en œuvre un protocole d'observation et d'étude de coûts qui comprend :

- des observations au vignoble pour déterminer les temps de travaux nécessaires aux différentes opérations prises en compte
- une extraction de la comptabilité analytique du château des éléments comptables permettant de préciser les coûts de main d'œuvre, mécanisation, de consommables, etc...

Modalités étudiées

- Coût confusion sexuelle exclusivement (cas de faible pression Eudémis en G_1, aucun traitement insecticide n'est appliqué)
- Coût confusion sexuelle + un traitement insecticide en G_1 (pression Eudémis plus forte, nécessité d'abaisser le niveau de population en G_1)
- Coût confusion sexuelle + un traitement RCI* sur cicadelles (cas de forte pression cicadelle connue)

Comparés à :

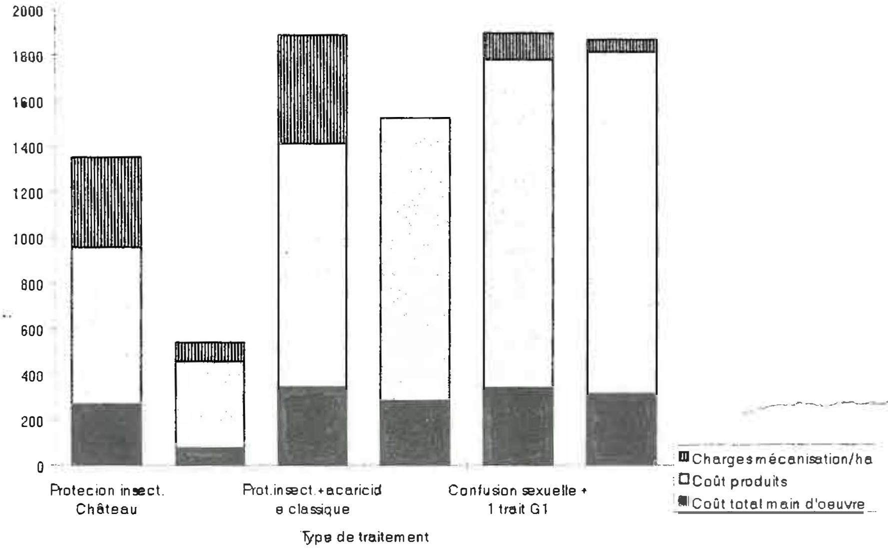
- Coût protection insecticide classique du Château (référence traitements 1993/1995)

Auquel nous ajoutons :

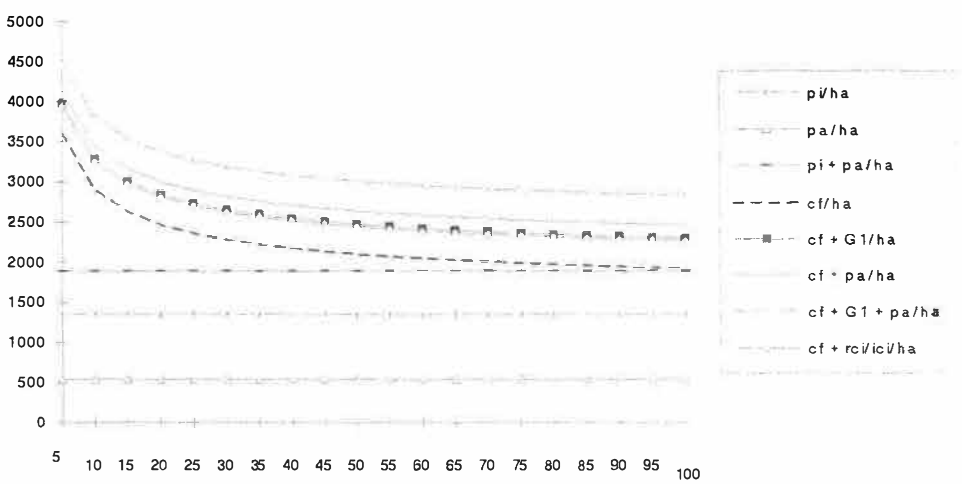
- Coût protection insecticide + acaricide du château, dans la mesure où à terme, la suppression des applications insecticides toxiques associée à un choix adapté de spécialités fongicides neutres à faiblement toxiques devraient permettre le rétablissement d'un équilibre biologique entre acariens phytophages et prédateurs. La confusion sexuelle permettrait alors également l'économie de la couverture acaricide classique.

Résultats

Récapitulation coûts par ha et par an par type de traitement
(charges de "zone de protection" non incluses pour la confusion sexuelle)



Coûts/ha comparés de différentes stratégies insecticides en fonction de la surface totale traitée
(zone de protection incluse)



(pi: protection insecticide classique, pa: protection acaricide classique, pi+a: protection insecticide + acaricide classique, cf: confusion sexuelle, cf + G1: confusion sexuelle + un insecticide en G1, cf+pa: confusion sexuelle + un acaricide, cf+G1+pa: confusion sexuelle + un insecticide en G1 + un acaricide, cf+rci/ici: confusion sexuelle + un traitement cicadelles (rci ou ici)

Conclusions

Dans le cas particulier de notre étude et compte-tenu des pratiques de protection du vignoble ayant cours sur l'exploitation étudiée, la lutte contre les tordeuses de la grappe par confusion sexuelle ressort d'un prix de revient plus élevé que la protection insecticide classique.

Cependant, l'hypothèse plausible d'une restauration de l'équilibre biologique grâce à l'arrêt d'emploi d'insecticides neurotoxiques permet d'envisager également l'économie des applications acaricides, ce qui réduirait le différentiel en terme de coût entre Protection classique et Protection par confusion sexuelle.

La possible nécessité d'une application insecticide en première génération certaines années ou d'intervention contre la cicadelle verte des grillures qui reste à envisager (selon résultats des contrôles biologiques effectués en cours de campagne) renchérit évidemment le coût total de la protection contre les ravageurs de la vigne.

Si l'importance de la surface du vignoble protégée "sous confusion sexuelle" conditionne l'efficacité de la méthode (le minimum serait de 10 ha), elle en conditionne également le prix de revient à l'hectare. D'un point de vue strictement économique, il conviendrait de travailler sur des îlots d'un minimum de 40 ha.

Directives européennes pour la production intégrée en viticulture

Application dans la pratique viticole

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Suite à une étroite collaboration entre chercheurs, vulgarisateurs et viticulteurs, des directives pour la production intégrée (P.I.) ont été élaborées et publiées (Schmid, 1996).

Elles expriment dans une première partie les **objectifs** de la P.I., résumés comme suit :

- Promouvoir une viticulture respectueuse de l'environnement, économiquement viable et soutenant la multifonctionnalité de l'agriculture dans ses aspects sociaux, culturels, récréatifs, etc.
- Assurer la production de raisins sains et l'obtention de produits viticoles de haute qualité; réduire au maximum le taux de résidus.
- Protéger la santé des producteurs lors de la manipulation d'intrants.
- Rechercher et maintenir une grande diversité biologique dans l'écosystème viticole et ses alentours.
- Utiliser avant tout les ressources et les mécanismes de régulation naturels.
- Conserver et favoriser l'équilibre du sol à longue échéance.
- Minimaliser la pollution des eaux, du sol, de l'air.

Dans une deuxième partie, elles formulent les **exigences de base** pour les différents travaux de la vigne. Cependant, elles ne contiennent pas de recettes, mais donnent le cadre dans lequel les directives régionales plus détaillées et plus précises peuvent être établies.

Ces directives ne sont que des écrits, mais elles constituent un document indispensable à une harmonisation au niveau européen, encore insuffisant dans la réalisation pratique. En effet pour la mise en oeuvre de ces directives, l'étroite collaboration entre recherche, vulgarisation et viticulture doit continuer, voire s'intensifier. Toute recherche sera inutile si on n'arrive pas à transférer tôt ou tard ses résultats dans la pratique viticole.

Suite à la réunion OILB de Freiburg, deux questions importantes subsistent : Actuellement,
a) que peut-on transférer vers la pratique ? et
b) de quelle manière peut-on faciliter ce passage ?

a) Réalisations possibles :
Les moyens de prévision pour ravageurs et maladies se sont améliorés ces dernières années: les seuils de tolérance pour des ravageurs clés sont établis; des méthodes de contrôle assez fiables existent pour certains ravageurs, d'autres nécessitent encore des précisions ou sont trop fastidieuses à l'heure actuelle. Des modèles de simulation pour le mildiou de la vigne sont élaborés et validés dans différentes régions viticoles et s'installent de plus en plus dans la pratique. Malheureusement, ce n'est pas le cas pour l'oïdium de la

vigne. Les avertissements régionaux profitent d'une part de ces progrès scientifiques et d'autre part des améliorations des prévisions météorologiques.

Dans **les moyens de protection**, le progrès a été certainement plus net dans le secteur des ravageurs que dans celui des maladies. En effet, les préparations biologiques à base de *Bacillus thuringiensis* sont entrées dans la pratique; les régulateurs de croissances des insectes sont une autre méthode de lutte spécifique et enfin la méthode de confusion est disponible pour les deux tordeuses de la grappe, eudémis et cochylis. La gamme des produits contre les maladies est certainement, moins spécifique mais elle est assez variée pour éviter un développement rapide de la résistance des champignons. Les connaissances des effets secondaires non intentionnels des pesticides sur la faune utile de la vigne, permettent d'établir des listes de produits spécialement conseillés pour la production intégrée.
Certes, des lacunes scientifiques et techniques persistent dans les connaissances biologiques et épidémiologiques des ravageurs et maladies, dans les études des interférences entre divers organismes de la vigne et toutes interactions à l'intérieur de l'écosystème vigne. Mais les progrès sont réels et des améliorations vont suivre.

b) Quant à savoir de quelle manière on transfère ces connaissances vers la pratique viticole. On peut développer la situation en 2 procédures :

- mise en oeuvre directe vers le viticulteur par une bonne formation de base et une formation continue sur le terrain, le viticulteur est l'observateur et l'exécutant
- le technicien s'occupe des observations dans les vignes, suit les conditions météorologiques, etc. et élabore le conseil pour le viticulteur.

Le deuxième schéma pourrait être à court terme du point de vue surface et efficacité plus spectaculaire, mais cette méthode déresponsabilise le viticulteur. Responsabiliser le viticuleur doit être un élément clé dans la réalisation de la production intégrée. Le terme "intégré" signifie plus qu'une application de recettes. Il exige des appréciations subtiles, des solutions à adapter aux différentes situations. Une application stricte du deuxième schéma est donc en contradiction avec les exigences de base de la production intégrée. Le technicien a des tâches importantes à remplir dans la formation continue, dans l'échange d'information entre recherche, vulgarisation et profession. Le technicien peut aussi décharger le viticulteur de certaines observations et fournir des informations qui ont une valeur régionale.

Cette responsabilisation du producteur est le meilleur garant pour maintenir l'idée évolutive de la production intégrée. Cependant, des règles sont indispensables (prescriptions, limites, etc.) mais sans que la volonté du viticulteur de progresser soit occultée.

Les structures pour cette mise en oeuvre sont à adapter aux conditions socio-économiques régionales. Dans beaucoup de régions, il n'y a pas lieu de créer de nouvelles structures. Les organisations interprofessionnelles existantes en collaboration avec les instances officielles peuvent répondre à ce défi.

Références bibliographiques

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Integrated pest management in grapevines in Hungary

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Research on the introduction of integrated fruit and grape management has a fairly long history in Hungary. Observations and research on environmental friendly technologies have been conducted for some 20 years. The communiqué appearing in the Official Agricultural Journal in 1993 is based on these results and experiences and makes recommendations for integrated management (in fruit and grape production) as well as for international standards and requirements for organic farming. In accordance with the EU directives, these standards specify the following objectives:

- reduction of loading the environment with harmful chemicals,
- maintenance of biodiversity in vineyards and orchards as well as in their surroundings,
- maintenance of soil fertility, decrease of harmful compounds in the soil,
- efforts for minimizing residue levels in end products,
- setting priorities for the use of selective pesticides with no impact on natural enemies of pests and pathogens.

As far as integrated pest management (IPM) in grapevines is concerned, we have to emphasize a well-known fact i.e. that the variety, the cultivation method, soil tillage and pest control build a comprehensive unit, therefore it is very difficult to separate the various components.

One basic condition for IPM recommendations is that the pesticides used in the treatments are classified in three categories in Hungary, according to international practice:

1. **the green list** includes the active ingredients that have no environmental and public health restrictions,
2. **the yellow list** contains formulations which can be used in integrated production with some restrictions,
3. **the red list** contains products which are prohibited for use in integrated production (their application is recommended only for preventing significant plant damage).

Pathogens

In Hungary grapevines are mainly attacked by three pathogens: downy mildew, powdery mildew and grey mould. The following are the prognoses used in Hungary in the case of these three diseases.

Downy mildew (*Plasmopara viticola*)

The so-called Istvánffi-Pálinkás method was established in 1913. It calculates the possible infections according to the daily mean temperature and the rainfall (coverage by leaf humidity). The question whether the downy mildew infection really arises under the given conditions or not is difficult to answer; additional research has to be performed to this effect.

Powdery mildew (*Uncinula necator*)

A prognosis for the damage caused by powdery midlew is even more difficult. With the exception of 1996, the weather conditions in recent years, i.e. warm with little rain, has favoured the development of infection by powdery mildew and resulted in high disease levels in many places. The number of treatments with systemic products registered for powdery mildew is well determined in Hungary, because we know that resistance to the fungus has already been observed in some countries of Western Europe.

Grey mould (*Botrytis cinerea*)

The grape mould of grapevine is a decisive element for production quality. The dry, warm weather of early autumn in recent years has made us forget this disease, but the cool and rainy September of 1996 called our attention to the fact that it still exists. It is well-known that the damage may be caused by the same biotic and abiotic factors which lead to the damage of the berries (splitting, chewing insects etc.)

Mites and other sucking insects

In Hungary several working groups have carried out observations regarding the determination of phytophagous and zoophagous mites on grapevine.The most frequently occurring mite living in our wine districts and causing most attacks is *Calepitrimerus vitis,* the grape rust mite. Its attack, in early spring during bud burst, becomes serious if the long cold period causes growth to slow down. The control of this mite is effective in spring if the overwintering population has already left the overwintering sites. The blue adhesive band is used for determination.

The other major mite of the grapevine is *Eriophyes vitis* but it does not cause damage of economic importance. Large populations of the following zoophagous mites occur in Hungary: *Amblyseius finlandicus, Zetzellia mali, Paraseiulus subsoleiger.* Ecological conditions in Hungary are not suitable for the occurrence of *Typhlodromus pyri*, though it is present with low population numbers in most plantations.

Grapevine-moth species, and other pests

In Hungary there are two moth species, *Lobesia botrana* and *Eupoecilia ambiguella,* that attack the grapevine. The main pest in the recent years was *L. botrana*, but higher populations of the latter species could also be observed. Flight activity monitoring is mostly done by Hungarian pheromone traps. These "Csalomon" traps are used for catching both species and are made at the Zoology Department of the Research Institute for Plant Protection of the Hungarian Academy of Sciences. We think that the flight curves obtained with the pheromone traps do not properly reflect the real seasonal activity in grape fields. Slight differences can be registered. However, this is currently the only available method which can help to predict the timing of chemical treatments, but the precise moment of infestation can not be determined with it. Alimentary traps have never been used for determining the flight activity of grapemoth species in Hungary.

Natural enemies: Larvae of the two moth species were collected from different parts of Hungary and evaluated in lab several times. Their parasitation was always below 15 %. The species belonging to the family of *Ichneumonidae* were more common. Two *Dibrachys* species were found : *Dibrachys affinis* and *Dibrachys cavus.*

The occurrence of other pests varies from region to region. Though several of them have been observed on grapes (mainly Lepidopterous species), their damage is sporadic. *Sparganothis* *pilleriana* has caused severe problems in the past and currently occurs in orchards. It has adapted to the high and semi high cultivation methods, but is of much less importance than in the past.

The IPM on grapevines in Hungary recommends the application of acaricides only for decreasing the phytophagous mite populations without harming the zoophagous ones.
For the control of grape moths chitin-synthesis inhibitors can be used (flufenoxuron, lufenuron, diflubenzuron formulations). Dipel (with active ingredient of *Bacillus thuringiensis* var. *kurstaki*) and in some cases, fenoxycarb are recommended. We have some problems using BT preparates, because the weather conditions during the second generation of *L. botrana* are not suited to the active ingredient. Not only is it hot during the day at the beginning of July, but also in the evening.