RIMpro Cloud Service info bulletin 2016-6
Zoelmond, June 17 2016

RIMpro-*Marssonina*

Marssonina coronaria is a new aggressive leaf fall disease on apple. Where it hits, complete orchards are defoliated before harvest. The disease has been mentioned in the literature since 1971, but only as a minor problem. The first severe attacks on apple were reported from Southeast Asia in 1995. *Marssonina* was first found in Europe in Italy in 2001. In the past five years, the disease has spread over apple orchards in the alpine region and to Brittany. Possibly even to Belgium. Currently severe damage is limited to untreated apple trees in the landscape, cider orchards, and organic orchards. But the disease is also present in IPM orchards in the alpine region, and increases late summer as soon as the fungicide program to control summer disease is lifted. Our knowledge on the infection biology of *Marssonina coronaria* is limited. A first version of an infection model for the timing of fungicide applications is now available on the RIMpro Cloud platform.

Individual users find the *Marssonina* model in the list of models in the RIMpro main menu. Consultants can create interactive links to the model on their website using the URL:
http://www.rimpro.eu/faces/marssonina.xhtml?id=*your stationID*

Figure 1 and 2: Apple tree defoliated in August, and a leaf showing typical Marssonina symptoms.

1- Quick start guide

Asian literature claims that first infections in spring are caused by ascospores, but so far no one was able to catch any ascospores in Europe. The first symptoms occurring in June- early July seem to appear in the same parts of orchards every year, but not necessarily on the same trees. Observations in 2014 and 2015 confirmed that *Marssonina* can survive in old leafs trapped in hail nets, or at other places, and start the epidemic from there. The severity of primary infections is related to the inoculum level. In orchards with a high disease level in the previous year, symptoms appear earlier and at higher incidence than in other orchards. A few disease cycles lead from a few infected leafs in the orchard in June, till complete defoliation two months later.

The Model

Our knowledge on the infection biology of *Marssonina coronaria* is limited. The model is based on published and un-published scientific information, discussions with experts, and field observations in the past years.

For apple scab, the spores are produced directly on the leaf surface and can be distributed by raindrops immediately. The acervuli of *Marssonina* need longer wetness periods for spore maturation and liberation. The longer leafs stay wet, and the longer raindrops are splashing on the leafs, the more spores are distributed. Severe infections need more that 15 mm of rain.

Germination of *Marssonina* spores requires higher temperature than apple scab. Although first spores can infect after 8 hours of wetness, important infections need 20 to 50 hours of leaf wetness.

The incubation time is depending on temperature and relative humidity. Under normal summer conditions, the first symptoms appear 2-3 weeks after infection. Below 15 °C, or during periods of low relative humidity, it can take more than 5 weeks before symptoms start to appear. The effect of humidity on the incubation time is critical. Relative humidity records should be representative for the orchard microclimate to allow exact simulation of the appearance of symptoms. As with the other RIMpro model you can view and edit the simulation parameters. Several parameters are however quite critical, and we strongly advice not to change any parameter unless you are fully aware of what you are doing.

Interpretation of the graph

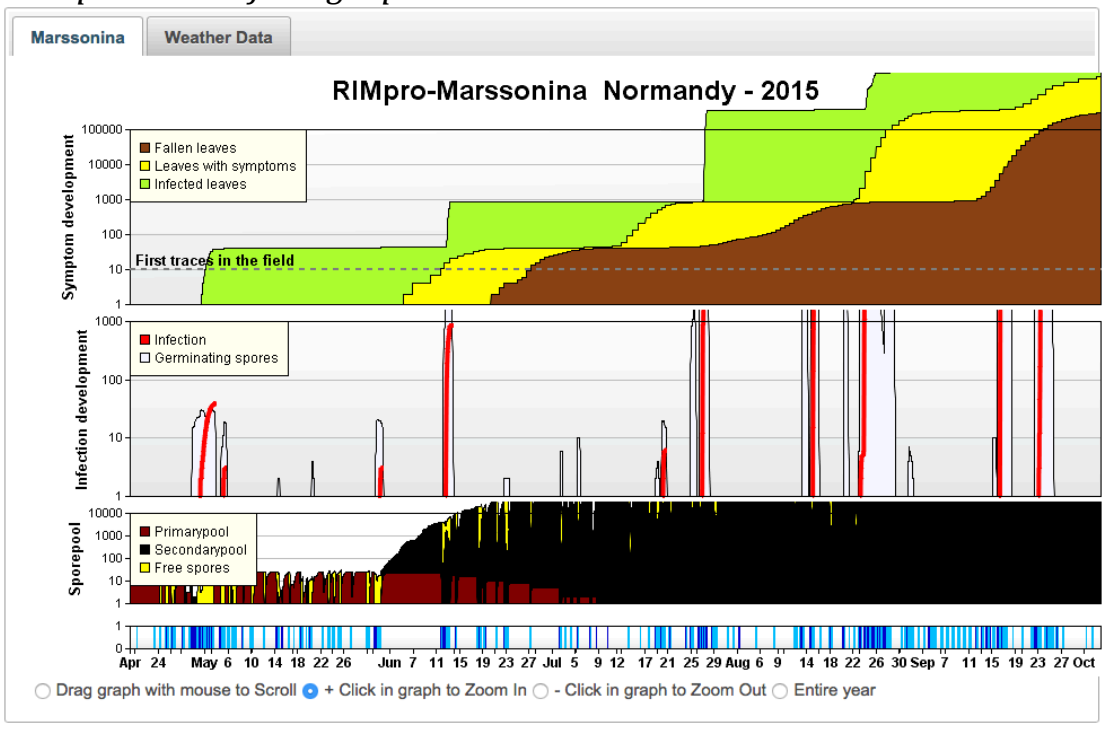


Figure 1: User output of the RIMpro Marssonina model

The lower graph shows the rain- (dark blue) and crop wetness- (light blue) as interpreted from the weather data according to the user settings for leaf wetness interpretation.
The middle graph indicates the number of spores splashed onto the leaves (white), and the number of these spores that are able to infect the leaf. (red line=infection value).
The upper graph indicates the disease development in the orchard. During the incubation period after each infection, the fungus is growing inside the leaf, but is not yet visible (green).
The moment the first acervuli become visible on the still green leaf that later starts to yellow. (yellow) Finally the leafs become necrotic and start falling (brown)

Management

In untreated apple orchards first symptoms are usually seen around the time the model indicates symptom level 10. In orchards receiving a fungicide program to control apple scab, first symptoms may be found considerably later (See graphic observations in Steiermark 2015). The first leafs with symptoms are difficult to find. The incidence of infected leafs is low, and leafs are still green at the moment the first acervuli are formed on the leaf surface.
The model simulates disease development for untreated orchards. In orchards treated with fungicides, the infection moments and development of the epidemic are basically the same, but at a much lower level.

In Europe, specific management of *Marssonina* is currently mainly relevant for cider orchards and organic apple production systems.
Copper (at reduced rate), sulphur and bicarbonate are not very effective to control *Marssonina*. Acidified clay powders (Trade names: Myco-Sin, Ulmasud) have shown reasonable control under trial conditions. However the use of these products complicates the control of other summer diseases.
The longer wetness periods at higher temperature that allow for *Marssonina* infections, also allow infections by other summer disease as apple scab and sooty blotch. Lime sulphur, applied either during the infection event or immediately after, will control all tree summer diseases.

2- Validation of the model

Methods

The very local, 'patchy' occurrence of the initial stage of the disease makes it difficult to quantify the development of the epidemic in the orchard.
To gather field information for the validation of the model we use a practical index following the steps in the development of the epidemic in the orchard.

Table 1: Severity scale for observations on the epidemiology of Marssonina coronaria

Index		
0	No symptoms found	
1	First symptoms	Single leafs in the lower part of the tree. Mostly older leafs. Only in a few isolated trees in the orchard.
2	Local increase	In the same isolated trees more than 10 leafs in the lower part of the tree show symptoms. First leafs dropping.
3	Spread to the top	In the same isolated trees now also leafs in the top of the trees show symptoms. Massive leaf drop in these trees.
4	Spread to neighbour trees	Leafs in neighbouring trees show symptoms and leaf drop.
5	Large circles	Increasingly more trees show symptoms and leaf drop.
6	Complete infestation	Most trees in the orchards show symptoms and massive leaf drop occurs in the complete orchard.

In 2015 observations according this severity index were made in six untreated apple orchards in France, Italy, Switzerland, Germany and Austria. Growers, consultants and scientists made these observations. The results of the observations were compared to results of RIMpro-*Marssonina* simulations using weather data from weather stations in or nearby these orchards. For all simulations the default parameters were used.

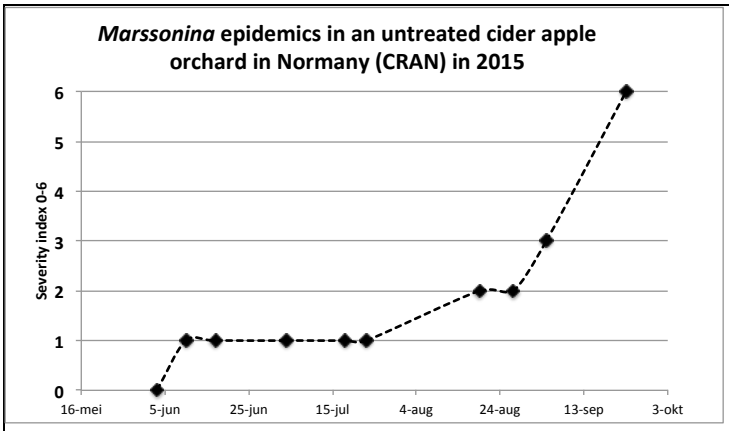
Results and conclusions

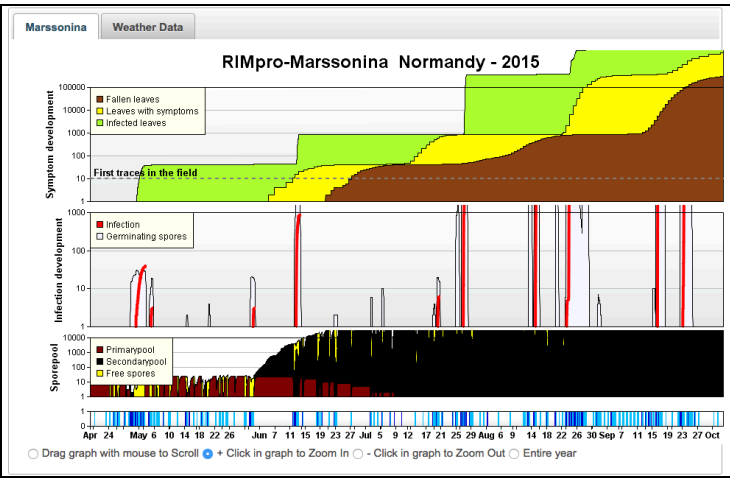
Table 2 summarizes the results.

- The model starts at the date of green tip, but did not find possibilities for infections by Marssonina until May.
- First symptoms were found in the orchards around the date the model predicted the first visible symptoms, or later (Frick).
- The observed development of the epidemic corresponds reasonably well to the simulated development.
- For low inoculum orchards the model tends to overestimate the risk (Trentino, South Tirol). For high inoculum orchards, the model tends to underestimate the infection risk (KOB, Steiermark).
- Delayed symptom expression due to low RH conditions was evident (Frick, KOB, South Tyrol)
- Until 2015, no *Marssonina coronaria* has been found in apple orchards in The Netherlands. According to the model output, the Dutch summer conditions would allow for infections by *Marssonina coronaria.*

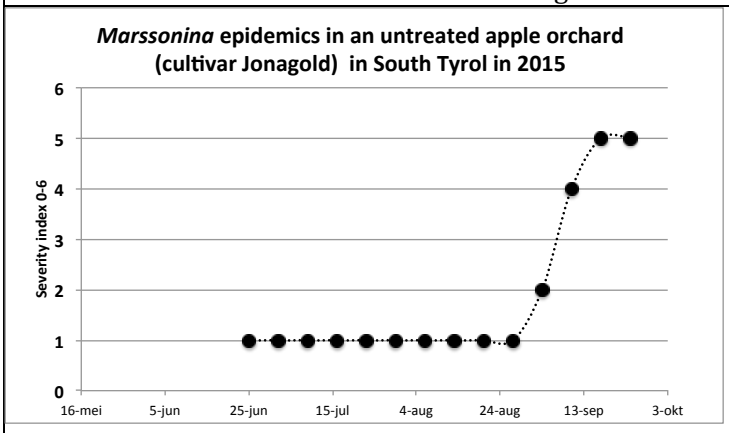
The first impression is that the model explains the observed epidemics reasonably well. Despite its limits, the model can already help growers and consultants to find the best moments for fungicide applications to control *Marssonina* leaf fall disease. With more information coming available, the model will improve and become a reliable decision tool.

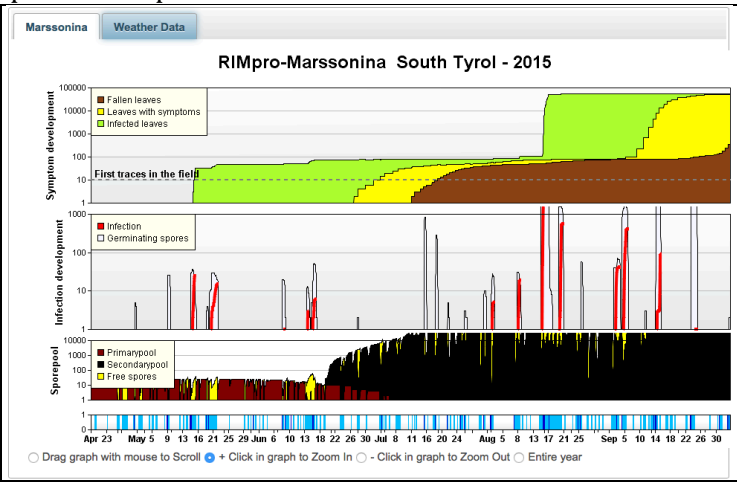
Table 2: Observed and simulated epidemics of *Marssonina coronaria* in apple orchards in 2015.



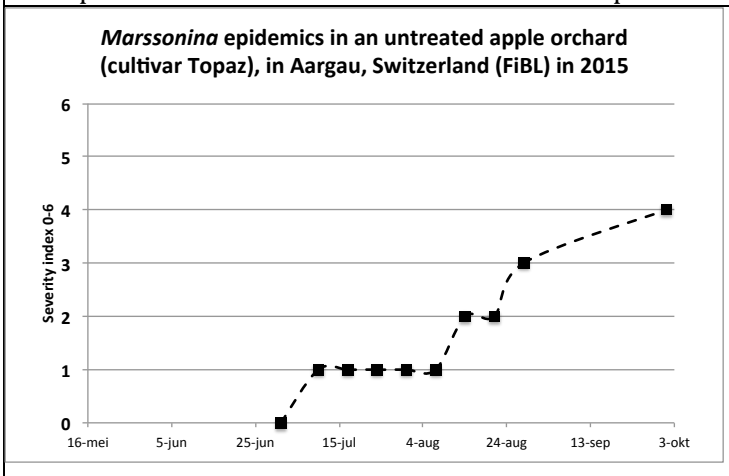


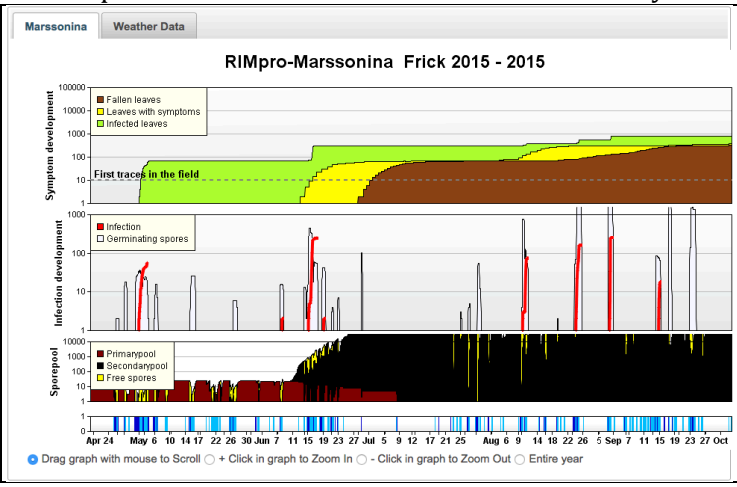
France, Parigny, CRAN Varieties: Patrick Jouault and Judaine
First symptoms found June 10, consistent with the model results. Second infection mid June overestimated by the model. Later infections and observed strong increase of symptoms in September are consistent with the model results.



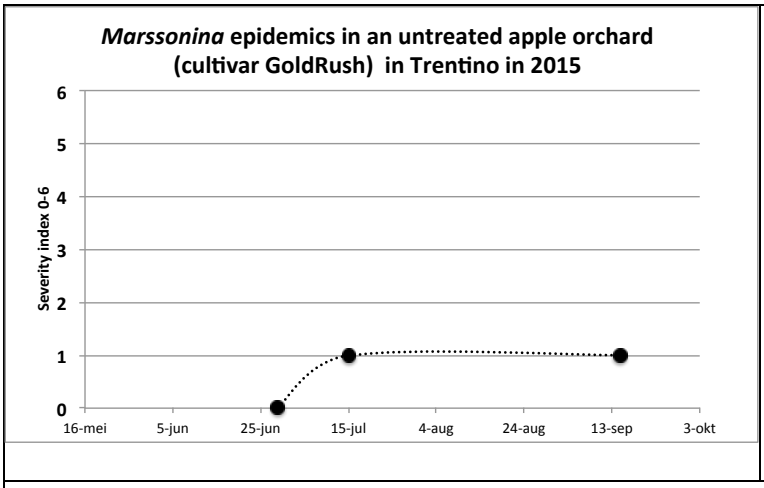


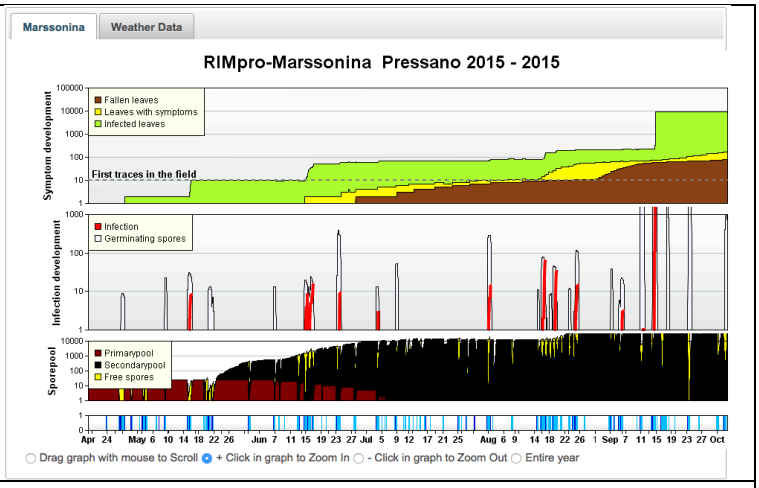
Italy, Lana, South Tyrol, Varyety Jonagold
First minimal symptoms in this orchard and in Meran June 25, which is in agreement with the model output. Both in the field, and in the model no further develoment of the epidemic untill the beginning of september. Strong increase of the epidemic was observed and simulated in september. The same pattern was observed in other orchards in Tyrol.





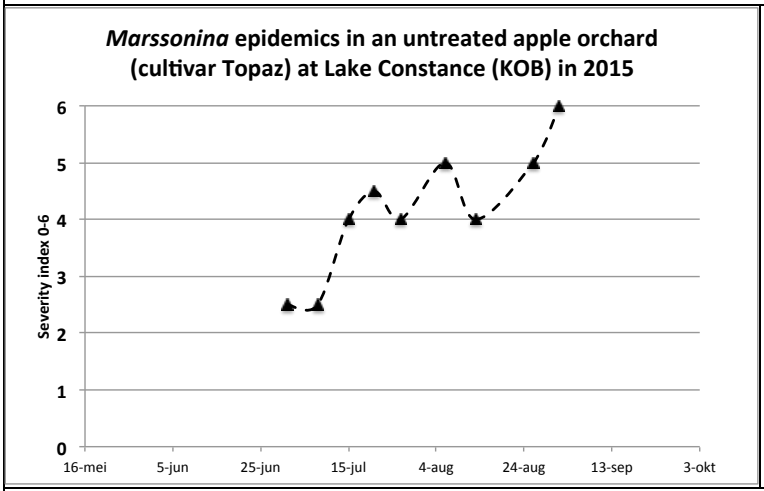
Switzerland, Frick, FiBL observations on Vf scab resistant varieties.
First symptoms were found on July 10. This is 4 weeks after the model predicted the first symptoms. Symptoms started to increase from beginning of August. The model predicted an infection event mid June, that should become visible at that time, but the severity seems underestimated by the model.

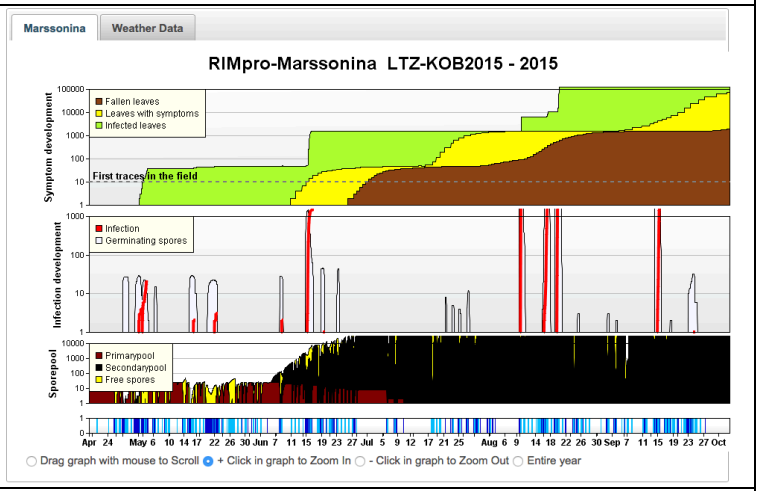




Italy, Maso Del Gusto**,** Trentino, Variety Goldrush

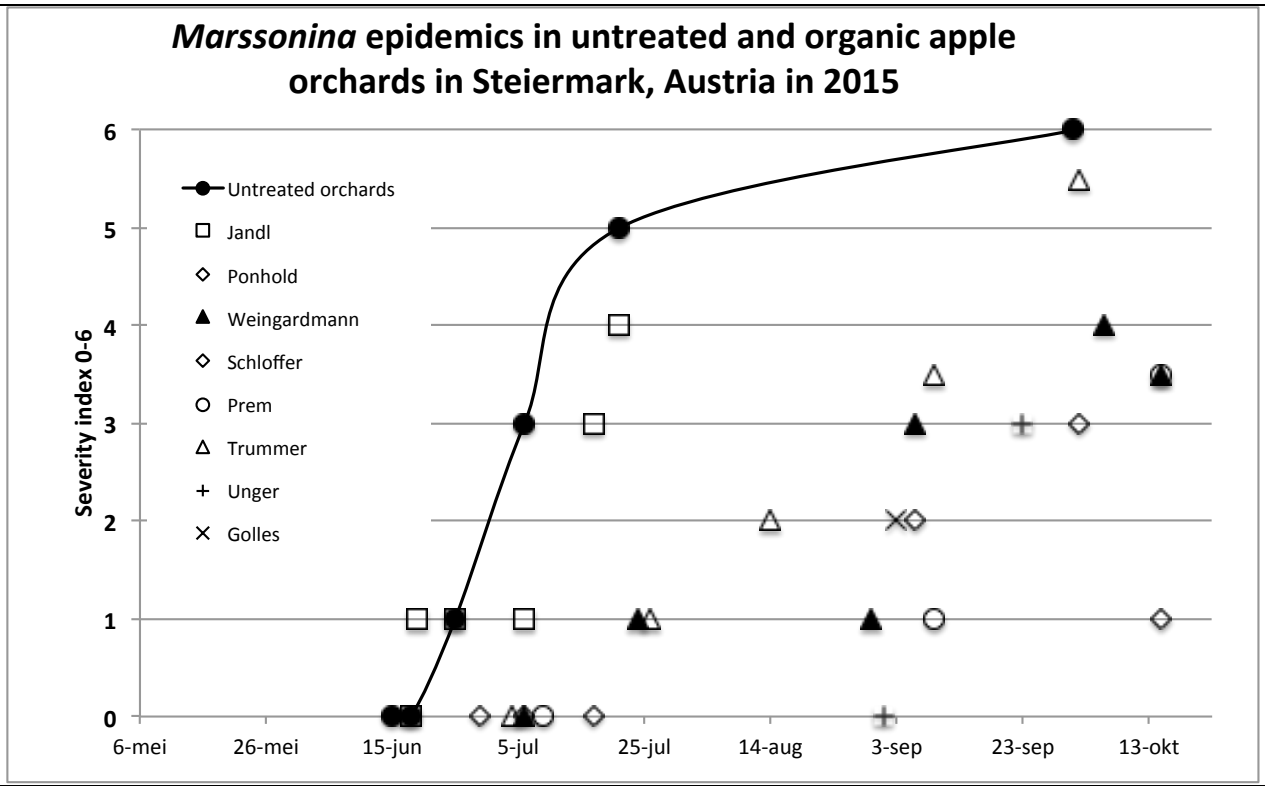
A few leafs with symptoms were found July 13, which is in agreement with the model output. No further development of the epidemic was seen in the orchard in 2015. Until mid September, the model only simulated minor infection events that overestimated the real infection risk

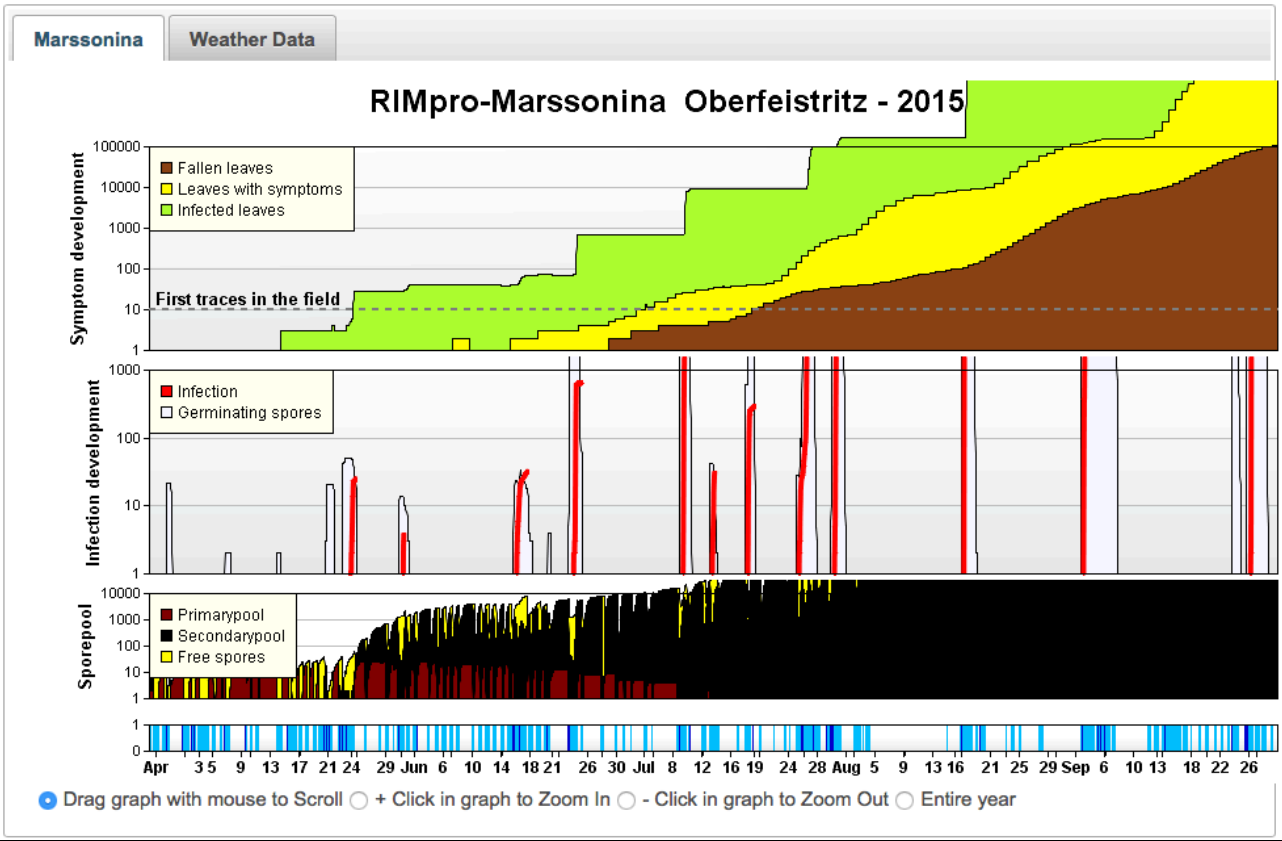




Germany, KOB, Bavendorf. Variety Topaz. High inoculum orchard.

First observations were made July 1st when immediately severity level 2-3 was noted. In another untreated orchard severity index 2 was noted on June 29. The first symptoms might have occurred around June 15, the date the model expected the first symptoms. The epidemic increase until mid July. From mid July till end of August the noted index is about stable during a long dry period. In September again an increase in the epidemic was seen in the orchard and simulated by the model. The model underestimated the overall severity of the epidemic in this high inoculum orchard.

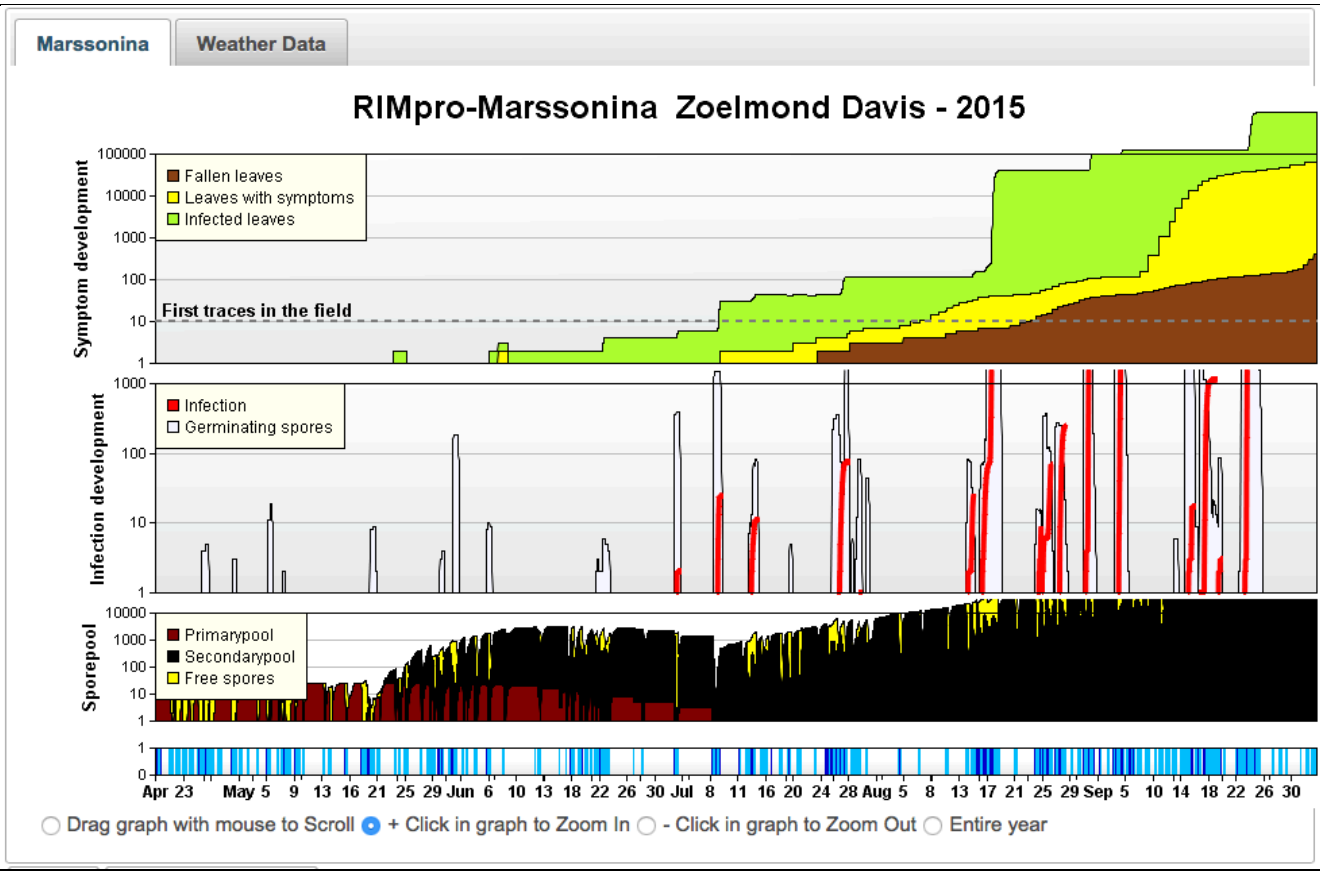




Austria, Steiermark

Observations were made in untreated and organic apple orchards. The organic orchards received a fungicide program to control summer diseases, based on low rates of copper, bicarbonate and lime sulfur.

First symptoms in a high inoculum orchard were found July 17, shortly after the model expected the first symptoms. Following the frequent rain periods, the model simulated a continuous increase of the epidemic. The epidemic in the organic orchards followed this pattern depending on inoculum level and the fungicide schedule applied.



The Netherlands

Until 2015, no *Marssonina coronaria* has been found in apple orchards in The Netherlands. According to the model output, the Dutch summer conditions would allow for infections by *Marssonina coronaria* when this disease is present.