

## Tomato Disease Models

1. **Tomato Late Blight *Phytophthora infestans***: Due to the immense importance of this disease there are numerous different simulation models for Late Blight. We decided to implement three of the most common for tomato. SMITH Periods is widely used in the United Kingdom to point out Late Blight infection periods. The IPI Tomato Late Blight Negative Prognosis form BUGIANI, CAVANNI and PONTI has been developed in Italy. FRY Phytophthora Units are a relatively new solution practically used within the NegFRY Model in Denmark.
2. **Potato Early Blight *Alternaria alternata* and related diseases**: TomCast has been developed for early blight and other moisture related non Phytophthora diseases in Michigan state University
3. The *Botrytis cinerea* model has been developed for viticulture, but we think that it can be used beneficial in viticulture too.

## Potato Late Blight *Phytophthora infestans* Smith Periods

Definition: Two consecutive days with minimum temperature of 10 °C and 10 hours of relative humidity higher than 90% on the first day and 11 hours of relative humidity higher than 90% on the second day is a **Smith Period**.

If the criteria for the first day is fulfilled and the second day reaches 10 hours of relative humidity higher than 90% this indicates that 90% of the Smith period or **Near Smith**.

Biological Basis: *Phytophthora infestans* can grow if temperature is lower than 10°C.

But sporulation will be nearly nothing at this temperatures. Therefore it needs a moist period with temperatures higher than 10°C to get a reasonable sporulation. Infection of *Phytophthora infestans* needs free moisture. In longer periods of high relative humidity free moisture either by rain or by dew is very much probable.

Result: Smith periods or near Smith periods are pointing out periods where the climate is very favourable for the disease. The model points out periods with a very high risk of this disease.

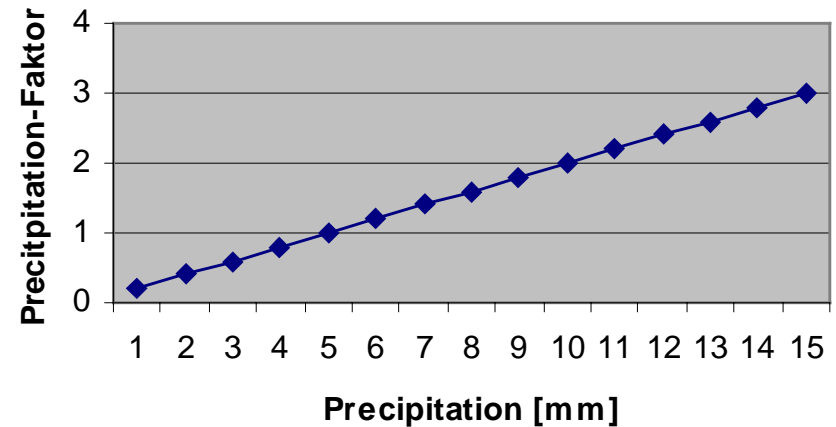
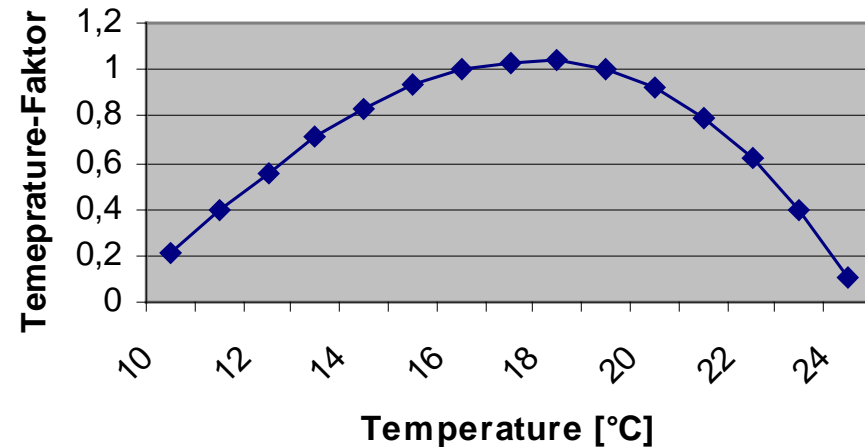
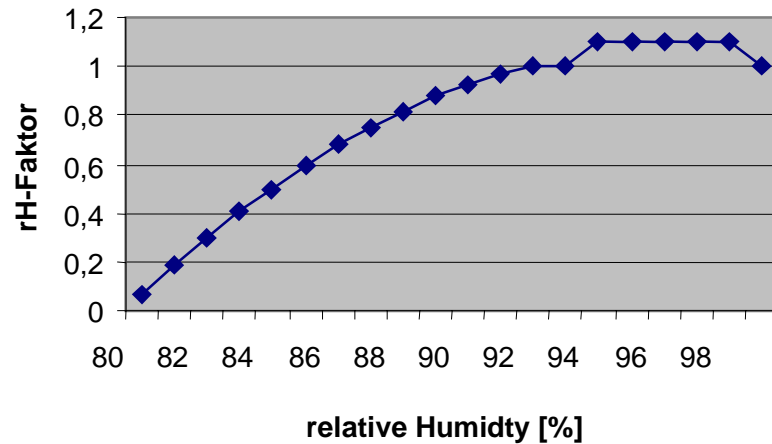
Experiences: This is an empirical model showing very good results in UK where it is used as a negative prognosis too. As long it is too cold for 2 moist days with temperature always higher than 10°C no spray is needed. This is only valid where temperature increase during spring is very steady (Ocean Climate).

# IPI Tomato Late Blight Negative Prognosis form BUGIANI,CAVANNI and PONTI

**Model Description:** This model generates infection potential indexes (IPI) that predict the most probable inoculum increase of *Phytophthora infestans* in the environment. In Italy, IP indexes are used along with indicator plants plus spore traps to warn farmers about when to start spraying. The model does not give recommendations about subsequent fungicide applications. Negative Prognosis can't be used in areas with permanent cropping of potatoes, areas with no winter.

**Functionality:** To calculate daily IPI, relative indexes for average temperature and relative humidity and precipitation are calculated independently and combined by multiplying the temperature index by either the precipitation index or the relative humidity index. The cumulative daily IPI over a defined period is used by the model to evaluate late blight risk. The IPI-Model is used as a negative prognosis in Italy. At the time the IPI-Value comes over 15 they start to spray against Late Blight in tomato. As long as it stays below no spray is indicated.

**Result:**  $\mu$ METOS displays a steady increasing value for the IPI-Value.  $\mu$ Link displays a steady increasing line. At the time the IPI-Value reaches 18 a qualitative line is displayed in the bottom of the graph.  $\mu$ METOS stops this calculation if temperature stays below 11°C for 96 hours. It starts the calculation again if temperature never falls below 6°C within 96 hours. The maximum value of this calculation is 40.



To calculate daily IPI, relative indexes for average temperature and relative humidity and precipitation are calculated independently and combined by multiplying the temperature index by either the precipitation index or the relative humidity index. IPI only needs to be calculated when days have a minimum temperature higher than 7°C, an average temperature between 9 °C and 25°C and more than 0.2 mm of rain or an average relative humidity of more than 80%. Favorable weather conditions for *Phytophthora infestans* produce a positive IPI. Functions for index calculations are following the graphs beside.

The IPI model for Tomato Late Blight is a negative prognosis model too. It is only helpful in areas where we have no permanent cropping of tomato. This means in areas with frost during winter. In such areas *Phytophthora infestans* inoculum potential is reduced during winter and has to build up in spring again. The IPI model indicates the build up of inoculum in field. If the IPI value reaches 15 the first spray is indicated in the area the model has been developed. If you use the area in another area please check if this value is valid for you.

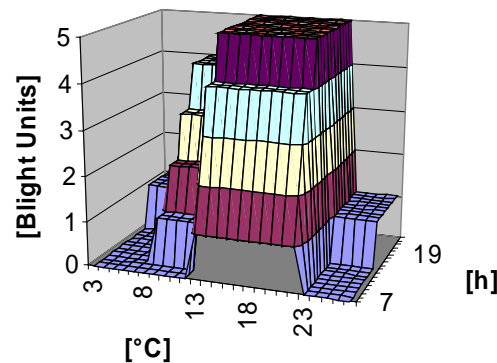
# Potato Late Blight *Phytophthora infestans* Fry Blight Units

## The Infection Model

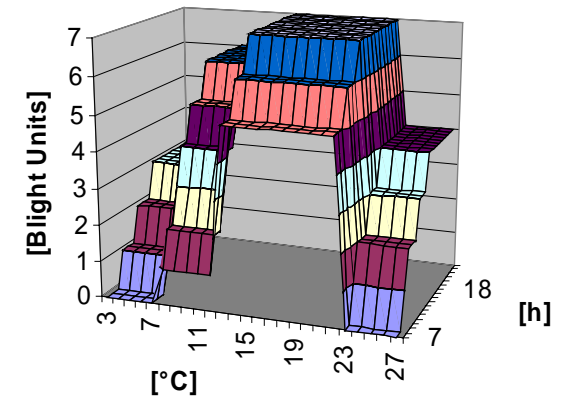
... uses relative humidity higher than 90% or Leaf wetness to estimate moist periods.

Depending on the duration of moist periods and the temperature during this period Blight Units for susceptible, moderate susceptible and moderate resistant cultivars are estimated following the graphs beside.

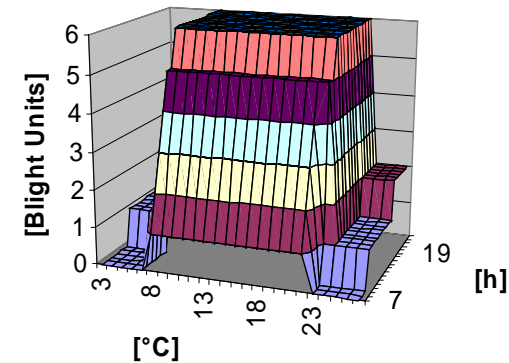
Temperature and Duration of Moist Period leading to Blight Unit for moderate resistant cultivars



Temperature and Duration of Moist Period leading to Blight Unit for susceptible cultivars



Temperature and Duration of Moist Period leading to Blight Unit for moderate susceptible cultivars



# Potato Late Blight *Phytophthora infestans* Fry Blight Units

## The Spray Interval Estimation Model

... uses the result of the daily calculations from the infection model described at the slide before. With different thresholds for susceptible, moderate susceptible and moderate resistant cultivars the model helps to decide if a spray is needed or not.

### **A spray is indicated if:**

the last spray is longer than 6 days away

and

the accumulated blight Units are exceeding:

**30** for susceptible varieties

**35** for moderate susceptible varieties

**40** for moderate resistant varieties

# Potato Late Blight *Phytophthora infestans* Data Presentation in $\mu$ METOS

- $\mu$ METOS presents the results of Smith Periods as one asterix if Near Smith is fulfilled and as two asterix if Smith is fulfilled. In the same screen SCHRÖDTER and ULLRICH Negative Prognosis value is shown from 0 to 400.
- FRY Phytophthora Units for susceptible, moderate susceptible and moderate resistant are shown in a separate screen.
- There is a third screen to accumulate FRY Blight Units over a selectable interval.

Phytophthora  
Smith Period, Moist hours, Negative P  
M-DD HH Sm Mh nPr

Label

5-12 07		9	130
5-12 08	*	10	130

M-DD HH Sm Mh nPr			
M-DD HH Sm Mh nPr			

1th Screen

Acc. FRY Units  
Rain, susc. m susc, m resistant  
Rain Sus Msu Mre

Label

5-12 - 5-19				
30.4	17	13	9	

Rain Sus Msu Mre			
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3rd Screen

FRY Phytophthora Units  
susc. m susc, m resistant  
M-DD HH sc ms mr

Label

5-12 07	2	1	0
5-12 08	3	2	0

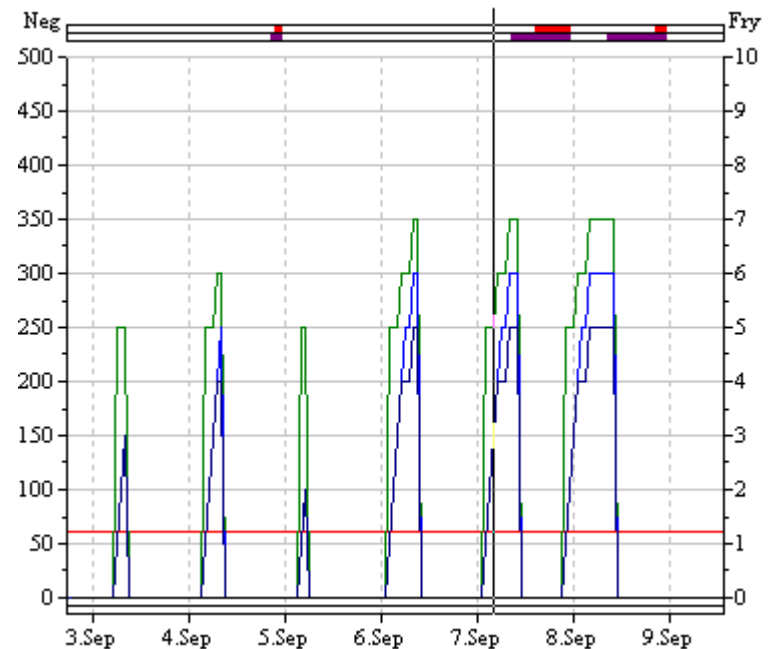
M-DD HH sc ms mr			
M-DD HH sc ms mr			

2nd Screen



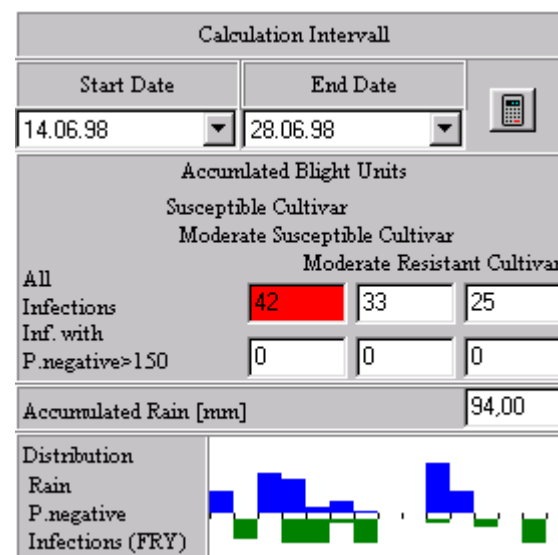
# Potato Late Blight *Phytophthora infestans* Data Presentation in $\mu$ LINK and MetWin II

- The software presents the results of Smith Periods in 2 lines at the top of the graphic. The lower line indicates Near Smith and the upper line indicates complete Smith Period.
- Negative Prognosis is presented as an increasing line between 0 and 500. If the value reaches 150 it is indicated by a line at the bottom of the graph. If the value reaches 270 a second line occurs.
- FRY Blight Units are presented in three lines (for susceptible, moderate susceptible and moderate resistant cultivars) as values between 0 and 7.



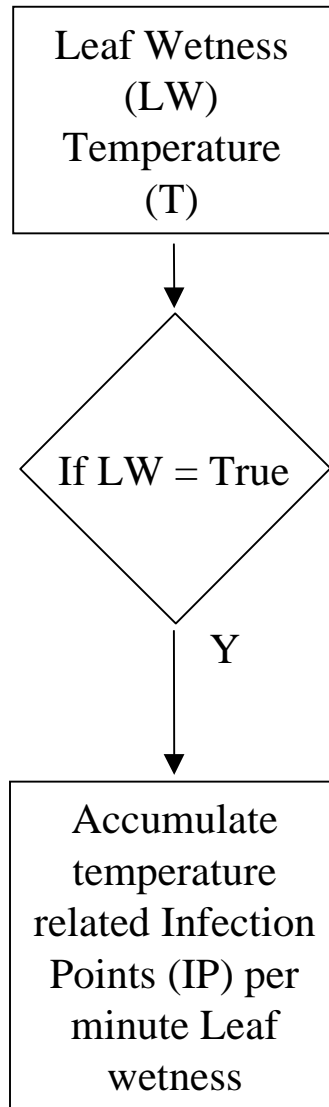
# Potato Late Blight *Phytophthora infestans* FRY Blight Unit Accumulation in μLINK and MetWin II

- The software accumulates FRY Blight Units over a selected interval.
- It shows the results for susceptible, moderate susceptible and moderate resistant cultivars independent from Negative Prognosis and separate together with the condition Negative Prognosis value higher than 150.
- Distribution of Rain, Pnegative > 150 and FRY Infections is shown in a small graphic at the bottom of the window.

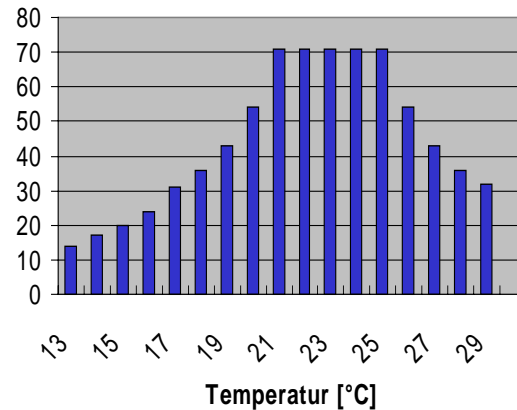


# Early Blight of Tomato and Potato *Alternaria alternata*

Infection Model:



Temperature related Infection Points



... Model assesses the possibility of Infection, severity of Infection, grades the previous day for disease Severity and accumulates Disease Severity over periods on:

- Hourly Temperature during a 5 day period
- Hourly Relative Humidity during a 5 day period
- Accumulated Rain during a 7 day period
- Temperature
- Leaf wetness duration

Results:

- Infection progress value on actual day
- Infection severity on actual day
- Disease severity for every day
- Accumulated disease severity for a certain period

# Early Blight of Tomato and Potato *Alternaria alternata*

## Disease Severity Evaluation Model:

This model is calculated at the end of a day 11:30pm. The model calculates and compares the disease severity values following both the tables aside and uses the higher value of both.

Mean Temp of actual day[°C]	Hours of Leaf Wetness of actual Required to Produce Daily Disease Severity Value (S) of:				
	0	1	2	3	4
13 – 17	0 – 6	7 – 15	16-20	21+	
18 – 20	0 – 3	4 – 8	9-15	16-22	23+
21 – 25	0 – 2	3 – 5	6-12	13-20	21+
26 - 29	0 - 3	4 - 8	9-15	16-22	23+

Temperature Average of last 5 days [°C]	Hours RH>90% within last 5 days [h]	Total Rain within last 7 days [mm]	Disease Severity Value
<22	<60	<2.5	0
>22	<60	<2.5	0
<22	>60	<2.5	1
<22	<60	>2.5	1
<22	>60	>2.5	1
>22	>60	<2.5	2
>22	<60	>2.5	2
>22	>60	>2.5	3

# Early Blight of Potato

## *Alternaria alternata* Data

Presentation:

Infection Progress and  
Infection Severity:

µMETOS and µLink shows you the Infection progress figures and the infection severity on the hourly data.

Disease Severity Value:

µMETOS and µLink shows you the Disease severity values on the daily data.

Disease Severity Value  
Accumulation:

µMETOS and µLink gives the opportunity to accumulate Early Blight Disease Severity Values over a selected time interval. This Accumulation is Part of the Fry Units and Alternaria Severity Accumulation Screen.

Early Blight (*Alternaria Alternata*)  
Infection, Inf.Severity, Click both Disease Severity  
**M-DD HH INF SEVE**

Label

5-12 07 85
5-12 08 100 *
M-DD HH INF SEVE
M-DD HH INF SEVE

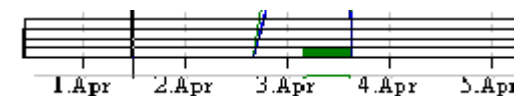
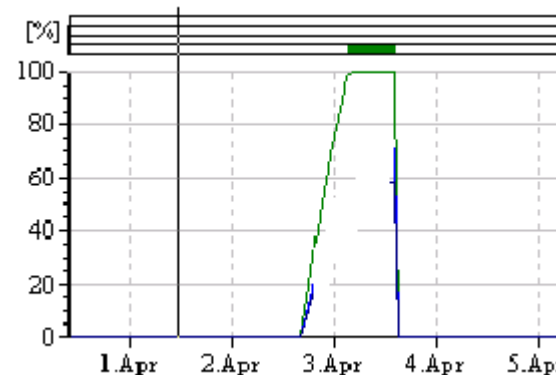
1st Screen, hour

5-12 _____ *
5-13 _____ *****
M-DD _____ SEVE
M-DD _____ SEVE

1st Screen, day

__5-10 --- 5-17__
12
__M-DD --- M-DD__
Rain FS FM FR AS

2nd Screen Accumulation



## Early Blight of Potato *Alternaria alternata* Data Use:

### Infection Progress and Infection Severity:

This is indicating the possibility of an Early Blight Infection. The Severity Value indicates the importance of the Infection. If the disease is already present in the crop Information about date and severity of infections are helpful to check the applied spray program and correct it with curative sprays if needed.

### Disease Severity Value:

Disease Severity indicates how favourable the climate was for the disease. Under unfavourable climate conditions no fungicide control of the disease is needed.

### Disease Severity Value Accumulation:

The developers of the model are supporting the use of the model as a negative prognosis. A accumulated disease severity from planting date until now of 35 indicates the need of the first spray against *Alternaria alternata*. A threshold to indicate the next sprays have to be developed for your certain area