Protocol validation RIMpro-*Plasmopara* 2013

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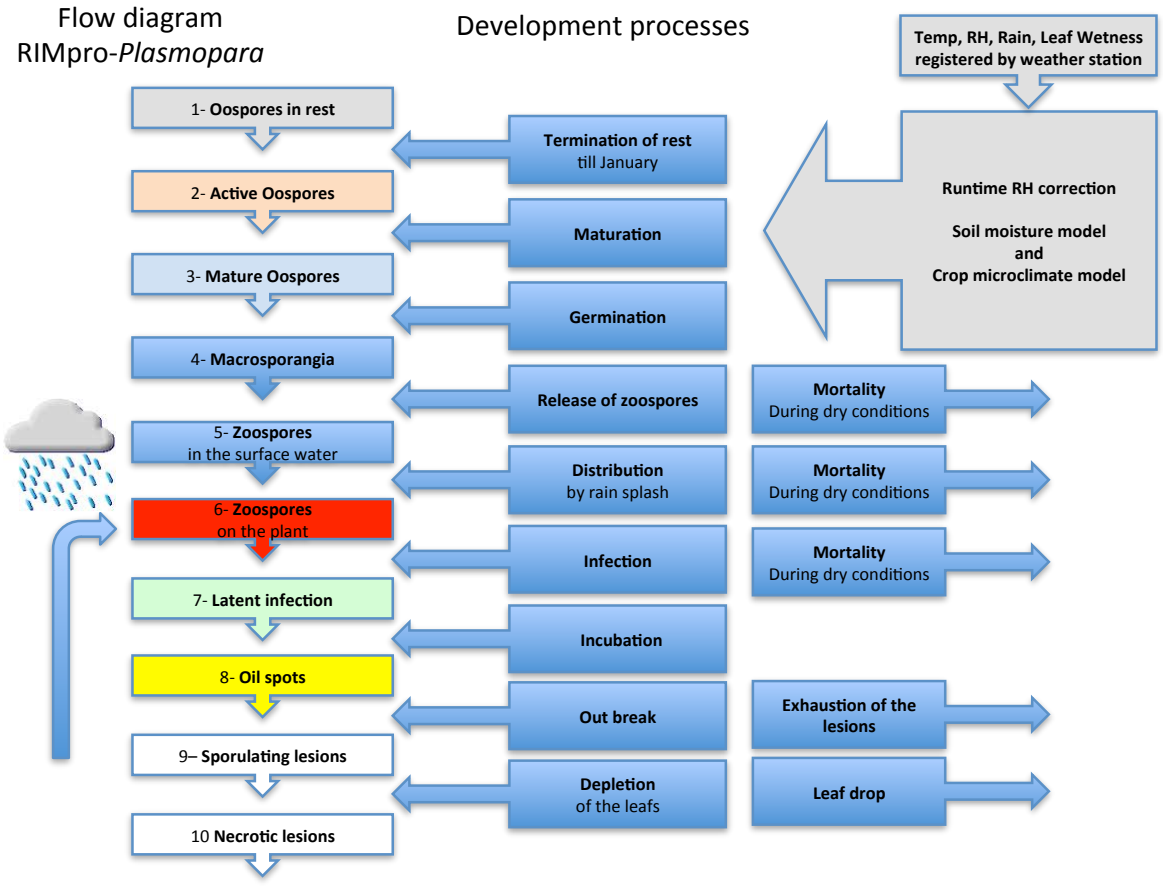
Introduction

RIMpro-*Plasmopara* is a new generation dissension support system (DSS) for the management of Downy Mildew (DM) in grape production. The DSS is based on a dynamic simulation model that is quantifying the seasonal epidemiology of *Plasmopara viticola*. The model simulates both primary infections, and the growth of the disease in secondary infection cycles. Infection moments are forecasted and quantified to enable the user to plan and adapt crop protection measures to the infection risk.
Calculations are made in real time based on data collected by a weather station in the vineyard and local weather forecast data provided by a meteo service.

The structure and the parameters of the sub-models describing the processes in the infection biology of the fungus, are based on published and unpublished data, expert knowledge and experience. Figure 1 presents the flow diagram of the simulation model (version 2013).



The development of DM in the vineyard is driven by the local microclimate. Often weather stations are not placed in the crop canopy, and even then our measurements don't have the accuracy of laboratory experiments. The major challenge in the development of a practical DSS is to develop robust algorithms from the detailed information gained in lab experiments under controlled conditions.

The disease model is not directly driven by the measured climatic data.
Crosschecks between parameter values and runtime RH correction are performed on the incoming data. Small data gabs are interpolated. The resulting values are used to estimate the crop microclimate and soil surface moisture content. These values are used to drive the sub-processes on the disease model.

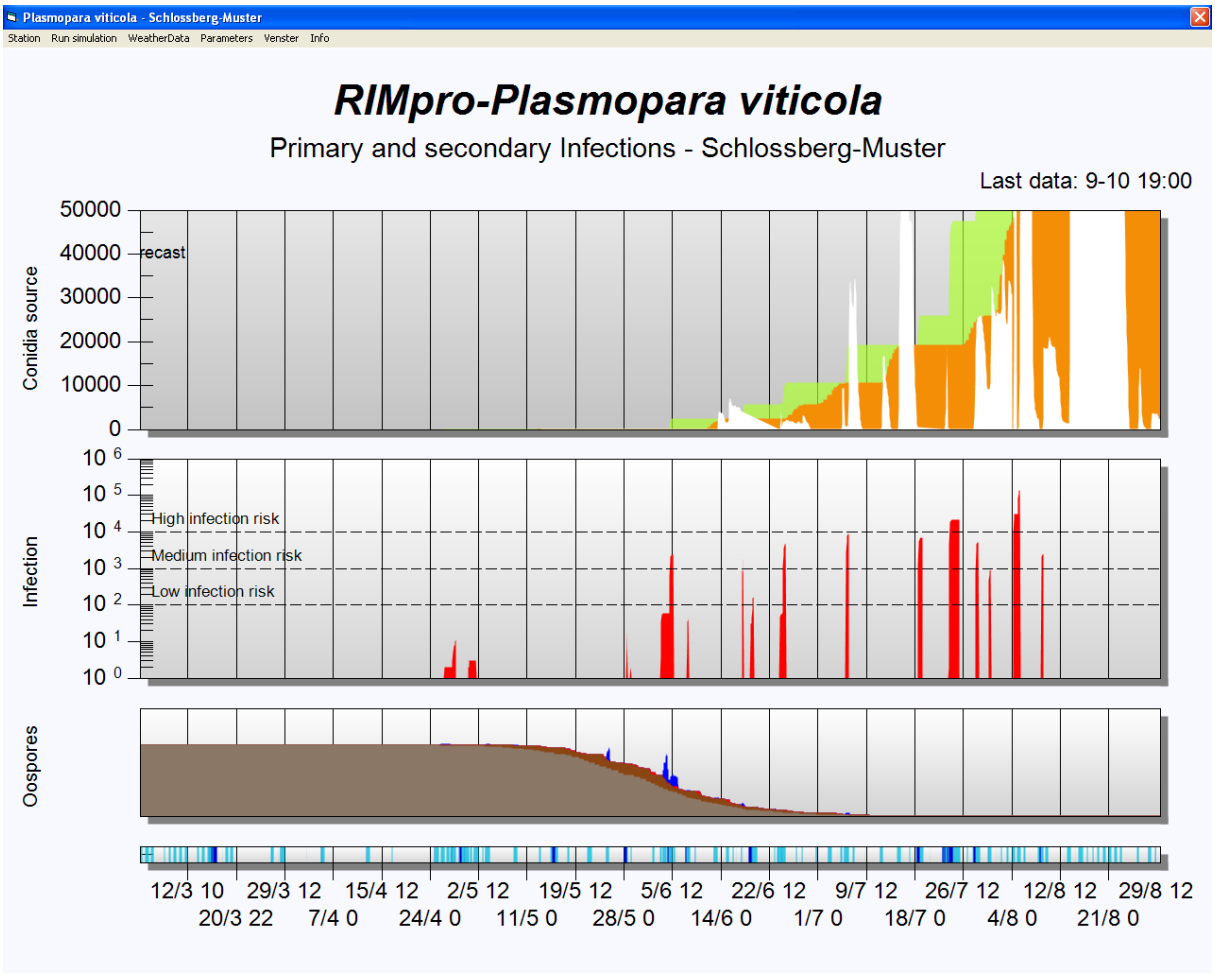
The model is still experimental. On all levels of development: data reading, code logic, simulation algorithms, parameter settings, user interface, and practical interpretation of the results, improvements may be necessary. All comments that help to improve the practical value of the DSS are most welcome.

User interface

Parameters for most sub-processes can be set by the user, but we strongly recommend to keep the default setting that we believe are most realistic. A user manual is not yet available. The program uses weather data measured by a local on-farm weather station representative for the vineyard. RIMpro has interfaces to read the data files of most used types of weather stations. For other file types we have to code an interface. Most fungicides to control DM are protectants that need to be applied before the infections occur. For that reason RIMpro-*Plasmopara* DSS includes a prediction of infection events using local hourly weather forecast. These forecasts have to be ordered at our meteo service based on the coordinates of the location.
Your weather data file should be complete from February onward. Special care should be taken that RH and leaf wetness readings correspond with the situation in the vineyard, as these are vital parameters in the infection epidemiology of Downy Mildew.

The screen output in its present layout consists of four graphs.

1. The lower graph represents the leaf wetness and precipitation data.
2. The second graph represents the calculated development of oospores population in the soil surface form oospores in rest, over various steps, to free zoospores in the surface water (blue). These zoospores can be splashed into the plants by heavy rain.
3. The third graph represents the infection events. These can be caused by oospores, conidiospores, or both. We indicate some preliminary indications for the interpretation of the infection values. (Low-Medium–High infection risk)
4. The upper graph represents the development of the epidemic in the crop. Green are latent infections, orange are the visible lesions. White is the conidia production (and survival) by the lesions at the lower leaf surface.



Availability of RIMpro-Plasmopara in 2013

In 2013 RIMpro-*Plasmopara* is free for use by anyone who seriously attributes to the further development of the DSS by making **accurate observations** in an untreated vineyard according to the protocol described in this document.

When you are already using RIMpro for Apple Scab or Codling Moth, you are familiar with the system, and I can supply you a RIMpro 2013 version that contains the experimental model for Downy Mildew.
Alternatively you could provide me a web location where your weather data are accessible (over FTP or HTTP), I can add a local weather forecast for you, and publish the graphs for your trial location on our public internet page.

The localized weather forecast costs 75 euro per location, and has to be ordered at our meteo service. For that I need the geographical coordinates of your vineyard. It takes at 7 days to organize this.

Informal cooperation

As with the other RIMpro models, the development of RIMpro-*Plasmopara* is a private initiative. The development is carried by the voluntary work and enthusiasm of advisers, researchers and growers who all share the wish to understand the biology and management of DM better. It is fine when you are able to fund your contribution to the development of RIMpro from local projects, but take care that the data you produce should be public, and your financers will never be able to claim any rights on the software developed.
Form 2012 Bio Fruit Advies takes part in the European project CO-FREE. The project's aim is to reduce the use of copper as fungicide. Improving warning systems is one possibility to reduce the use of copper fungicides. CO_FREE Partners form several European countries will provide additional epidemiological data, and attribute to the validation of the model.
We validate the RIMpro model by comparing the observed epidemiology of DM with the model output for the same location. For a proper validation we need a large number of observation series from different locations and years.
Validation so fare has been based on field data from several years form Spain, Italy, Austria, Bulgaria, England, Canada, Belgium and The Netherlands. Simulations seem to be close to reality, but are susceptible to the quality of the weather data. Especially the RH and leaf wetness data should represent the reality of the vineyard to make valid calculations.

The aim of the work in 2013

The aim of the work in 2013 is to collect as many datasets as possible that describe the local epidemiology of Downy Mildew, under as many climatically different situations as possible. Datasets should always be combined with local recorded weather data that are valid for the microclimate in the vineyard where the observations are made. The field observations will be used to evaluate the output of the RIMpro–*plasmopara* model using the local recorded weather data.
The results will be published after we have completed the validation in 2014.

The protocol: Methods

Trial field

The observations on the epidemiology of DM should be made in **an untreated part** of a vineyard. If treatments against *Uncinula necator* are necessary, please use fungicides that have no effect on DM (e.g. sulphur and potassium bicarbonate).
We are interested in the epidemiology of DM both on common European grape varieties, and on interspecific varieties.
As the incidence of the first primary infections may be as low as 1 lesion on 50-100 plants, for the first observations an untreated block of at least 100 plants is necessary. Later, when the epidemic develops 50 plants would be enough. Take care that these plants stay free of any spray drift.
As soon as nearly 100% of the leafs has one or more lesions, further observations have no meaning, and you could apply fungicide treatments again to reduce the crop loss due to the trial.

Weather data

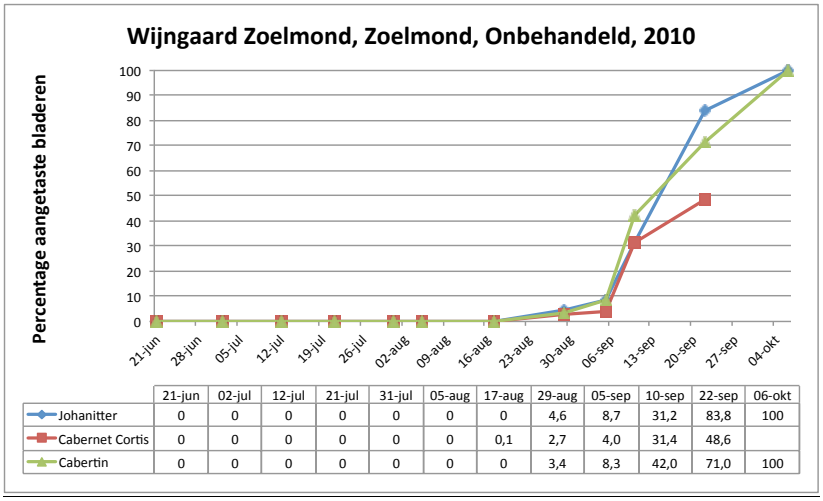
The weather data should be collected in or nearby the trial field. The resolution of the file should be 30 or 60 minutes. Parameters to collect are: Air temperature in the crop, RH in the crop, Rainfall (resolution 0.2 mm), leaf wetness (ideally 2 leaf wetness: one in the crop, and one above the crop)

Observations:

The annex to this document contains an excel form for the registration of your observations. Please rename the file with your location and send me a copy of your observation form at regular intervals during the vegetation season.
(marc.trapman@biofruitadvies.nl)

1- Disease incidence

Establish with 7 to 10 day interval the percentage Downy Mildew infected leafs. Focus on moments just before and just after you or RIMpro expect lesions to become visible. As long as no primary lesions have been found, check all plants in your trial plots carefully for symptoms, and note NONE as long as you find nothing.
From the moment on you find the first oil spots, change the method to quantify the disease level. Check at 10 random spots in your trial field 100 leafs for Downy Mildew symptoms, and note the number of infected leafs in each series of 100 leafs. A convenient way to do this is to observe 100 leafs from lower, middle and upper part of the canopy, and count the number of infected leafs with a hand counter.
Your results could look like these in a vineyard in The Netherlands in 2010.



	21-jun	02-jul	12-jul	21-jul	31-jul	05-aug	17-aug	29-aug	05-sep	10-sep	22-sep	06-okt
Johanitter	0	0	0	0	0	0	0	4,6	8,7	31,2	83,8	100
Cabernet Cortis	0	0	0	0	0	0	0,1	2,7	4,0	31,4	48,6	
Cabertin	0	0	0	0	0	0	0	3,4	8,3	42,0	71,0	100

2-Sporulation
An essential driving factor for the secondary infections is the sporulation of lesions. So to be successful RIMpro DSS should simulate the sporulation well.
On each observation date note the level of sporulation of 20 random chosen leafs and note the magnitude of sporulation:

0= no sporulation
1= very limited number of spores present on the surface of the lesions
2= intermediate number of spores present on the lesions. (e.g. from an old sporulation)
3= fresh, strong sporulation

3- Situation notes
In your trial-log, make notes that help to understand the situation better. E.g. on what leaf level are the fresh oilspots developing.

4- Crop phenology
On each observation date note the phenological stage of the crop according the BBCH-scale for grapes. See attachment.

5- Additional observations
Until 2013 I asked participants only to record the percentage infected leafs. (= disease incidence) This is an easy observation that takes little time and can be done by every wine grower or adviser. The results are valuable, and I would rather have that you look at the % infected leafs more often, than spend time on more in depth observations.
Who want to do more can also score the % infected grape bunches.
Scores on disease severity are less objective, and more difficult to use in the validation.

Communication
If you have any questions please send me an e-mail or call : +31 6 53 176118
Please let ne know as soon as you find the first oilspots of *Plasmopara viticola* in 2013 your trial field.

Success !
Marc Trapman

Growth stage	Code	Description
0: Sprouting/Bud development	00	Dormancy
	01	Beginning of bud swelling: buds begin to expand inside the bud scales
	03	End of bud swelling: buds swollen, but not green
	05	“Wool stage”: brown wool clearly visible
	07	Beginning of bud burst: green shoot tips just visible
	09	Bud burst: green shoot tips clearly visible
1: Leaf development	11	First leaf unfolded and spread away from shoot
	12	2nd leaves unfolded
	13	3rd leaves unfolded
	1 .	Stages continuous till . . .
	19	9 or more leaves unfolded
5: Inflorescence emerge	53	Inflorescences clearly visible
	55	Inflorescences swelling, flowers closely pressed together
	57	Inflorescences fully developed; flowers separating
6: Flowering	60	First flowerhoods detached from the receptacle
	61	Beginning of flowering: 10% of flowerhoods fallen
	62	20% of flowerhoods fallen
	63	Early flowering: 30% of flowerhoods fallen
	64	40% of flowerhoods fallen
	65	Full flowering: 50% of flowerhoods fallen
	66	60% of flowerhoods fallen
	67	70% of flowerhoods fallen
	68	80% of flowerhoods fallen
	69	End of flowering
7: Development of fruits	71	Fruit set: young fruits begin to swell, remains of flowers lost
	73	Berries groat-sized, bunches begin to hang
	75	Berries pea-sized, bunches hang
	77	Berries beginning to touch
	79	Majority of berries touching
8: Ripening of berries	81	Beginning of ripening: berries begin to develop variety-specific colour
	83	Berries developing colour
	85	Softening of berries
	89	Berries ripe for harvest