ADCON
TELEMETRY

addVANTAGE Pro 6.0

Extensions and Crops

SMART WIRELESS SOLUTIONS

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Proprietary Notice

Document Release 6.0.037, June 2010

Contents

Chapter 1. Introduction

This manual details the installation and use of the extensions and crops supplied with the addVANTAGE Pro 6.x package. With the release of addVANTAGE Pro 6.0, crops are pulled out from extensions and treated separately.

Rather than tie a disease model to a specific crops, in addVANTAGE Pro 6.0, we provide several crop models you can set up separately for treatments and irrigations, and apply calculation extensions and disease models to a crop as necessary.

The former Plant Protection and Irrigation extensions are now known as calculation extensions and disease models, but are still collectively referred to as extensions. Disease models can be added only to crops, while calculation extensions can be added to crops or areas.

For information about the installation and use of the addVANTAGE Pro 6.x software, please read the *addVANTAGE Pro 6.x User Guide*. The guide is provided on the installation CD, or can be downloaded from Adcon Telemetry's website at *http://www.adcon.at*.

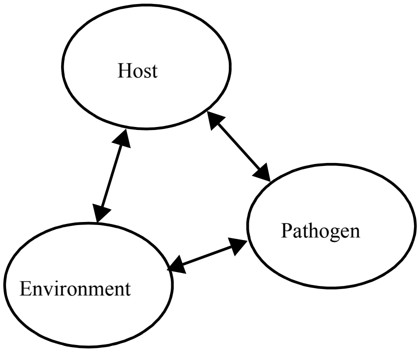
CAUTION *The disease models are tools that help you correctly manage an optimized spraying program against some diseases. They are not, and should not be seen as, decision instruments. A computer program cannot make decisions—the humans who are using it must decide whether a certain recommendation should be followed.*

The Disease Triangle

The disease triangle (*Figure 1*) is composed of:

- The host
- The pathogen
- The environment

Figure 1. The Disease Triangle



The pathogen is the causal organism. The host is the plant or crop. The environment is a measurable set of conditions that need to occur. Disease and the resultant damage are what occurs when all three are present.

If the host is not susceptible, no symptoms will exist. If the pathogen is not present, but the host is susceptible and the environmental conditions are favorable, no symptoms will exist. Finally, if the host is susceptible and the pathogen is present, but the environment is not favorable, symptoms will again not exist.

Models typically estimate the likelihood of disease risk or infection. When risk or pressure is high, you should intensify control strategies. When the environmental conditions are not favorable for disease, your control strategies can be less intensive because the risk of disease is lower.

The models allow a great degree of control for a wide range of diseases. Because of the modular approach used, they can be easily upgraded as soon as new versions are available. In addition new models are constantly implemented, so please check Adcon Telemetry’s website (*www.adcon.at*) for the latest releases.

A Flexible Plant Protection System

The centralized nature of the system allows the use of many observation points (the RTUs), which send their data to the addVANTAGE Pro server where the intelligence is located—the algorithms processing the information stored in the local database. Couple this with the ability to install the stations at distances up to several tens of miles, and you have an idea of the large coverage you can get with the system. By using an appropriate number of RTUs, you can control regions of thousands of hectares/acres.

Of course, you can also use the system for smaller areas. Farmers having small farms can use their PCs to log in via the Internet to an addVANTAGE server and consult their data. Several possibilities are discussed below.

Associations

Large systems have a number of stations—this could be anything between 10 and several hundred. They collect the data from the RTUs, store it on the local hard disk, and process it according to the model. Large systems usually have a server available on the Internet with a fixed IP address through which other subscribers can log in and inspect the data from one or more stations. These large systems with the Internet server apply to bigger farms or, if several farmers pool their resources to form an association, they can also acquire such a system.

The server must be supervised by an administrator appointed by the members of the association. Administrators make sure that the system operates properly and the required maintenance is done in a timely manner. They also use the appropriate resources to inform the participating farmers of the warnings issued by the system (e.g. via e-mail). In order to successfully fulfill their duties, it is important that administrators have sufficient plant protection knowledge.

The advantage of such a solution is that the costs for each farmer are reduced, offering to all participants valuable information about the necessity of treatments. Good results can be obtained by applying a strict spraying methodology, based on the information delivered by the system.

Big Farms

The solution above applies to big farms. In such cases, the advantages of the system are obvious because a single person, the plant protection specialist, can have good control over the entire acreage. He or she can concentrate the necessary human and material resources on the right spot and at the right time.

Service Providers

A service provider can buy or lease the system, and then install the stations to individual farmers wanting better control of the diseases. By offering the farmers a value-added service, the provider can easily recoup his investment in one to three years.

Individual Users

Individual users can use a web browser on a computer with Internet access to log in to an addVANTAGE Pro server (if they have an account) and use the data from one or several stations placed near their fields. Based on a warning issued by the system, the users can take the protective measures that suit them the best.

Some Explanations About the Disease Models

Various parameters such as infection conditions, incubation periods, pressure indexes, and so forth are computed by using climatic data measured in the field and data provided by the user. Depending on how the model was originally developed and validated, the sensors must be placed accordingly—sensor height can vary from 30 cm to 2 m from ground. For example, the potato model for Late Blight uses the 2m height, while the Downy mildew model for lettuce uses the crop height level. See each model's description for additional information about this subject.

Most fungi develop in close correlation to the meteorological parameters. For instance, the downy mildew (*Plasmopara viticola*) needs specific temperatures and leaf wetness conditions for sporulation, as well as darkness. Such conditions are not very often recorded, so it becomes possible to predict with quite a high degree of precision the right time when infections may occur.

On the contrary, other fungi like powdery mildew (*Uncinula necator*) have a specific development cycle that prohibits the use of classical modelling methods because it has a relatively wide range of climatic conditions deemed as favorable. In such cases, multiple regression relations have been statistically or empirically derived, leading to a so-called *pressure index* of the disease. The index is then used to allow for a flexible but effective spraying program.

Chapter 2. Getting Started

This chapter provides additional information about system setup and using the extensions, crop models, and chemicals.

Changing extension and crop properties causes an automatic recalculation of the input data. Due to the improved method used to implement extensions, this operation usually takes only a couple of seconds, or at most several minutes (it depends on the extension and the amount of data to process). You can also force a recalculation of a calculation extension or disease model by selecting it in an Explorer, right-clicking, and choosing **Recalculate**.

Installing the Extensions on your System

The installation procedure is very similar to that of the addVANTAGE Pro 6.x Server (it is assumed that the server is already installed). Crops are installed by default with the basic software package.

If you did not install the free extensions package when you installed your addVANTAGE Pro 6.x Server, refer to the “Getting Started” chapter of the *addVANTAGE 6.x User Guide* for instructions to do so.

Adding Extensions to Nodes

Calculation extensions can be added to areas and crops, while disease models can be added only to crops.

To add a calculation extension, follow these steps:

1. Open an Explorer.
2. Right-click the area or crop where you want the extension added (use the shift and control keys if you're selecting multiple locations).
3. Select **Create New Node** ▸ **Calculation extension** ▸ *extension*.

To add a disease model, follow these steps:

1. Open an Explorer.
2. Right-click the crop where you want the model added (use the shift and control keys if you're selecting multiple locations).
3. Select **Create New Node** ▸ **Crops** ▸ *crop*.

The extension or disease model is added to the node in the Explorer, where you can configure it as needed. When you add a crop, all of the disease models associated with the crop are created by default.

Properties for Extensions

Disease models and calculation extensions are new to addVANTAGE Pro 6.0. Disease models are extensions that apply only to crops. They "hear" events issued by the crop. Calculation extensions usually apply to an area. Although they can be children of a crop node, calculation extensions do not "hear" events issued by the crop (such as when a treatment is applied).

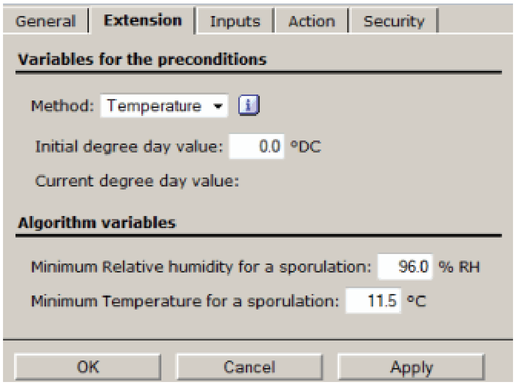
In addition to the **General**, **Action**, and **Security** tabs (see the *addVANTAGE 6.x User Guide*), extensions have an **Extension** tab, **Advanced Settings** tab (this tab can also be hidden), and **Inputs** tab.

Extension Tab

The **Extension** tab (*Figure 2*) allows you to enable or disable individual models/features and, depending on the particular extension, could contain customization elements. Depending on the individual models, the software might need other types of information to work properly. For example, for some diseases, you can choose between two different models (e.g. the powdery mildew extension).

Please see each individual model’s description for more details about such possibilities.

Figure 2. Extensions Tab



Variables for the preconditions

Method: Temperature

Initial degree day value: 0.0 °DC

Current degree day value:

Algorithm variables

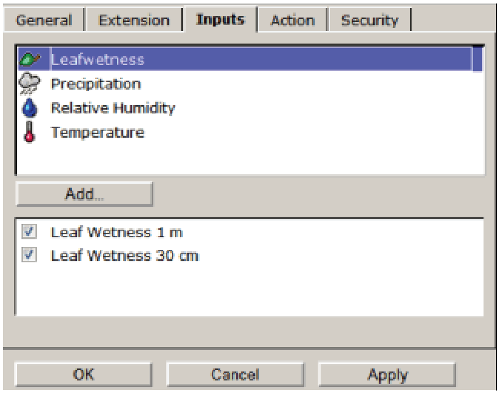
Minimum Relative humidity for a sporulation: 96.0 % RH

Minimum Temperature for a sporulation: 11.5 °C

Inputs Tab

The **Inputs** tab (*Figure 3*) allows you to set the input tags for the extension. The extensions have an intelligent algorithm that searches for the appropriate tags, but only within the extension’s own area. If not all tags are present and the auto-discovery feature fails, you must manually intervene to identify the necessary tags. If multiple tags of the same type exist on a given area, you will also have to manually select which tag type you want the extension to use. However, you can copy tags from other areas if you need the same type of tag in more than one area.

Figure 3. Inputs Tab



Leafwetness
Precipitation
Relative Humidity
Temperature

☑ Leaf Wetness 1 m
☑ Leaf Wetness 30 cm

The Input Tags Slot Interval

addVANTAGE Pro 6.x collects and stores raw data from tags at variable intervals. However, most tags are collected at the default 15-minute interval. The extensions are programmed to cope with data intervals at other rates, but in general there is a limit to this. Specifically, it doesn't matter to the extension if the rate is less than 15 minutes, but stretching it to several hours may affect the proper operation of some extensions. Most extensions operate with average values for larger intervals (e.g. one hour or even one day), therefore they will be less affected by longer intervals between data points.

The bottom line is that even though most extensions can still properly operate with different data rates for individual input tags, you should avoid stretching the intervals between data points to more than one hour.

Properties for Crops

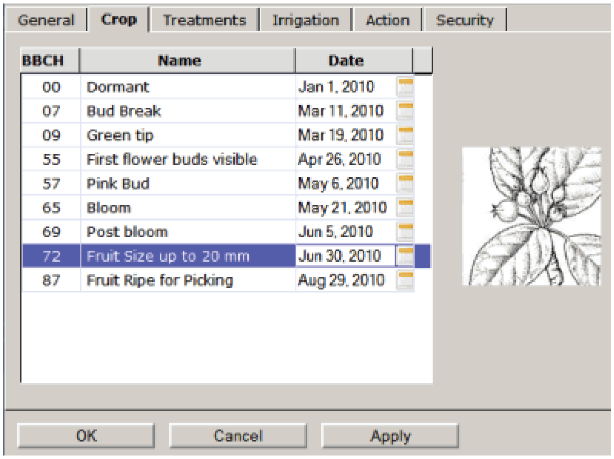
Remember that crops are nodes that store information about phenophases, irrigations, and treatments. They are not extensions.

In addition to the **General**, **Action**, and **Security** tabs (see the *addVANTAGE 6.x User Guide*), crops have a **Crop** tab that is used to specify and monitor the phenological stages of the crops. They also have a **Treatments** tab used to inform the extension that a chemical treatment was applied. The final tab that is specific to crops is the **Irrigation** tab, where irrigation schedules can be set up.

Crop Tab

Use the **Crop** tab (*Figure 4*) to specify and monitor the phenological stages of crops.

Figure 4. Apple Crop Properties, Crop Tab

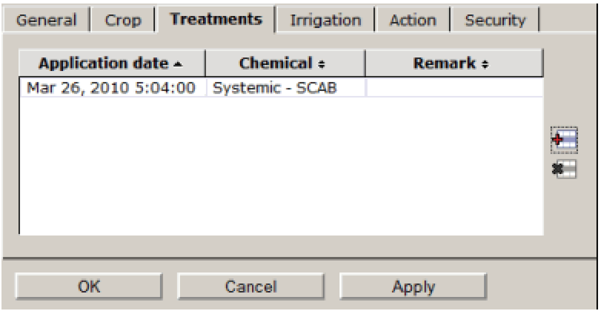


BBCH	Name	Date
00	Dormant	Jan 1, 2010
07	Bud Break	Mar 11, 2010
09	Green tip	Mar 19, 2010
55	First flower buds visible	Apr 26, 2010
57	Pink Bud	May 6, 2010
65	Bloom	May 21, 2010
69	Post bloom	Jun 5, 2010
72	Fruit Size up to 20 mm	Jun 30, 2010
87	Fruit Ripe for Picking	Aug 29, 2010

Treatments Tab

Use the **Treatments** tab (*Figure 5*) to inform the extension that a chemical treatment was applied.

Figure 5. Apple Crop Properties, Treatments Tab

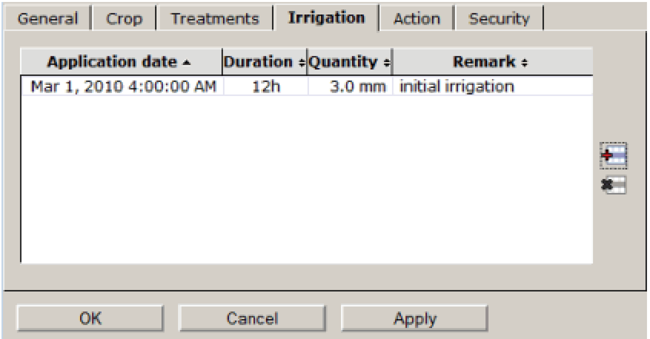


Application date ▲	Chemical ⇕	Remark ⇕
Mar 26, 2010 5:04:00	Systemic - SCAB	

Irrigation Tab

Use the **Irrigation** tab (*Figure 6*) to create irrigation schedules for the crop.

Figure 6. Apple Crop Properties, Irrigation Tab



Application date ▲	Duration ⇕	Quantity ⇕	Remark ⇕
Mar 1, 2010 4:00:00 AM	12h	3.0 mm	initial irrigation

User Input

Crops use two types of data: climatic data, collected by the measuring stations in the field; and user data, such as phenological phases, type of cultivar, treatments, and so on. Obviously, the model’s results are heavily dependent on the correctness of the user-supplied data.

Depending on each crop, several configuration dialog boxes for user data input may be present, but some of them are standard for all the models and are described in the following paragraphs.

To access the configuration panels, highlight the crop and select **Edit ▸ Properties** or right-click the crop in an Explorer and select **Properties**.

More about Treatments

The two basic types of treatments are *curative* and *preventive*. Generally, the models based on computed indexes (disease pressure or infection indexes) are more prevention-oriented. The models observing the states of the disease (like grape downy mildew or apple scab) can lead to preventive spraying, that is, towards the end of an incubation (about 70 – 80%). The treatment might prove unnecessary if the next infection condition isn't met at the right time. You could wait until the next infection condition before executing a treatment, but then it will be curative and have to be carried out as soon as possible. Certain risks are inherent in such an approach, but specific conditions can be evaluated to take the appropriate measures.

It is worth noting that the vast majority of curative products are systemic, and they can easily induce resistance if they are used too often. To avoid such a situation, you can use several alternative products, although the choice won't always appear very broad. Preventive treatments applied at specific development phases of the vegetation can also help substantially.

During certain phenological phases, the plants' sensitivity to some diseases is higher. In particular, the young organs (young leaves, flowers, and so forth) with a thin epidermis offer vulnerable surfaces to the fungi, so they must be carefully protected.

Treatments with curative fungicides minimize the outbreaks if they are applied soon after the infection conditions are reported. Each fungicide has its own way of acting on the diseases. An important issue arising is, of course, the pathogen's resistance to the product. In any case, these limits can vary. For example, in the case of apple scab, the maximum limit could be 96 hours after infection, for some products. Currently, no product can guarantee sufficient protection if applied later. This form of disease fighting offers the most in terms of fungicide economy.

The following factors influence the effectiveness of the plant protection measures:

- Climate
- The state of the vegetative organs, leaves (wet or dry)
- Contact or systemic fungicide
- Preventive, curative, or eradicating effect
- Growth stage
- Spray coverage quality

Washoff Limit

Contact fungicides (averaging 8 to 10 days of control) are washed away after a specific amount of precipitation, meaning that the controlled period is over. Therefore, you have to be aware of the manufacturer's information when adding chemical products in the database. Exact values are difficult to state, so adjust them according to your practical knowledge and pertinent information received from the product manufacturer or distributor.

Systemic products (averaging 14 to 20 days of control) are not washed away by precipitation, except if a heavy rain falls in the first 2 hours after application. In such cases the system will neither observe nor report the washoff for systemic products. The delay between the actual treatment and the time when the system is informed about the treatment is usually long enough to justify such an implementation decision.

The Chemicals Service

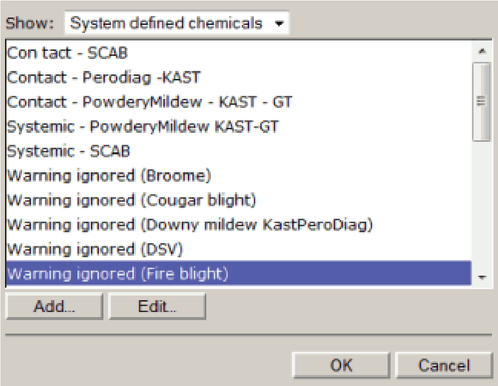
This service is automatically activated if you have at least one crop that requires it.

Adcon does not supply lists of chemicals because the rules for their use differ between locations. The addVANTAGE Pro server provides a list only of false “treatments” you can apply to ignore warnings you might get from your extensions. You can add your own chemicals or edit the existing ones.

Only users with administrator rights are allowed to edit the default database (also called system-defined chemicals). However, all users can maintain their own chemicals database (user-defined chemicals).

To access the chemicals database, select **Tools ▸ Chemicals**. A window appears, containing a list of chemicals (*Figure 7*). You can select either the system- or user-defined chemicals from the **Show** combo box.

Figure 7. The Chemicals window



Show: System defined chemicals

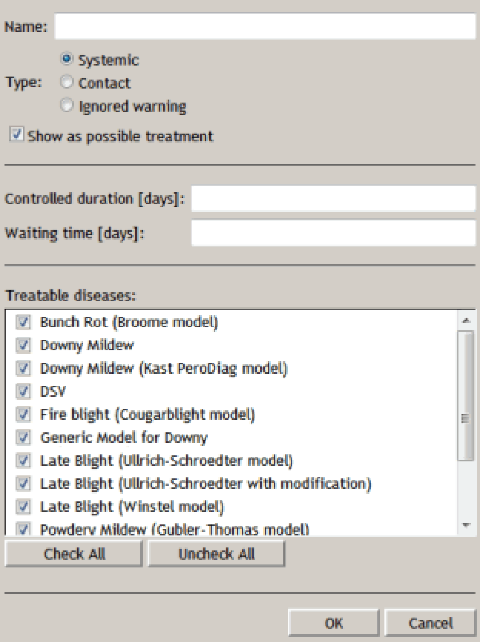
Con tact - SCAB
Contact - Perodiag -KAST
Contact - PowderyMildew - KAST - GT
Systemic - PowderyMildew KAST-GT
Systemic - SCAB
Warning ignored (Broome)
Warning ignored (Cougar blight)
Warning ignored (Downy mildew KastPeroDiag)
Warning ignored (DSV)
Warning ignored (Fire blight)

You can add or edit chemicals according to the rights you have. Follow these steps to add or edit a chemical:

1. Select the appropriate list of chemicals in the **Show** combo box.
2. Select **Add** or **Edit** as appropriate. The window shown in *Figure 8* appears.

Note: You can select or clear all of the checkboxes by clicking the ***Check All*** *or* ***Uncheck All*** *button.*

Figure 8. Adding or editing chemicals



Name:

Type: ● Systemic ○ Contact ○ Ignored warning

☑ Show as possible treatment

Controlled duration [days]:

Waiting time [days]:

Treatable diseases:

☑ Bunch Rot (Broome model)
☑ Downy Mildew
☑ Downy Mildew (Kast PeroDiag model)
☑ DSV
☑ Fire blight (Cougarblight model)
☑ Generic Model for Downy
☑ Late Blight (Ullrich-Schroedter model)
☑ Late Blight (Ullrich-Schroedter with modification)
☑ Late Blight (Winstel model)
☑ Powdery Mildew (Gubler-Thomas model)

3. Type the name of the chemical in the **Name** field.
4. Select either **Systemic** or **Contact** for the **Type**.
5. Enter the **Controlled duration** in days. This is the number of days the chemical treatment will be effective. The extensions use this information to determine if the plants are safe or not, in case of an imminent outbreak.
6. Enter the **Waiting time** in days (optional). This is the number of days that the sprayed plants cannot be consumed. This information is not used by any extension at this time.
7. Select the diseases for which the chemical is effective in the **Treatable diseases** list of checkboxes.
8. Select **OK** to confirm the changes and return to the Chemicals window.

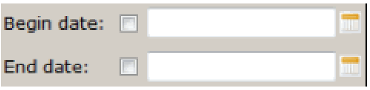
Note: If you are in doubt about certain parameters of the chemicals you are using, contact the manufacturer of the respective product.

You cannot delete a chemical. You can, however, remove a treatment using a chemical you no longer want. Then add a treatment using the correct chemical.

A Word about Dates and Hours

You’ll find that some of the **Properties** dialogs discussed in this book have begin and end date fields, or require a start hour, or even both.

Following is an explanation of the date fields.



Begin date: ☐

End date: ☐

- To enable a date field, click the checkbox immediately in front of the field.
- Specify a date by entering it or by using the calendar icon to select a date.
- If you leave the **Begin date** field blank, the computation starts with the first available data. If you leave the **End date** field blank, the computation never stops.

9. Enter the **Begin time** in hours and/or minutes.

Following is an example of the **Start hour** field.

Start hour: 12

This field represents the hour of the day you want to start a computation, using a 24-hour clock. Valid values are 0 through 23.

The application also uses a **Begin time** field.

Begin time: 0 : 0

In this case, you can enter an hour and/or minute (or use the spinboxes) for the operation to start.

Sometimes the **Properties** dialogs also indicate a time zone, either by showing something like Europe/Vienna or Time zone: CET (for Central European Time). The time zone shown means the time where the server is located.

Finding Additional Information

Some extensions and disease models have background or explanatory data. When you see a small Info button (i), you can click it to display a dialog with this helpful information.

Chapter 3. Using the Calculation Extensions

This chapter describes the operation of the calculation extensions. It is not intended to be an extensive compendium on plant protection techniques and methods; rather, it focuses on the extensions included in the software package addVANTAGE Pro 6.x. For more details about a particular extension or model, consult *"References,"* or try to contact the model's authors.

Note: *All dialogs in addVANTAGE have* **OK** *and* **Cancel** *buttons at the bottom. If you don't see these buttons when you open a dialog, enlarge the dialog until they are visible.*

Basic Arithmetics

The Basic Arithmetics extension can be used to perform mathematical computations using single values of an input tag. This means you define a tag to be used for the extension and you define a formula, where *x* in the formula stands for a single value in the input tag.

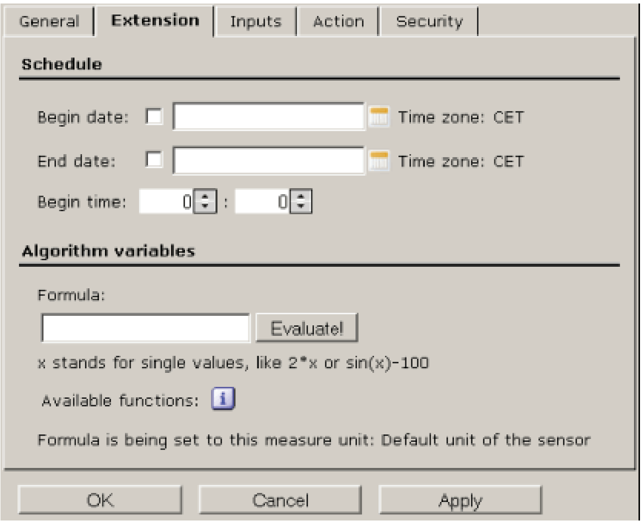
For example, if you use `x+100` as the formula and the water level sensor as the input, the output will be a water level sensor, where 100 is added to each value of the sensor.

Configuring the Basic Arithmetics Extension

Follow these steps to set up the Basic Arithmetics extension:

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 9*.

Figure 9. **Basic Arithmetics Properties Dialog, Extension Tab**



Begin date: ☐ Time zone: CET

End date: ☐ Time zone: CET

Begin time: 0 : 0

x stands for single values, like 2*x or sin(x)-100

Formula is being set to this measure unit: Default unit of the sensor

3. Set the **Begin date** and **End date**.
   To enable a date field, click the checkbox immediately in front of the field.
4. Enter the **Begin time** in hours and/or minutes.
5. Enter the formula to use.
6. Click **Evaluate!** to determine the validity of your formula (optional).
   - You must enter the formula in the same units that the input tag uses (usually the metric system).
   - You cannot use multiple tags as inputs. More specifically, you cannot calculate the difference between multiple inputs.
7. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.
8. Click the **General** tab and make sure the extension is enabled.
9. Click **OK** to accept any changes you've made and close the dialog.

Chill/Heat Hours

The growth and development of plants, insects, and many other invertebrate organisms is largely dependent on temperature. This has been known since the mid-seventeenth century. The French scientist René A. F. de Réaumur first studied this concept in 1735. He recognized that physiological development for many organisms was driven primarily by the accumulation of thermal energy rather than by the accumulation of time. In other words, a constant amount of thermal energy is required for the growth and development of many organisms, but the time period over which that thermal energy is accumulated can vary. It was further realized that many organisms slow or stop their growth and development when temperatures are above or below threshold levels.

The former Heat Units Extension has been split into the Chill/Heat Hours and the Degree Days extensions. You'll find information specific to chill/heat hours in this section, and you can skip to *page 30* for information about degree days.

Model Operation

You can use the chill/heat hours extension with many previously validated degree-day and heat unit models. The most commonly used methods of calculating heat units are included in this extension. In general, each model requires the user to provide the method of calculation, cutoff thresholds and base (if appropriate), the developmental thresholds at which addVANTAGE will issue warnings, and the messages associated with those warnings. Local agronomic and pest management information sources should be consulted before using any of those models. Once the model has been enabled, daily chill/heat hours calculations will be made and warnings will be issued based upon accumulated totals.

Calculation Methods

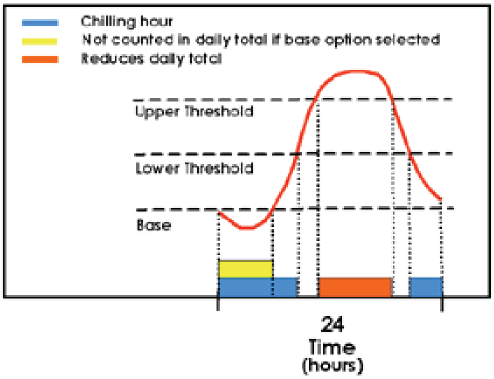
Three methods used to calculate heat and chilling hours are provided in this extension. Each calculation method reports the hours above or below a threshold, but each is different and may yield different values from the same data set. Adcon recommends that you choose the same calculation method as the one being used to validate the model. What follows is a brief description of the calculation methods.

Chill/Heat Hours

The Chill and/or Heat hours methods report the number of hours with temperatures below or above a user-entered low/high threshold temperature. No cutoff methods are associated with the Chill and/or Heat methods.

For example chill hour values are used to predict several management factors. Deciduous fruit tree growers are the primary users of chill hours. Decisions such as varietal selection, pruning, and other management factors related to potential yields can be aided by chill hour calculations. Chill and heat hour calculations are based on average hourly temperatures calculated from 15-minute measurements (0, 15, 30, and 45 minute time slots). A user-entered low temperature threshold is used as the point below which chill hours are accumulated. An upper threshold serves as a point above which chilling hours are subtracted from the cumulative total. For each hour above the upper threshold, 0.5 hours are subtracted from the cumulative total. An optional base temperature threshold is also available. Temperatures below the base threshold are not added to the cumulative chilling hours.

Figure 10. Chill/Heat Hours Method of Operation



Note: *The minimum daily chilling hour value is 0; temperatures exceeding the upper threshold are not allowed to cause a negative daily chilling hour value.*

Chilling Units, Utah Method

This computation method is similar to the standard Chilling hours method above except that it introduces the concept of relative chilling effectiveness and negative chilling accumulation (or chilling negation). It basically gives different weights to different segments of the temperature spectrum. For additional details on this computation method, you can check the following link: *http://aggie-horticulture.tamu.edu/stonefruit/chillacc.htm*.

Sensor Placement

The chill/heat hours and degree days extensions use the temperature sensor for calculations. Different placements of the temperature sensor can yield different measurements based upon temperature gradients, reflective surfaces, wind, etc. Refer to the details of the desired phenology model for the best placement of the sensor. If no information on sensor placement is available in the published model, contact your local pest management advisor/agency for suggestions on the best sensor placement relative to the use of the model in your area.

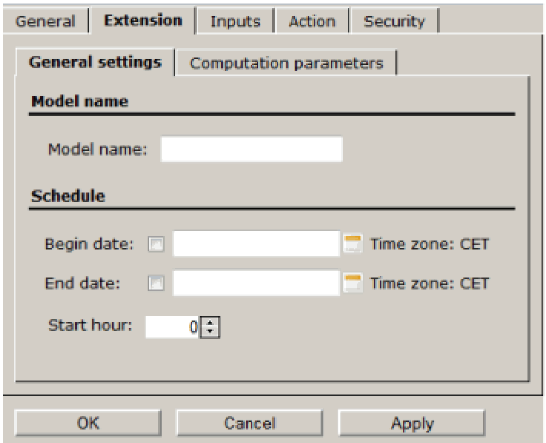
Configuring Chill/Heat Hours Options

You'll need to configure the extension in each area where it's used. Follow the configuration steps detailed in the following sections.

General Settings

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 11*.

Figure 11. Chill/Heat Hours Properties Dialog, Extension Tab’s General Settings



3. Enter a **Model name**.
4. Set the **Begin date** and **End date**.
   To enable a date field, click the checkbox immediately in front of the field.
5. Enter the **Start hour**.

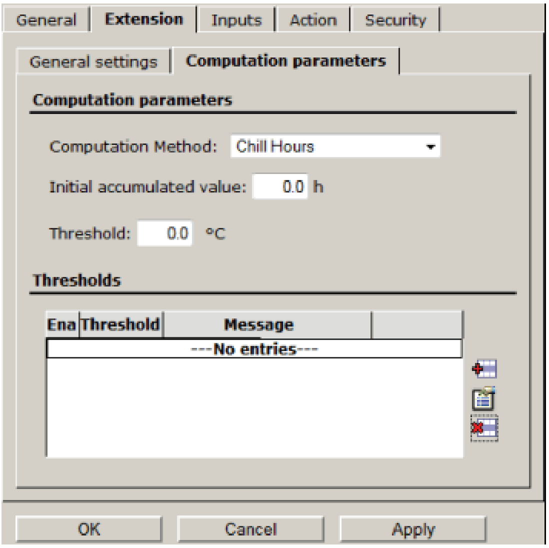
Computation Parameters

1. Click the **Computation parameters** tab to display the dialog shown in *Figure 12*.
2. Select a **Computation Method**.
3. The **Initial accumulated value** defaults to 0 hours. You can change this if needed, such as when you start using the extension mid-season.
4. Enter the **Threshold** to use for this computation.

Note: *If you are uncertain of the appropriate threshold value to enter, you can enter an extremely high value (example: 140° F or 60° C) to allow for proper functioning of the calculation method without limiting the accumulation of heat units at high temperatures.*

5. To have the extension generate an alarm in the Events panels, add an alarm by clicking the **Add** icon.

Figure 12. Chill/Heat Hours Properties Dialog, Extension Tab's Computation Parameters



Computation parameters

Computation Method: Chill Hours

Initial accumulated value: 0.0 h

Threshold: 0.0 °C

Thresholds

Ena	Threshold	Message	
---No entries---			

6. In the pop-up that appears, enter the threshold value and the alarm message the extension should issue when the threshold is reached.

   You can edit and remove alarms as needed by clicking the appropriate icon to the right of the alarms table. You can also deactivate an alarm by clicking the checkbox in the **Ena** (for Enable) column.

Note: *Alarms are generated when the threshold value is passed (that is, if a threshold is set at 400, a message will not be generated at 400; it will be generated when the cumulative heat unit value is greater than 400).*

7. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.
8. Click the **General** tab and make sure the extension is enabled.
9. Click **OK** to accept any changes you've made and close the dialog.

Daily Operation

Degree-days and other heat units are typically calculated on a daily basis. The daily calculation period for heat units in this extension is considered to be the 12:00 AM through 11:59 PM time slots. As an example, the heat units for day one are calculated at 12:00 AM on day two. The warning messages for thresholds/message combinations entered by the user are posted at the time of calculation. Therefore, a warning message for a threshold that is exceeded on day one will be posted at 12:00 AM on day two. Further, if you are using the Double Sine or Double Triangle methods, the warning messages are not posted until 12:00 AM of day three because the double calculation methods require the minimum temperature from day two.

Use the following steps for daily operation:

- Check the raw data to make sure all the data has been downloaded for each area by opening an appropriately configured Trend panel.
- Check the Events list for each area every day after 12:00 AM. Make sure to thoroughly check and identify any warnings for any area.
- Double-click any alarms to acknowledge that they have been read.

Conditions

The Conditions extension is quite similar to the previous Main extension, which checked conditions but also performed various other calculations in the background. The Conditions extension focuses only on the checking of conditions. You can enter thresholds for various tags, you can also select whether the overall condition is true if all or at least one threshold is met.

Configuring the Conditions Extension

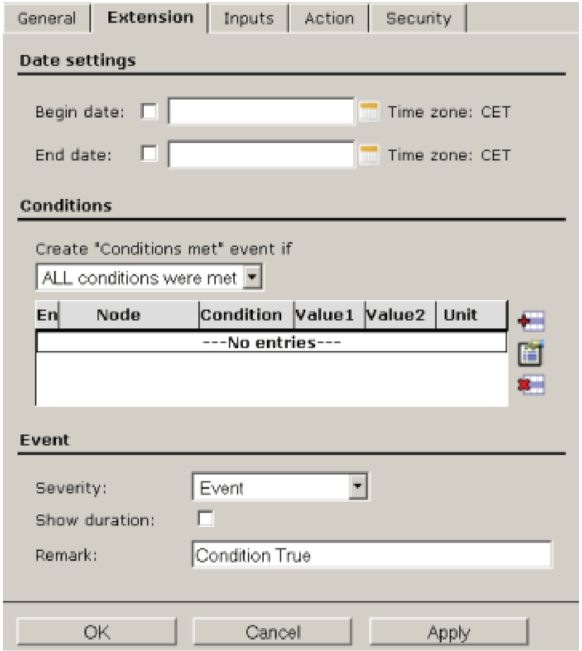
Follow these steps to set up the Conditions extension:

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 13*.

Setting Dates

Set the **Begin date** and **End date**.
To enable a date field, click the checkbox immediately in front of the field.

Figure 13. Conditions Properties Dialog, Extension Tab



Date settings

Begin date: ☐ Time zone: CET

End date: ☐ Time zone: CET

Conditions

Create "Conditions met" event if

ALL conditions were met

En	Node	Condition	Value1	Value2	Unit
---No entries---					

Event

Severity: Event

Show duration: ☐

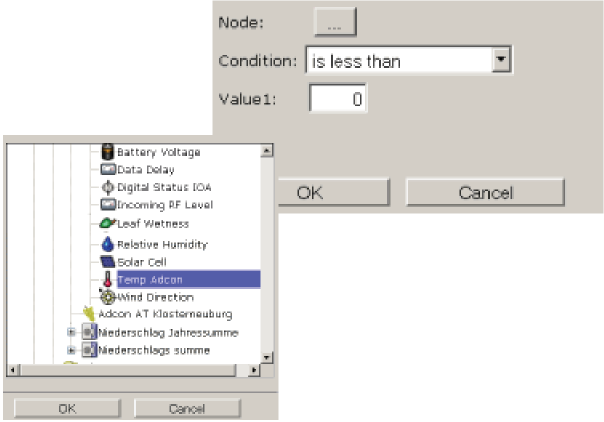
Remark: Condition True

Setting Conditions

Follow these steps to add a condition:

1. Click the **Add** button on the right side of the dialog to display the Add Condition dialog shown on the right side of *Figure 14*.

Figure 14. Adding a Condition



Node: ...

Condition: is less than

Value1: 0

2. Click **Node** to display the dialog shown on the left side of *Figure 14*.

3. Find the appropriate RTU in the dialog, then select the node you want to use in the condition.
4. Click **OK** to return to the Add Condition dialog.
5. Select the **Condition** you want:
6. Enter the **Value**.
   If you select any of the conditions that use “between,” you will need to enter a **Value1** and a **Value2**:
   - is between (incl): includes both values
   - is between (excl): excludes both values
   - is between (incl - excl): includes the first value but excludes the second
   - is between (excl - incl): excludes the first value but includes the second
7. Click **OK** to display the condition in the Condition Properties dialog.
8. Repeat steps *1* through *7* for each condition you want to include.
9. In the Conditions Properties dialog, select whether the overall condition is met when **ALL of the conditions were met** or when **ANY condition was met**.

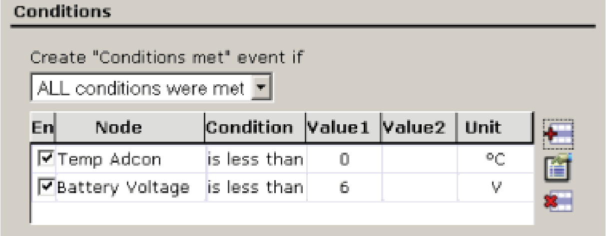
Finalizing Condition Settings

1. Select the **Severity** of the condition—that is, whether you want to view the condition as an **Event**, an **Alarm**, or an entry in the **Service Log**.
2. Click the **Show duration** checkbox if you want to see the how long the condition occurred.
3. Enter a **Remark** for the log (optional).
4. Click the **Inputs** tab and make sure all of the extension’s inputs are connected to a valid sensor.
5. Click the **General** tab and make sure the extension is enabled.
6. Click **OK** to accept any changes you’ve made and close the dialog.

When the overall condition is met, an event, alarm, or service log entry named **Condition true** is issued. If you entered a remark, it is shown in parentheses after the name.

Figure 15 shows a completed Conditions pane.

Figure 15. Completed Conditions Pane



Conditions

Create "Conditions met" event if

ALL conditions were met

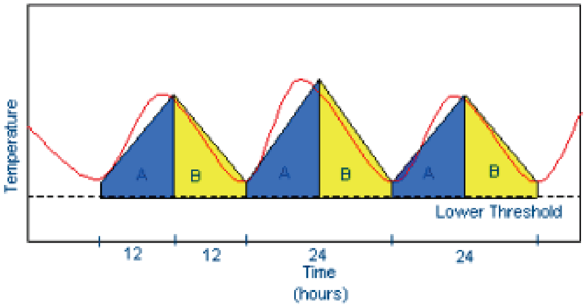
En	Node	Condition	Value1	Value2	Unit
☑	Temp Adcon	is less than	0		°C
☑	Battery Voltage	is less than	6		V

Refer to the *addVANTAGE Pro 6.0 User Guide* for information about creating actions that are executed whenever an event occurs, such as sending an e-Mail or performing a VoIP-call when the overall condition is met.

Degree Days

By the beginning of the twentieth century the accumulation of thermal energy over time became known as *degree-days*. Degree-days and other heat unit measurements have been used for determination of planting dates, prediction of harvest dates, and selection of appropriate crop varieties. More recently, the use of heat units in pest management has increased. Models relating the phenological development of pests to heat units have been developed for many species.

Figure 16. Graphical Display of Degree-Days Calculation



Researchers have used various methods of calculating heat units when developing phenological models. Proper use of phenological models for management decisions requires the use of calculation methods similar to those used in developing the models. This extension includes the most commonly used methods for calculating heat units. The user is able to create assessments based on information found in published models. The templates can include the method of heat unit calculation and thresholds levels for alarms. A listing of some web sites that contain heat unit-based phenological models is included at the end of this section.

Calculation Methods

Seven calculation methods used to calculate degree-days are provided in this extension. Each degree-day calculation method estimates the area under the daily temperature curve but above the lower developmental threshold. Each method, however, is different and may yield different values from the same data set. Adcon recommends that you choose the same calculation method as the one being used to validate the model. What follows is a brief description of each calculation method.

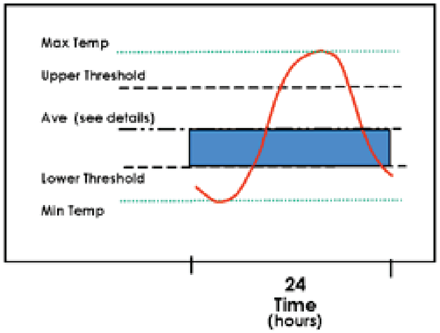
Average

The Averaging method uses a daily average temperature (historically daily minimum and maximum temperatures). The average is calculated, then the lower threshold value is subtracted from the result. Daily values are accumulated to give a cumulative degree-day value.

Average (Adjusted)

Options are available to the Average method (see also *"Sensor Placement" on page 24* for more details on these options). The Average (adjusted) method selects only on the averaged minimum and maximum temperatures resulting out of the samples.

Figure 17. Averaging Method Set to Average Values

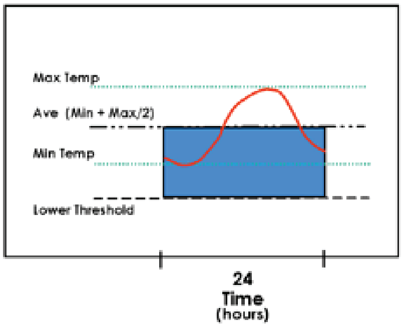


The Average (adjusted) computing method is similar to that used for many agronomic crops in the midwest of the U.S. This method calculates degree-days using the daily minimum and maximum temperatures. Maximum temperatures above the upper threshold are set as being equal to the upper threshold. Minimum temperatures below the lower threshold are set as being equal to the lower threshold. The daily minimum and maximum values are added and then divided by two. The lower threshold value is then subtracted from the result. Daily values are accumulated to give a cumulative degree-day value.

Discrete

Another options is the Discrete method, which selects all data samples (typically every 15 minutes).

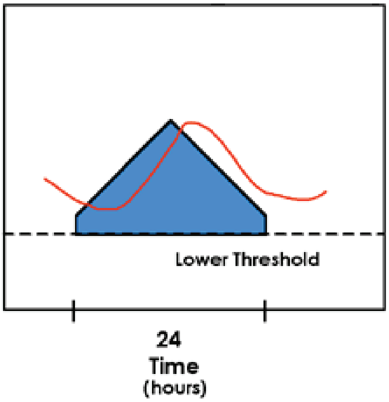
Figure 18. Averaging Method Set to Discrete Values



Single Triangle

The Single Triangle method calculates degree-days using daily minimum and maximum temperatures to create triangles that estimate the shape of the daily temperature curve over a 24-hour period.

Figure 19. The Single Triangle Method Operation

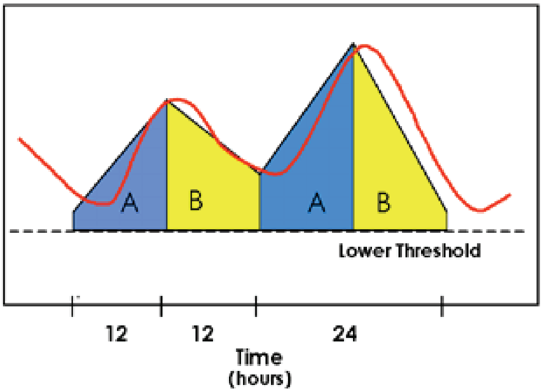


The first side of the triangle consists of a line drawn from a day's minimum temperature to that day's maximum temperature. The second side is drawn using the same minimum temperature as the first side. The area under the triangle and above the lower threshold is used as an estimation of the degree-day value for a 24-hour period. An upper threshold setting is available when a cutoff method is selected. When a cutoff method is selected, the area in the triangle that is used to estimate the degree-day value is reduced according to the rules of the cutoff method.

Double Triangle

The Double Triangle method estimates the area under a daily temperature curve by drawing triangles over two 12-hour periods using minimum and maximum temperatures. The first side of the first triangle is drawn between the daily minimum and maximum. The second side is drawn as a vertical line through the maximum temperature. A second triangle is drawn for the second 12-hour period using the same guidelines but using the daily maximum temperature and minimum temperature from the next day. Degree-days are calculated as the sum of the areas under both curves and between any thresholds. An upper threshold setting is available when a cutoff method is selected. When a cutoff method is selected, the areas in the triangles that are used to estimate the heat-unit values are reduced according to the rules of the cutoff method.

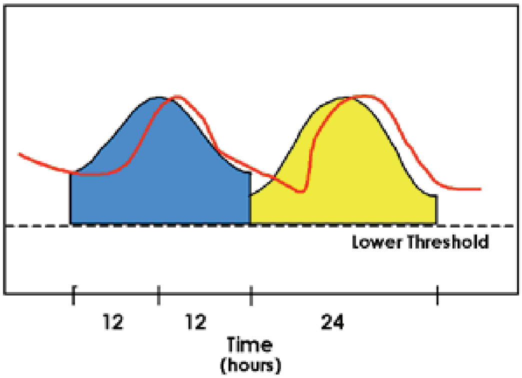
Figure 20. The Double Triangle Method of Operation



Single Sine

The Single Sine method estimates the area under a daily temperature curve by drawing a sine curve over a 24-hour period through the daily minimum and maximum temperatures. Degree-day values are estimated as the area within the sine curve that is above the lower threshold. When a cutoff method is selected, the area used for determining degree-day values is reduced according the to the rules of the cutoff method. According to UC IPM, the single sine method with a horizontal cutoff has been the most commonly used method of determining degree-day values in California for many years.

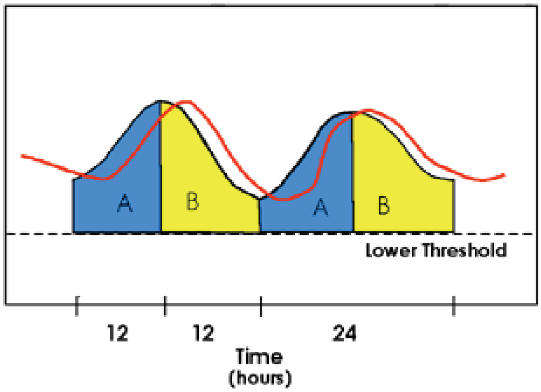
Figure 21. Single Sine Method of Operation



Double Sine

The Double Sine method estimates the area under a daily temperature curve by drawing sine curves over two 12-hour periods. The first curve is drawn using the daily minimum temperature with the first half of the sine curve to represent the first 12 hours. The second curve is drawn from the daily maximum temperature and the minimum temperature of the following day and using the second half of this curve to represent the second 12 hours. An upper threshold setting is available when a cutoff method is selected. When a cutoff method is selected, the area under the curves that is used to estimate the degree-day value is reduced according to the rules of the cutoff method. Degree-days are calculated as the sum of the areas under both curves and between any thresholds.

Figure 22. Double Sine Method of Operation



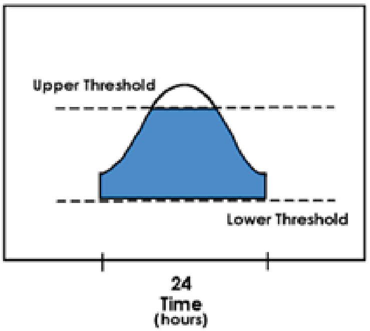
More About Cutoff Methods

The cutoff method is also a key component of a phenological model. It modifies the daily degree-day calculation to more accurately reflect an organism’s growth response to high temperatures. Three cutoff methods are included in this extension. They are the Horizontal, Intermediate, and Vertical cutoff methods.

Horizontal Cutoff

The Horizontal cutoff method treats phenological development as continuing at a constant rate above the upper threshold. The area calculated above the upper threshold is subtracted from the area above the lower threshold when this method is used.

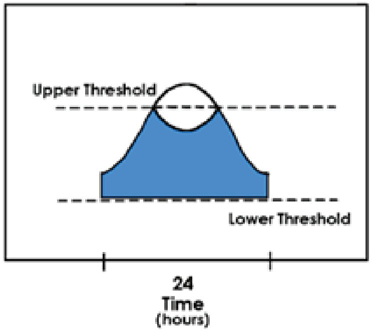
Figure 23. Graphical Representation of the Horizontal Cutoff



Intermediate Cutoff

The Intermediate cutoff method is used in cases where development slows above the upper threshold. In this case, the area calculated above the upper threshold is subtracted twice from the area above the lower threshold.

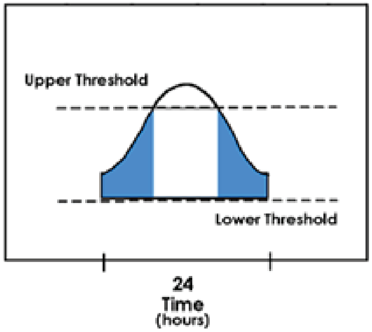
Figure 24. Graphical Representation of the Intermediate Cutoff



Vertical Cutoff

The Vertical cutoff method is used in cases where no development above the upper threshold exists. Temperatures in the area above the upper threshold are not used in this case.

Figure 25. Graphical Representation of the Vertical Cutoff



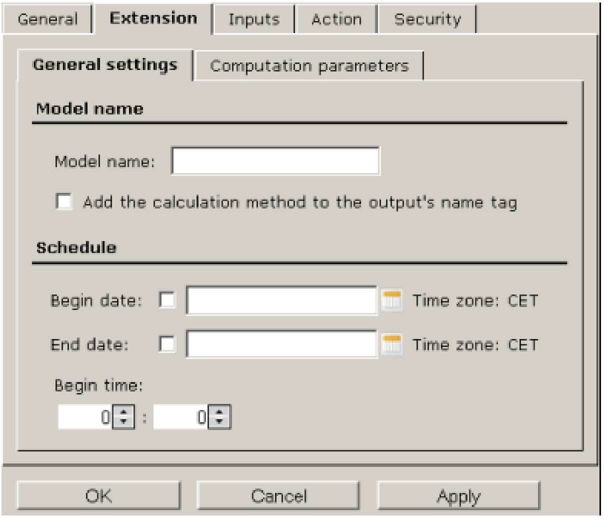
Configuring Degree Days Options

You'll need to configure the extension in each area where it's used. Follow these configuration steps detailed in the following sections.

General Settings

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 26*.

Figure 26. Degree Days Properties Dialog, Extension Tab's General Settings



Model name

Model name:

☐ Add the calculation method to the output's name tag

Schedule

Begin date: ☐ Time zone: CET

End date: ☐ Time zone: CET

Begin time:
0 : 0

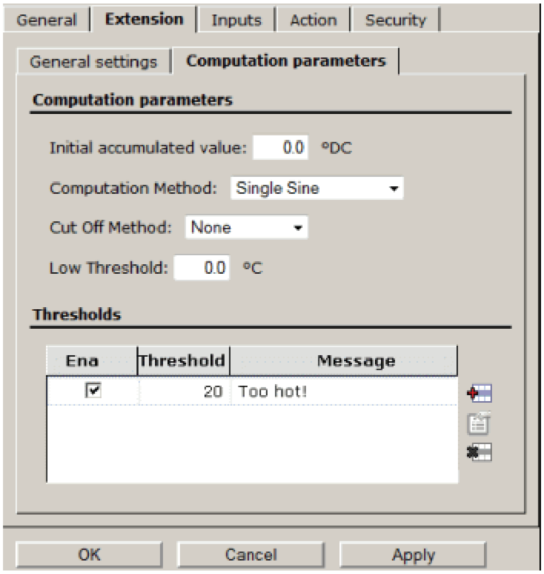
3. Enter a **Model name**.
4. Click the checkbox if you want the model's name to include the calculation method selected on the next tab.
5. Set the **Begin date** and **End date**.
   To enable a date field, click the checkbox immediately in front of the field.

6. Enter the **Begin time**, in hours and/or minutes.

Computation Parameters

1. Click the **Computation parameters** tab to display the dialog shown in *Figure 27*.

Figure 27. Degree Days Properties Dialog, Extension Tab's Computation Parameters



Computation parameters

Initial accumulated value: 0.0 °DC

Computation Method: Single Sine

Cut Off Method: None

Low Threshold: 0.0 °C

Thresholds

Ena	Threshold	Message
☑	20	Too hot!

2. The **Initial accumulated value** defaults to 0 hours. You can change this if needed, such as when you start using the extension mid-season.
3. Select a **Computation Method**.
4. Select a **Cut Off Method**.
5. Enter the **Low Threshold** to use for this computation.

Note: *If you are uncertain of the appropriate threshold value to enter, you can enter an extremely high value (example: 140° F or 60° C) to allow for proper functioning of the calculation method without limiting the accumulation of degree days at high temperatures.*

6. To have the extension generate an alarm in the Events panels, add an alarm by clicking the **Add** icon.
7. In the pop-up that appears, enter the threshold value and the alarm message the extension should issue when the threshold is reached.

   You can edit and remove alarms as needed by clicking the appropriate icon to the right of the alarms table. You can also deactivate an alarm by clicking the checkbox in the **Ena** (for Enable) column.

Note: *Alarms are generated when the threshold value is passed (that is, if a threshold is set at 400, a message will not be generated at 400; it will be generated when the cumulative heat unit value is greater than 400).*

8. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.
9. Click the **General** tab and make sure the extension is enabled.
10. Click **OK** to accept any changes you've made and close the dialog.

Sources of Phenology Models

The following list is a sample of heat-unit-based phenology models that were available on the Internet at the time this user's guide was written. The content of each web site is subject to change. This list, however, can serve as a starting point in searches for phenology models.

The models contained in the web sites listed here vary in their applicability to crop and pest management and to specific geographic areas. These model lists are presented only as examples of the information available on the Internet. Adcon Telemetry has not validated these models and therefore no recommendation for their use is implied. Locally validate a model before using it to make crop and pest management decisions.

Iowa State University (*http://www.ipm.iastate.edu/ipm/icm/1998/4-6-1998/dd.html*)

Black cutworm

Alfalfa weevils

Stalk borer moths

Ohio State University (*http://ohioline.ag.ohio-state.edu/hyg-fact/2000/2502.html*)

Billbugs in turfgrass

Michigan State University

(Models contained in individual pest fact sheets under sections titled “Monitoring”)

Codling moth

Oriental fruit moth

Apple maggot

Obliquebanded leafroller

Grounds Maintenance Magazine (*http://www.grounds-mag.com/usedeg.htm*)

Smooth crab grass
emergence

University of Kentucky (*http://www.uky.edu/Agriculture/Entomology/entfacts/fldcrops/ef106.htm*)

European corn borer

University of California (*http://www.ipm.ucdavis.edu/MODELS/index.html*)

Beneficial Insects & Mites
Anagrus epos
Aphytis melinus
Bathyplectis curculionis
Convergent lady beetle
Encarsia formosa
Metaseiulus occidentalis
Sevenspotted lady beetle
Transverse lady beetle
Twospotted lady beetle
Voria ruralis

Nematodes
Columbia root-knot nematode
Stubby root nematode

Weeds
Black nightshade
Bluegrass
Johnsongrass
Smooth crabgrass
Wild oats
Yellow nutsedge

Crops
Alfalfa harvest
Citrus flower model
Common bean
Grapevine
Pistachios-shell hardening
Rose--flowering shoots
Sweet corn
Tepary bean

Insect & mite pests
Alfalfa weevil
Apple maggot
Armyworm
Artichoke plume moth
Asparagus beetle
Beet armyworm
Beet leafhopper
Black cutworm
Blackberry leafhopper
Blue alfalfa aphid
Cabbage aphid
Cabbage butterfly
Cabbage looper
Cabbage maggot
California red scale
Calocoris norvegicus
Elm leaf beetle
English grain aphid
European elm scale
European red mite
Fruittree leafroller
Fullers' rose beetle
Green peach aphid
Greenhouse whitefly
Gypsy moth
Hop vine borer
Imported cabbageworm
Indian meal moth
Lilac borer
Lygus bug
Meadow spittlebug
Mediterranean fruit fly
Melon fly
Peachtree borer
Pear psylla
Pear rust mite
Pink bollworm
Plum fruit moth
Potato leafhopper
Potato tuberworm
Russian wheat aphid
San Jose scale
Seedcorn maggot
Serpentine fruit fly
Sod web worm
Spodoptera litura
Spotted tentiform leafminer
Spruce budworm
Squash bug
Strawberry spider mite

Carrot weevil
Celery looper
Cereal leaf beetle
Citricola scale
Citrus thrips
Citrus red mite
Codling moth
Corn earworm
Corn leaf aphid
Cotton aphid
Cotton bollworm
Crucifer flea beetle
Cuban laurel thrips
Diamondback moth
Egyptian alfalfa weevil
Mexican bean beetle
Nantucket pine tip moth
Navel orangeworm
Northern corn rootworm
Obscure scale
Olive scale
Omnivorous leafroller
Onion maggot
Onion thrips
Orange tortrix
Oriental fruit fly
Oriental fruit moth
Pacific spider mite
Pea aphid
Peach twig borer
Sunflower beetle
Sunflower moth
Sunflower stem weevil
Sweet potato whitefly
Tobacco budworm
Tomato fruitworm
Tomato pinworm
Twospotted spider mite
Variegated cutworm
Vegetable leafminer
Western cherry fruit fly
Western grape leafhopper
Western grapeleaf skeletonizer
Western pine shoot borer

See *page 26* for some daily operation considerations.

Evapotranspiration

Evapotranspiration is defined as the loss of water from the soil both by evaporation and by transpiration from the plants growing on it. The Penman-Monteith method of computing the reference evapotranspiration (ETo) is based on two main equations: an energy equation (global radiation) and an aerodynamic equation (wind and air humidity). Depending on the predominant climatic situation, any of the equations can take a leading role. For instance, during quiet weather conditions, the aerodynamic factors have a lower influence. Consequently, under such conditions, the reference evapotranspiration is valid not only for the cold and humid climates, but also for the warm, semi-arid regions. Due to the day and night climatic differences and their effect upon the evapotranspiration, the Penman-Monteith calculation is based on hourly climatic data.

The model implemented by the Evapotranspiration extension is based on the “FAO Irrigation and drainage paper 56”; for further reading, you can find it at *http://www.fao.org/docrep/X0490E/x0490e00.htm*.

Note: *The combo sensor (temperature and RH), the wind speed sensor, and the global radiation sensor must be installed at the 2 m standard height. All of these sensors are essential for the ETo extension.*

You can calculate ETo at any of several intervals:

- One hour
- Four hours
- Six hours

- Eight hours
- Twelve hours
- One day

If you have a large amount of data to compute (more than two years of data) it is better to set the recalculation to one day (or 12 hourly). Otherwise, it will take a long time to recalculate.

Factors Affecting ETo

Sometimes it is desirable to use climatic data recorded from a distant weather station. This is possible as long as the weather conditions are uniform for a wide area. In regions where this is not obvious (due to the geographical situation, for example, deep valleys and frequent hills), you have to verify that the values recorded from such a distant station are still representative for your area. If in doubt, consult a local weather service.

In arid and semi-arid climates (as well as for the summer months in humid zones), the irrigated fields are often surrounded by large, dry soil surfaces. Under such conditions, massive air displacements such as warm winds lead to the so-called oasis effect, which further leads to a substantially higher evapotranspiration rate, especially towards the fields' boundaries.

The Influence of the Soil Moisture

The evapotranspiration model assumes that the plants' roots have sufficient water. After irrigating, or after a rainfall, the water content will be predominantly influenced by the water needs of the crop. The plants' roots easily absorb this water. Concurrently to the water absorption, the soil water supply diminishes. If a critical threshold is reached, the crop evapotranspiration will sink under the actual computed values.

The effect of the soil moisture on the evapotranspiration varies with crop type and its root system and soil type. Under moderate evapotranspiration conditions (up to 5 mm per day) and high water content, the available water in the soil has practically no effect. However, if the evapotranspiration rate is over 5 mm per day, and the soil moisture in the roots region is reduced, the crop evapotranspiration remains low, especially in heavy and light soils.

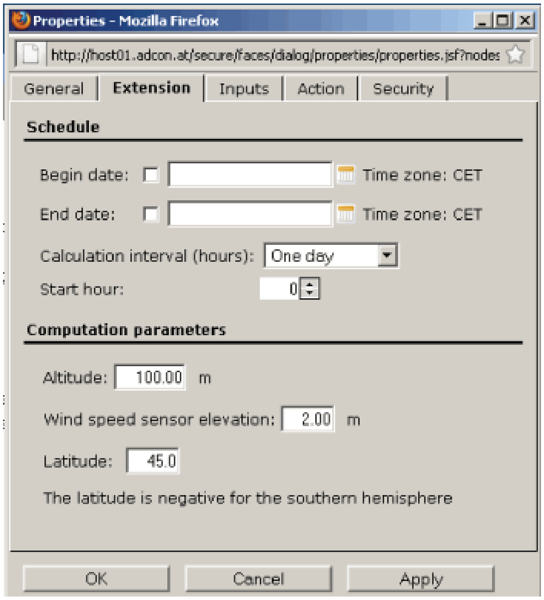
Setup and Operation

Follow these steps to set up the ETo extension on an area:

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 28*.
3. Set the **Begin date** and **End date**.
   To enable a date field, click the checkbox immediately in front of the field.

4. Select the **Calculation interval (hours)** to choose how frequently you want to calculate ETo.
5. Enter the **Start hour** for the calculation. The interval is based on this hour.

Figure 28. ETo Properties Dialog, Extension Tab



Properties - Mozilla Firefox

http://host01.adcon.at/secure/faces/dialog/properties/properties.jsf?nodes

Schedule

Begin date: ☐ Time zone: CET

End date: ☐ Time zone: CET

Calculation interval (hours): One day

Start hour: 0

Computation parameters

Altitude: 100.00 m

Wind speed sensor elevation: 2.00 m

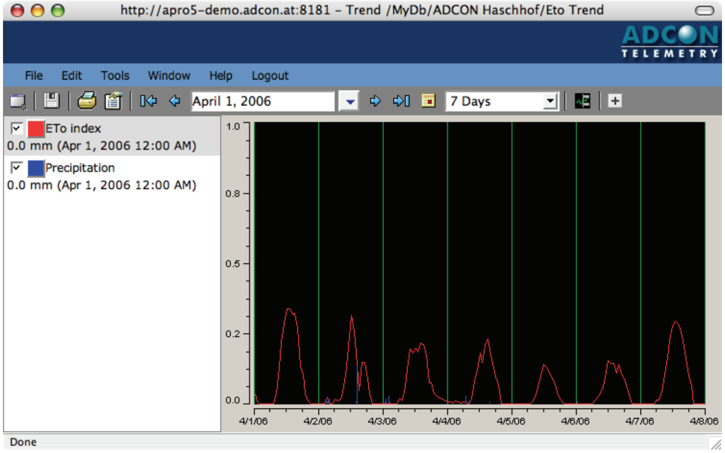
Latitude: 45.0

The latitude is negative for the southern hemisphere

6. Set the proper values for **Altitude**, **Wind speed sensor elevation**, and **Latitude**.
7. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.
8. Click the **General** tab and make sure the extension is enabled.
9. Click **OK** to accept any changes you've made and close the dialog.

The ETo extension generates a tag (Eto index) that you can display in a trend and/or allow to be used by other extensions as an input tag.

Figure 29. ETo Index Displayed in a Trend Panel



http://apro5-demo.adcon.at:8181 – Trend /MyDb/ADCON Haschhof/Eto Trend

☑ 🟥 ETo index
0.0 mm (Apr 1, 2006 12:00 AM)

☑ 🟦 Precipitation
0.0 mm (Apr 1, 2006 12:00 AM)

April 1, 2006

7 Days

Done

ETc

ETc is a new extension that represents Evapotranspiration at the crop level. The ETc extension is available for all crops.

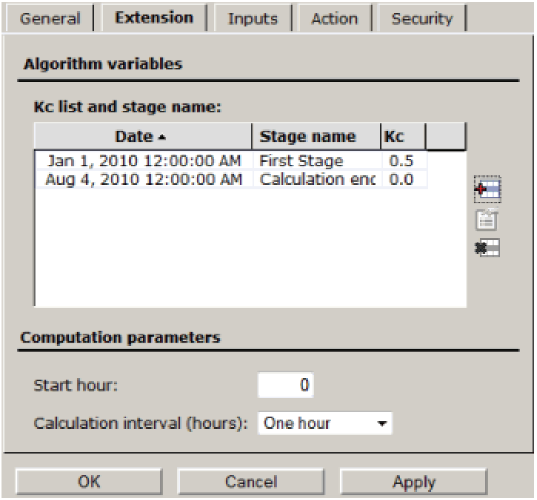
The influence of a crop on the water requirement is devised by using the kc coefficient. The values for the kc coefficient may vary considerably, depending on the crop, its growth stage, the time of the year, and the local regional conditions. The resulting parameter, ETc (or the actual evapotranspiration) is also expressed in mm. ETc is the result of kc multiplied by ETo.

Setup and Operation

Follow these steps to set up the ETc extension on a crop:

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 30*.

Figure 30. ETc Properties Dialog, Extension Tab



Algorithm variables

Kc list and stage name:

Date ▴	Stage name	Kc
Jan 1, 2010 12:00:00 AM	First Stage	0.5
Aug 4, 2010 12:00:00 AM	Calculation enc	0.0

Computation parameters

Start hour: 0

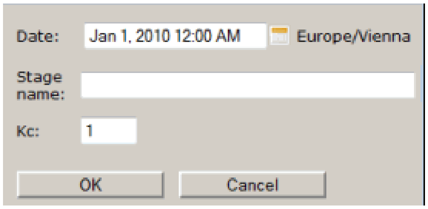
Calculation interval (hours): One hour

3. Verify the information in the **Kc list and stage name** table. Use the **Edit** icon to change items in the table. You can also click the **Add** icon to display a pop-up where you enter stage information (*Figure 31*).

Note: *You must have at least one stage. If you delete all stages, the default ones are recreated.*

The Start date of computation is given by the default first stage. You cannot enter a stage before this date. If you need such a stage, first change the start date of computation of the extension for this crop, then create the stage.

Figure 31. New ETc Stage



Date: Jan 1, 2010 12:00 AM Europe/Vienna

Stage name:

Kc: 1

4. Enter the **Start hour** for the calculation. The interval is based on this hour.
5. Select the **Calculation interval (hours)** to choose how frequently you want to calculate ETc (see *page 42*).
6. Click the **Inputs** tab and make sure all of the extension’s inputs are connected to a valid sensor.
7. Click the **General** tab and make sure the extension is enabled.
8. Click **OK** to accept any changes you’ve made and close the dialog.

Flow to Volume

The Flow to Volume extension mirrors the Volume to Flow extension discussed on *page 53*. That is, if a flow sensor is attached to the RTU, you can use this extension to calculate the volume that passed through within a certain time range. A flow meter measures the rate of flow for a specific time range so if the sensor on the RTU is set to measure mililiters per hour, for example, you can calculate the volume that passed through the meter during that time range, in mililiters.

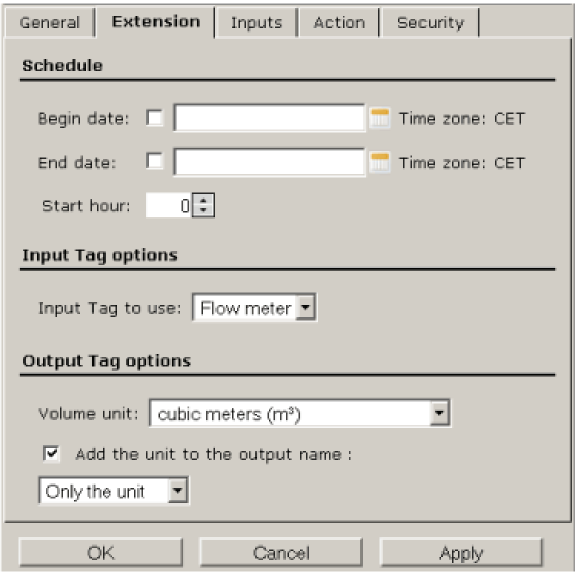
If the RTU has only a digital sensor that shows if the pump was active or the valve was opened, you can enter the volume that must pass through this device to calculate the flow of liquid that passed.

You can also choose the unit of the output tag created and whether to add this unit and/or its name to the output tag.

Follow these steps to set up the Flow to Volume extension:

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 32*.

Figure 32. Flow to Volume Properties Dialog, Extension Tab



Schedule

Begin date: ☐ Time zone: CET

End date: ☐ Time zone: CET

Start hour: 0

Input Tag options

Input Tag to use: Flow meter

Output Tag options

Volume unit: cubic meters (m^3)

☑ Add the unit to the output name :

Only the unit

3. Set the **Begin date** and **End date**.
   To enable a date field, click the checkbox immediately in front of the field.
4. Enter the **Start hour**.
5. Select the tag to use as the **Input Tag**.
   If you select **Digital**, enter the **Volume for digital inputs** also.
6. Select **Volume unit** to use for the **Output Tag**.

7. Click the checkbox if you to **Add the unit to the output name**, then select how much information you want added.
8. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.
9. Click the **General** tab and make sure the extension is enabled.
10. Click **OK** to accept any changes you've made and close the dialog.

Running Total

The Running Total extension in addVANTAGE Pro 5.x was included in the Statistic extension. Starting in addVANTAGE Pro 6.0, the Running Total is a separate extension using an interface that is better tailored to it use.

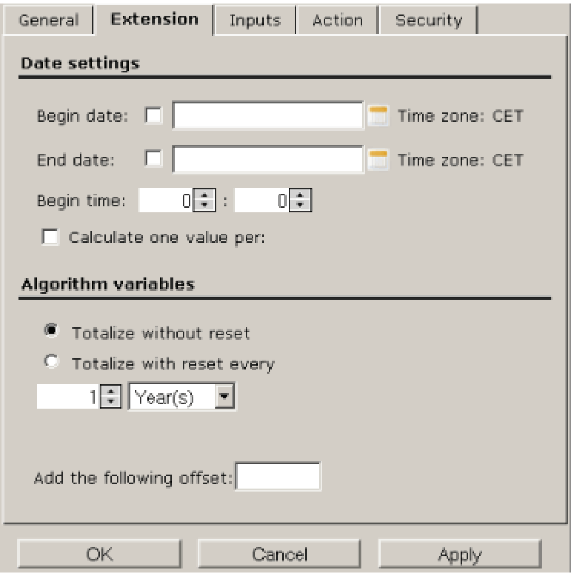
The running total adds all previous values. This calculation is very important when, for example, it has rained for several days or perhaps a watering schedule has been affected and you need to calculate the amount of water that has accumulated.

Configuring the Running Total Extension

Following these steps to configure the Running Total extension:

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 33*.
3. Set the **Begin date** and **End date**.
   To enable a date field, click the checkbox immediately in front of the field.
4. Enter the **Begin time** in hours and/or minutes.
5. Click the **Calculate one value per** checkbox to display the fields for setting the calculation interval.
   You can select to have each single value from the input tag shown *x* number of times per **Minute**, **Hour**, **Day**, **Week**, **Month**, or **Year** in the output tag.
   If you do not click this checkbox, every single input value creates exactly one output value.
6. Determine the interval for regular resets.
   Normally the running total sums all values and does not drop to 0 (this is the **Totalize without reset** radio button). For some calculations such resets are useful, for example, to see the amount of rain that has fallen within this month until now. For such an application you would select **Totalize with reset every 1 Month(s)**.

Figure 33. Running Total Properties, Extension Tab



Date settings

Begin date: ☐ Time zone: CET
End date: ☐ Time zone: CET
Begin time: 0 : 0
☐ Calculate one value per:

Algorithm variables

● Totalize without reset
○ Totalize with reset every
1 Year(s)

Add the following offset:

7. Enter a value in the **Add the following offset** field (optional). If you enter a value here, the running total starts the calculation not at 0 but at a value you specify. This value could be, for example, the initial water meter reading when the sensor was installed. Note that the offset is counted as starting point only in the very first calculation. When you also select a regular reset, the reset is to 0, NOT to the offset value.
8. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.
9. Click the **General** tab and make sure the extension is enabled.
10. Click **OK** to accept any changes you've made and close the dialog.

Soil Moisture

The Soil moisture extension was devised to operate with capacitive type soil moisture probes. A range of sensors operating on the principle of measuring the dielectric of the soil has been developed lately (Sentek's EasyAG, Agrilink's C-Probe, etc.). However, the output of these sensors expresses values that cannot be used readily with standard irrigation modeling software. Therefore the sensor values—usually expressed in Scaled Frequency Units (SFU)—must be converted to volumetric soil water content (vsw), taking into account the soil type.

You can install the soil moisture probes in a large variety of soil types, from coarse to heavy clay, and their output varies significantly. The output depends on the water-holding capacity of the soils: the heavier the soil, the higher the output of the probe.

Apart from the conversion to volumetric values, the Soil moisture extension offers you the ability to generate compound values, i.e. averages and sums of the probes' outputs. These output tags can be further used as input tags for other extensions, or as such to help you determine the optimum time to irrigate, as well as the amount of water needed by the crop.

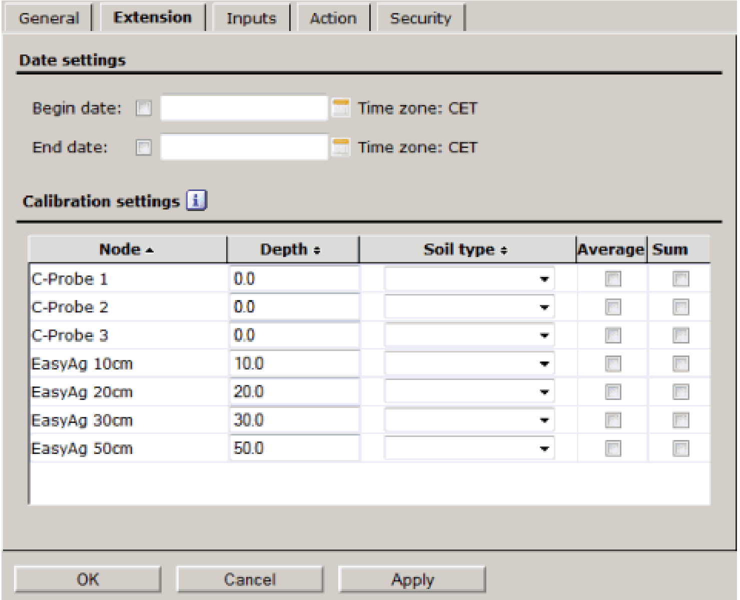
Setup and Operation

It is assumed that the soil moisture probes are already installed in the field; for details about installing your probe, see the respective probe's user guide. In addition, it is assumed that the data source (e.g. the Telemetry Gateway) is already properly configured and the soil moisture probe's data has been transferred to addVANTAGE Pro's database. For more details about configuring the soil moisture probes in the Telemetry Gateway, see the respective user guide. Note that the Soil moisture extension is expecting data from input tags of SFU type, which is important when you set up a custom driver.

Follow these steps to set up the Soil moisture extension on an area:

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 34*.
3. Enter the **Begin date** and **End date** for running the extension. To enable a date field, click the checkbox immediately in front of the field.
4. Verify and, if needed, correct the **Depth** for each sensor.
5. Select the appropriate **Soil type** for each sensor.
6. If you need the **Average** and/or **Sum** composite output tags, click the appropriate checkboxes. The average tag is computed as an average of all the selected input soil moisture sensors, while the sum tag is the sum value of all the selected input soil moisture sensors.
7. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.

Figure 34. Soil Moisture Properties, Extension Tab



Date settings

Begin date: ☐ Time zone: CET

End date: ☐ Time zone: CET

Calibration settings

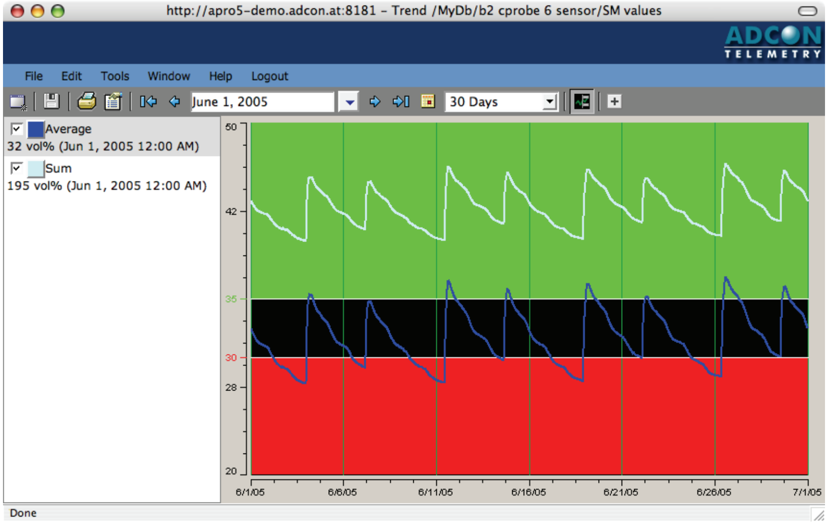
Node	Depth	Soil type	Average	Sum
C-Probe 1	0.0		☐	☐
C-Probe 2	0.0		☐	☐
C-Probe 3	0.0		☐	☐
EasyAg 10cm	10.0		☐	☐
EasyAg 20cm	20.0		☐	☐
EasyAg 30cm	30.0		☐	☐
EasyAg 50cm	50.0		☐	☐

8. Click the **General** tab and make sure the extension is enabled.
9. Click **OK** to accept any changes you’ve made and close the dialog.

The model starts computing the individual output values and the composite values immediately. As with any other tag in the system, you can view the output tags graphically by placing them in a Trend panel (*Figure 35*). Using the many options offered by the Trend panel, you can set up thresholds for different values of the sensors (e.g. to the refill and full points), change colors, offset the graphs, and so forth.

The output tags can be further used as input tags for other extensions. For example, you can set up the Apple disease model to issue alarms in the Events list when specific thresholds have been reached or to send e-mails in extreme cases. You could also use the Statistics extension to generate statistic reports.

Figure 35. Sum and Average Tags on a Trend Panel



June 1, 2005

30 Days

☑ Average
32 vol% (Jun 1, 2005 12:00 AM)

☑ Sum
195 vol% (Jun 1, 2005 12:00 AM)

Additional Information about Calibration

The soil calibrations available in the **Soil type** list are controlled by the `soilmoisture.cal` file. If you need additional soil types, add them as new columns in the file.

Following are the predefined soil types:

- **AquaSpy Linear**: a linear calibration for use with the AquaSpy probes.
- **AquaSpy Polynomial**: a polynomial calibration for use with the AquaSpy probes.
- **Raw Smooth L1**: the raw values that are smoothed using a low level of rolling average prior to being written to the output tag.
- **C-Probe Default**: a calibration for use with the Series 2 to 3 C-Probes that includes scaling but no correction for soil type.
- **C-Probe Clay**: a calibration for use with the Series 2 to 3 C-Probes in clay soils.
- **C-Probe Loam**: a calibration for use with the Series 2 to 3 C-Probes in loam soils.
- **C-Probe Sand**: a calibration for use with the Series 2 to 3 C-Probes in sand soils.
- The raw data that is written straight to the output tag (no calibration).
- **NP-10, NP20-30, NP40-100**: sample calibrations for correlation to neutron probe data.

The **Average** column provides the arithmetic average of the values of the sensors selected in this column. The calculation is useful for analysing moisture through the profile when using soil moisture tension sensors.

The **Sum** column provides the sum of the values of the sensors selected in this column. The calculation is useful for analysing total moisture levels through the soil profile.

Custom Soil Type Configuration

The conversion between input SFU values and output vsw values is done with a configuration file that stores calibration parameters. The file is called `soilmoisture.cal` and is located in the `\addVANTAGE-Pro\config` directory. You can edit the file with a standard text editor such as Notepad. The file format is 100% compatible with the file format of the `cprobe.cal` file used by the C-Probe extension in the addVANTAGE 3.45 software. Therefore, if you already have configured custom soils, you can use your original file by simply changing its name to `soilmoisture.cal` and placing it in the `\addVANTAGE-Pro\config` directory on your addVANTAGE Pro 6.x server.

Note: *You might want to save the original distribution file under a different name.*

For more information on the significance of the parameters in the `cprobe.cal` file, as well as how you can set up your own soil type, refer to the “C-Probe Technical Manual” issued by the C-Probe Corporation (version 3.2, March 2001).

Statistic

Use the Statistic extension to perform statistical computations based on any input tag. The following computation methods are provided:

- Minimum (MIN)
- Maximum (MAX)
- Midrange (which is (Min+Max) / 2) (MID)
- Average (AVG)
- Sum (SUM)
- Circular Average (cAVG)

(Circular Averages are the proper calculation method for events happening in circles/spheres as compared to arithmetic values. Circular averages are required, for example, to properly calculate and display the average wind direction.)

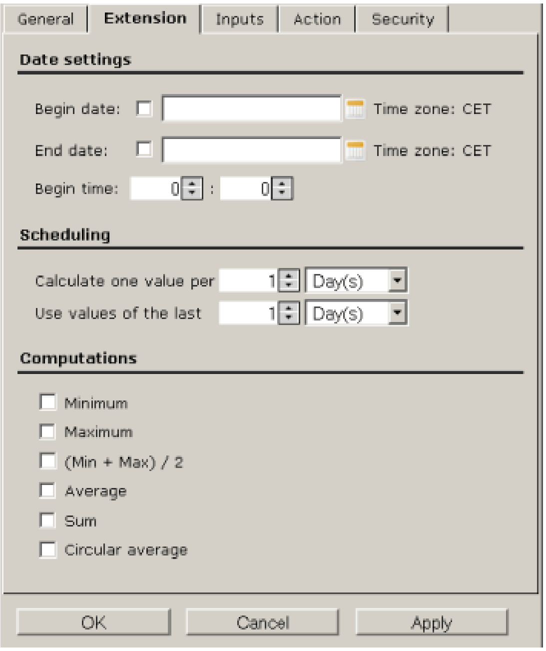
The extension needs one or more input tags of the same type (same subclass), for example, one or multiple Temperature tags. It performs the above calculations using those input tags. Each calculation creates one output tag, e.g. Temperature (AVG)

Configuring a Statistical Calculation

Follow these steps to set up the Statistics calculation extension:

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 36*.

Figure 36. Statistics Properties Dialog, Extension Tab



Date settings

Begin date: ☐ Time zone: CET

End date: ☐ Time zone: CET

Begin time: 0 : 0

Scheduling

Calculate one value per 1 Day(s)

Use values of the last 1 Day(s)

Computations

☐ Minimum
☐ Maximum
☐ (Min + Max) / 2
☐ Average
☐ Sum
☐ Circular average

3. Enter the **Begin date** and **End date** for running the extension. To enable a date field, click the checkbox immediately in front of the field.
4. Enter the **Begin time** in hours and/or minutes.

   If you enter 00:00 as the calculation **Begin time**, the resulting value will be stored at 00:00 of the NEXT day. For example, if your **Begin date** is December 24, your **Begin time** is 00:00, and you calculate one value per day, the first result will be stored on December 25 at 00:00. If what you want is a calculation at the end of each day, use 23:59 as the **Begin time**. A computer's clock starts at 00:00 and ends at 23:59—it does not recognize 24:00 as the end of a day.
5. Select how often to calculate values.
6. Select how old the values used for the calculation can be.
7. Click a checkbox for each type of computation you want.
8. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.
9. Click the **General** tab and make sure the extension is enabled.

10. Click **OK** to accept any changes you've made and close the dialog.

How the Time of Computation is Determined

The time of computation is determined by using the specified begin date and time and repeating the computation at the specified interval (**Calculate one value per**).

Examples:

Begin Date/Time	2011-01-01 00:00
Interval	1 Hour
1st Time of Computation	2011-01-01 00:00
2nd Time of Computation	2011-01-01 01:00
3rd Time of Computation	2011-01-01 02:00

Begin Date/Time	2011-02-03 11:00
Interval	1 Day
1st Time of Computation	2011-02-03 11:00
2nd Time of Computation	2011-02-04 11:00
3rd Time of Computation	2011-02-05 11:00

Consider the following information when you select the type of interval:

- If you choose **Minute** or **Hour**, the intervals are well-defined without variance.
- If you choose **Day**, the times of computation are determined considering a potential time change, so if you specify 01:00 it means 01:00 regardless whether the specified time is DST (Daylight Savings Time) or not.
- If you choose **Month**, the dates of computation are determined considering the maximum number of days of the targeted month. Specifying 31 23:59 will result in Jan. 31st, Feb. 28th (Feb. 29th in a leap-year), Apr. 30th, and so on.
- If you choose **Year**, the dates of computation are determined considering leap-years. Specifying Feb. 29th will thus result in Feb. 29th in a leap-year, and Feb. 28th in a non-leap-year.

You'll also define the period of time with the values you want to use (**Use values of the last**).

Volume to Flow

This extension, along with the Flow to Volume extension discussed on *page 45*, is especially useful in water management. If you have a RTU that has only a volume meter, you can calculate the flow rate at a certain time. If the sensor on the RTU shows mililiters, for example, it indicates how many cubic meters have passed since the last time slot, and you can calculate the flow in mililiters per hour.

Additionally, you can combine the volume meter with a number of emitters after meter (EAMs). In this case, the calculated flow is divided by the number of EAMs, resulting in the flow rate per EAM.

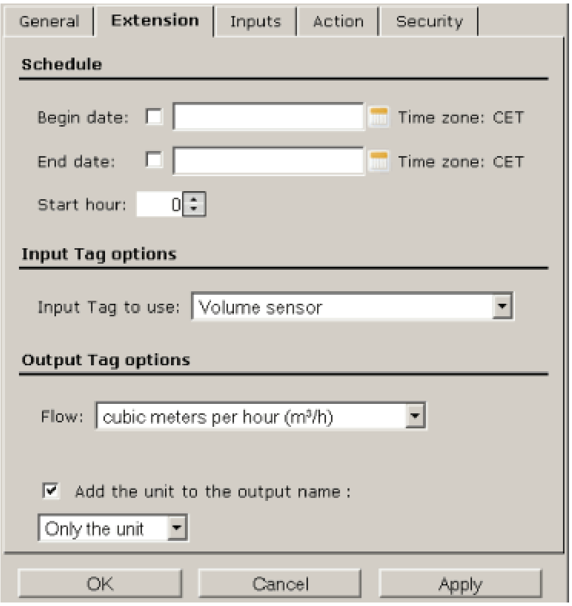
Finally, you can use this extension to calculate the rain intensity by using a rain sensor, which works like the volume meter first described in thi section.

You can also choose the unit of the output tag created and whether to add this unit and/or its name to the output tag.

Follow these steps to set up the Volume to Flow extension:

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 37*.

Figure 37. Volume to Flow Properties Dialog, Extension Tab



Schedule

Begin date: ☐ Time zone: CET

End date: ☐ Time zone: CET

Start hour: 0

Input Tag options

Input Tag to use: Volume sensor

Output Tag options

Flow: cubic meters per hour (m^3/h)

☑ Add the unit to the output name :

Only the unit

3. Set the **Begin date** and **End date**.
   To enable a date field, click the checkbox immediately in front of the field.
4. Enter the **Start hour**.
5. Select the tag to use as the **Input Tag**.
   If you select **Volume sensor thru EAM/Sprinklers**, you must also enter the **EAM/Sprinkler Number**.
6. Select the **Flow** to use for the **Output Tag**.

7. Click the checkbox if you to **Add the unit to the output name**, then select how much information you want added.
8. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.
9. Click the **General** tab and make sure the extension is enabled.
10. Click **OK** to accept any changes you've made and close the dialog.

Wet Bulb

The wet-bulb temperature[1] is a type of temperature measurement that reflects the physical properties of a system with a mixture of a gas and a vapor, usually air and water vapor. Wet bulb temperature is the lowest temperature that can be reached by the evaporation of water only. It is the temperature you feel when your skin is wet and is exposed to moving air. Unlike dry bulb temperature, wet bulb temperature is an indication of the amount of moisture in the air.

An important consideration for the wet bulb extension is the dew point[2].

The dew point is the temperature to which a given parcel of humid air must be cooled, at constant barometric pressure, for water vapor to condense into water. The condensed water is called dew. The dew point is a saturation point.

The dew point is associated with relative humidity. A high relative humidity indicates that the dew point is closer to the current air temperature. Relative humidity of 100% indicates the dew point is equal to the current temperature and the air is maximally saturated with water. When the dew point remains constant and temperature increases, relative humidity will decrease.[3]

Configuring the Wet Bulb Extension

Follow these steps to set up the Wet Bulb extension:

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 38*.

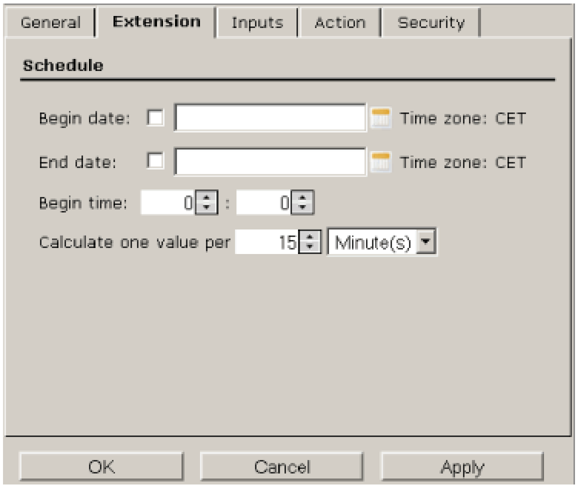
---

[1] Wet-bulb temperature definition from Wikipedia, the free encyclopedia (*http://en.wikipedia.org/wiki/Wet-bulb_temperature*)

[2] Dew point definition from Wikipedia, the free encyclopedia (*http://en.wikipedia.org/wiki/Dew_point*)

[3] Horstmeyer, Steve (2006-08-15). "Relative Humidity....Relative to What? The Dew Point Temperature...a better approach". Steve Horstmeyer, Meteorologist, WKRC TV, Cincinnati, Ohio, USA. http://www.shorstmeyer.com/wxfaqs/humidity/humidity.html. Retrieved 2009-08-20.

Figure 38. Wet Bulb Properties Dialog, Extension Tab



Schedule

Begin date: ☐ Time zone: CET

End date: ☐ Time zone: CET

Begin time: 0 : 0

Calculate one value per 15 Minute(s)

3. Enter the **Begin date** and **End date** for running the extension. To enable a date field, click the checkbox immediately in front of the field.
4. Enter the **Begin time** in hours and/or minutes.
5. Select how often to calculate values.
6. Click the **Inputs** tab and make sure all of the extension’s inputs are connected to a valid sensor.
7. Click the **General** tab and make sure the extension is enabled.
8. Click **OK** to accept any changes you’ve made and close the dialog.

Chapter 4. Using the Disease Models

This chapter describes the operation of the disease models. It is not intended to be an extensive compendium on plant protection techniques and methods; rather, it focuses on the disease models included in the software package addVANTAGE Pro 6.x. For more details about a particular extension or model, consult *"References,"* or try to contact the model's authors.

Adcon Telemetry does not assume any responsibility for the results obtained by using a given model, but only for the correctness of its implementation.

Scab (Mills-Jones)

The disease originated in Europe and was first observed in Sweden by Fries in the year 1819. It was successively recorded in 1833 in Germany, in 1834 in the USA, in 1845 in England, and in 1862 in Australia.

At present, the disease is widespread at a worldwide level, being found in almost all apple-growing areas and especially those characterized by humidity and moderate temperatures. In many countries it is considered the main apple disease.

The fungus multiplies in two ways: the sexual (teleomorphic) form and the asexual (anamorphic) form. The sexual multiplication represents the saprophytic form of the fungus, which develops on the fallen, wilted, degrading leaves, and not on the live leaves, hence the non-parasitic character. This form of existence and reproduction is specific to the autumn/winter/beginning of spring period—the period corresponding to the falling of the leaves, followed over the winter by their degradation and the beginning of bud break of the trees. The sexual saprophytic form of the fungus is known under the name of *Venturia inaequalis* (Cooke) Wint. or *Endostigme inaequalis* (Cooke) Syd.

The asexual form promotes massive multiplication during the entire growing season of the apple and pear trees, having an exclusively parasitic character. It develops upon different organs of the host plant (flowers, fruit, leaves, young branches), organs that it may damage severely. The asexual parasitic form of the fungus is known under the name of *Fusicladium dendriticum* (Wallr) Fuckel and originates in the spring, in a proportion of approximately 90% of the sexual form, respectively *Venturia inaequalis*. The rest of the overwintering source is due to the actual parasitic form, which within reduced limits manages to survive the rigors of winter, either in the form of mycelia, or in the form of conidia, especially in the cracks of the branches.

Disease Symptoms and Development

The fungus may develop on the different components of the floral organs: sepals (most often), petals, ovaries, floral peduncles. The consequence of the infections may be the abortion and the falling of the flowers.

On the growing leaves that are heavily attacked by the fungus, the tissues develop unequally, with deformities; leaves often fall before the end of the growing season. The early falling of the leaves leads to the reduction in nutrition of the tree, which automatically results in less of the fruit crop and the formation of a reduced number of fruiting buds for the following year.

The disease also occurs on the leaves, usually in the form of spots. For the sensitive varieties and in optimum climatic conditions for the pathogen, the apple scab fungus may cover the entire leaf, without a delimitation of the spots; in such situations total necrosis and early defoliation follow.

The fruit is vulnerable to attack from the beginning of their formation to harvest. If they are transported to storage with the conidia, or if they are in contact with affected fruit, the development of the fungus during storage is also possible. Most of the infected fruit, immediately after formation and during the first vegetation period, cannot continue growth and falls off.

In the area of the spots, the pulp of the fruit hardens and stagnates in its growth, which leads to deformation, as a consequence of the unequal growth between the attacked and healthy parts. In the years favorable for the evolution of the fungus, the harvest losses may reach values between 30% and 98%, and what remains is of inferior quality and cannot be stored.

The pathogen may also develop on the branches—the *hyphae* (the fungus filaments) penetrate deep into the cellular layers of the branch. However, the attack on the branches is a scarcer phenomenon and it appears, generally, only on the very sensitive varieties or in uncared-for orchards.

Using the System Against Scab

The damages caused by scab generate important production losses. As a result, there is a general tendency to overutilize the chemical methods against the disease. That means sometimes more fungicides than necessary are used. An efficient fight against the disease can be realized by integrating the observation of three factors: phenology, biologic reserve, and ecology. In the case of the *Venturia inaequalis,* the objectives of the prognosis are:

- The knowledge of the biological reserve of the fungus, the existing reserve in its perfect form in the leaves infected during the autumn of the previous year
- The recording of the evolution of the fungus and of its infectious potential, under the influence of the climatic factors, from the forming of the perithecia to the scattering of the ascospores in the environment

Infection periods and their intensities are detected using the Mills table, with the corrections made by McHardy. The processing begins normally with 1st of January, although this is not an absolute necessity.

After installing the model on all the areas placed in apple orchards, you have to set up, besides the phenological phases, the degree-day option. McHardy and Gadoury (1982) have issued a curve of ascospore maturation, depending on the degree day summation. They found that at about 300 degree days (base 0°C), approximately half of the ascospores are mature.

The next event the model is waiting for is the projection of the ascospores. This follows when a rain of at least 0.2 mm (.01 in) is detected. Having reached this state, the model issues the event *ascospore projection possible* in the Events list and waits for the phenological phase “green buds” to be reached. The order of these events may vary; it is important only that all the conditions are met (green buds and ascospores projection).

The model enters the phase of checking and recording all the infection conditions by using the Mills table. Depending on the leaf wetness duration and the temperature, different infection conditions are detected: light, moderate, or heavy. The interruptions in the leaf wetness duration are ignored if they are less than 8 hours when the RH is under 90% and 48 hours when the RH is over 90%. For longer dry-time periods, the model resumes and waits for a new infection condition.

If the leaf wetness duration is sufficient, an infection condition event is reported, for example, *infection conditions 3 (moderate), 49 hours*. That means it was the third infection condition detected since the season’s beginning, it was a moderate one (as per the Mills table), and the effective Mills duration (without valid leaf wetness interruptions) was 49 hours.

If the infection was moderate or heavy, and no active treatment is ongoing, a warning is issued. Normally, a light infection does not indicate a serious attack, so no warning is issued. However, if you have an extremely sensitive cultivar or a particularly high disease pressure in the orchard (ascertained by the use of spore traps or by close examination of the trees), you should consider the opportunity of a treatment even though the infection was light.

If the event *treatment recommended* is announced in the Events list you have to start treating as soon as possible. You have several fungicides to choose from, but few of them still have a good curative effect after more than 72 hours. After 96 hours, no fungicides can help fight the outbreak.

After each infection condition, the software computes the incubation period. The incubation has no direct influence on the model, but it is provided as supplemental information. If the fungicide used against the disease was systemic, the incubations are terminated; otherwise, they are computed until they reach an end, using the Jones table.

As long as an incubation is active, you will see the Mills-Jones index as a daily event. It tells you how many days the incubation needs if the current temperature conditions remain unchanged. This information may be used to ascertain the next critical period to come (a new massive spore generation).

Following are the five possible outputs of the extension:

- Light infection index
- Moderate infection index
- Heavy infection index
- Cumulative infection index
- Active incubations

The thresholds for the light, moderate, and heavy infection indexes are as follows:

- If the light infection index is greater than 100, conditions have been reached for a light infection.
- If the moderate infection index is greater than 100, conditions have been reached for a moderate infection
- If heavy infection index is greater than 100, conditions have been reached for a heavy infection

The thresholds for a cumulative infection index are as follows:

- If the cumulative infection index is greater than 100, conditions have been reached for a light infection
- If the cumulative infection index is greater than 200, conditions have been reached for a moderate infection
- If the cumulative infection index is greater than 300, conditions have been reached for a heavy infection

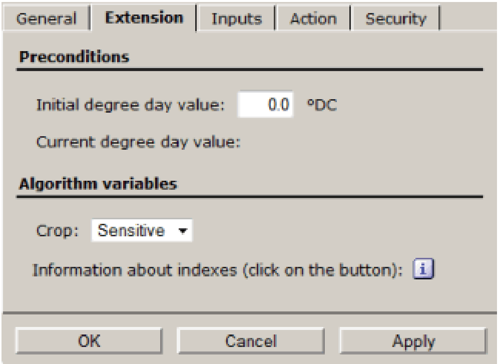
The **Active incubations** output tag provides the number of active incubations at the date of calculation.

Setup and Operation of the Scab Model

Follow these steps to configure the scab disease model:

1. In an Explorer, highlight the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 39*).

Figure 39. Scab Properties Dialog, Extension Tab



Preconditions

Initial degree day value: 0.0 °DC

Current degree day value:

Algorithm variables

Crop: Sensitive

Information about indexes (click on the button):

3. Enter the **Initial degree day value**.
4. Select whether the **Crop** is **Resistant** or **Sensitive** to the disease.
5. Click the **Inputs** tab and make sure all of the extension’s inputs are connected to a valid sensor.
6. Click the **General** tab and make sure the extension is enabled.
7. Click **OK** to accept any changes you’ve made and close the dialog.

Powdery Mildew (KastOiDiag)

The Kast model (*OiDiag*) was developed for apples and grapes and showed good results for the temperate continental regions in Europe. It works in two steps:

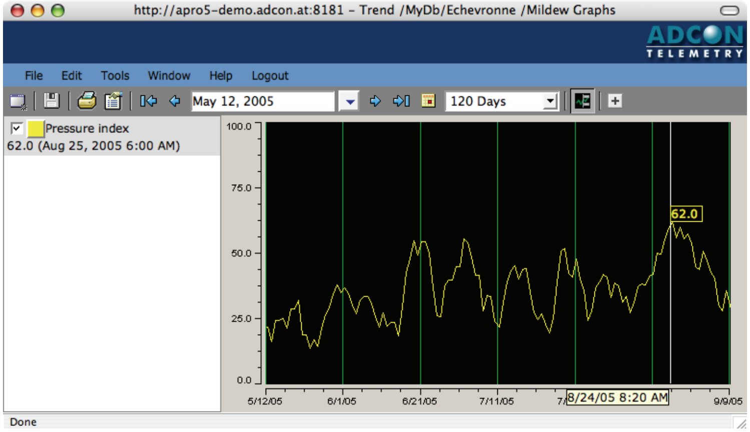
- Predicts the first occurrence of the disease
- Computes an index based on temperature, relative humidity, and leaf wetness (rain or non-rain generated) to obtain the distance between two successive sprays

The approximate first disease occurrence is computed using the minimum temperature over the winter preceding the season and the disease intensity during the previous season. These parameters must be set at the beginning of the current season (see *page 65*). The program issues a preventive warning after the 3 cm leaves phenological phase, but you must determine whether you need to spray at this point.

The index displayed is the average of daily indices calculated for the last seven days. Depending on this index, the coverage of an active treatment is “elongated” or “compressed,” taking as normal value the coverage specified in the chemicals list (for example, the normal duration will be used if the index remains at 100 all the time).

No treatment is issued until the index displayed (that is, the average of indices) surpasses the value of 20. The pressure index can also be displayed and printed graphically, for observations on its evolution over the whole or part of the season (*Figure 40*).

Figure 40. Trend Panel for Powdery Mildew (Kast OiDiag) Index



Apple

The disease was observed for the first time in 1877, in the USA (Iowa) by Bassey. In the USA the area most affected by the disease is the Pacific Northwest, an area in which important damages to the fruit are recorded (Hickey and Yoder, 1991). The powdery mildew may be considered as being present all over the world, wherever apples are grown. Of course, the intensity of the attack is graded from one geographical area to another, depending on the climatic conditions specific to the area and especially on the year (Lazar, 1982; Butt, 1988; Hickey and Yoder, 1991).

Regarding the extensive spreading of the fungus, in general the phytopathologists agree upon the causes:

- The appearance of orchards of an intensive type, which usually include heavy cropping, fertilization, and irrigation
- The use of cultivars characterized by high productivity and quality, and often also by a sensitivity towards the pathogen
- The use of fungicides not specific for the fungus

Disease Symptoms and Development

The disease is specific to the apple tree but the pear tree, admittedly more rarely, can also be attacked (Vukovits, 1976; 1990; Hickey and

Yoder, 1991). For both species various organs are attacked: the buds, the blossoms, the leaves, and the young branches. The fruit is also attacked, but the phenomenon is more scarce and appears only in conditions extremely favorable for the fungus. The *Podosphera leucotricha* fungus is an ectoparasite, its development taking place on epidermal cells. The germination filaments penetrate inside the cells, expand, and form haustoria that absorb the cellular juice (Vonica 1975).

The presence and development of the fungus' mycelium inside the buds leads to the weakening of their vitality. Consequently, a sensitivity to frost is produced, and a certain percentage of buds no longer develops, dries up, and falls off. Certain infected floral buds, even if they do not perish but continue their development, nevertheless ensure the possibility of further development of the fungus.

For the blossoms attacked by powdery mildew, the sepals deform and remain narrow and small. The petals also remain small and narrow, lengthen, and become fleshy, with a tendency of becoming greenish. These blossoms, in a later phase, turn brown, remain sterile, dry up, and fall off.

The attacked leaves are shorter, narrower, rigid, and folded towards the superior side, which gives them a boat-like appearance. On the leaves that are advanced in growth, upon the inferior side, as a consequence of the secondary infections, small, whitish spots appear, which expand with time, occupying large surfaces of the leaf and gradually passing onto a brown or reddish color. Such leaves become rigid, and can also become tattered due to the wind. Finally, the attacked leaves dry up and fall off the branches long before the healthy ones.

The development of the fungus on the shoots has its source either directly from the overwintering mycelium present on the shoots, or following the secondary infections. On the shoots, powdery and white-grayish mycelium forms. On the strongly attacked shoots, a number of leaves larger than the normal ones appear. Some of these leaves are of narrower dimensions, lengthened, and contorted.

The presence of the powdery mildew on the fruit is less common. For the fruit in a more advanced growth stage, the attack is evidenced through the burn produced by the fungus, on the epidermis, in the form of a network of irregular, serous, brown lines. Sometimes, following the secondary infections, the characteristic structure of powdery mildew appears. Respectively, the whitish growth and often the attacked fruit fall off before maturing. The fruit are admittedly less affected by powdery mildew, but due to the attack on the buds, inflorescences, leaves, and shoots, the apple harvest is much diminished.

Using the System Against the Powdery Mildew

The powdery mildew model implemented is a variation of the Kast model, developed for the grape powdery mildew, to which developmental similarities have been observed. The start of the computation is based on the phenological phase "green buds," rather than an estimation based on climatic parameters recorded over winter. However, you should note that temperatures during winter that are under -24°C, due to the destruction of a part of the resistance mycelium, reduce the overwintering reserve for the following spring by approximately 50%. Therefore:

- At temperatures below -24°C, part of the infected buds perish.
- At temperatures below -28°C, all the infected buds are destroyed and, at the same time, the resistance mycelium also perishes.

After entering the active phase, the model computes daily the disease pressure index and uses it to dynamically interpolate the appropriate time span between treatments. You'll see an index value in the Events list every day, showing the actual estimated disease pressure. You can also set up the index to display in graphical form (*Figure 40*) as the extension generates an index tag.

There are several thresholds for issuing warnings, according to the sensitivity of the organs' evolution through various phenological phases.

Grape

The grape powdery mildew (also called *Oidium*) is caused by a fungus that features reproduction of a sexual type, the teleomorphic stage *Uncinula necator* (Schw.) Burr., as well as asexual reproduction, the anamorphic stage *Oidium tuckeri* Bark.

The first appearance of the fungus took place in North America, and it apparently originated in this geographic area. In Europe, the first appearance dates from 1845, in a greenhouse in England, close to the Thames. Later, in 1847, it was also found in a vineyard in France, close to Paris.

Disease Symptoms and Development

The various organs of the vine are affected: leaves, shoots, tendrils, clusters, and berries. The powdery mildew does not produce defoliations to the proportions of that produced by the downy mildew, because, in the case of the first disease, the infections generally have the character of localized foci and do not expand throughout the entire plant, as in the case of *Plasmopara viticola*.

Bud Perennation – Conidial Infections

In the spring, when the shoots have only 3 – 4 leaves, the first symptoms of the attack are recorded. Upon the shoots as well as upon the leaves, mycelia develop from infected buds that generate conidiophores with conidia, which give it the aspect of a gray-whitish growth. Even in this phase of attack, the negative influence upon the growth of the shoots, as well as of the attacked leaves, can be noted. The parts of the plant with powdery mildew infections present a characteristic moldy odor.

Cleisthotecia – Ascospore Infections

In the spring or early summer, when leaves are wet and temperatures are mild for prolonged periods, cleisthotecia that are lodged in the bark release ascospores onto the lower surface of leaves. Isolated infections appear there. Such a phenomenon is still considered to have a lower importance in Europe, but is relatively consistent in the USA.

Following ascospore or conidia infection, a gray-white growth appears. The growth represents the mycelium of the fungus from which the conidiophores with conidia arise. As a consequence to the destruction of the leaf tissues by the fungus' mycelium, distortions of the lamina and leaves appear curl to upwards. The mycelium may also extend and develop on the petioles of the leaves or fruit.

The fungus easily can cover the entire shoot, from the base to the tip. The mycelium growth, bearing conidiophores, takes the shape of slightly visible patches. With the advance in vegetation and lignification of the shoots, the fructifications become more limited and in the attacked area the surface turns brown. Reddish-brown or reddish-black patches on the shoots become obvious.

The infections may appear, sometimes, before bloom. Therefore, the inflorescence may be entirely covered by the mycelium upon which its fructifications appear. In such situations, the inflorescences turn brown, dry out, and fall off. The infections continue on the berries in various development phases. Regardless of the stage of growth or ripeness of the berries, the negative effects acquire economic importance from the moment they are invaded by the mycelium growth. Therefore, we note:

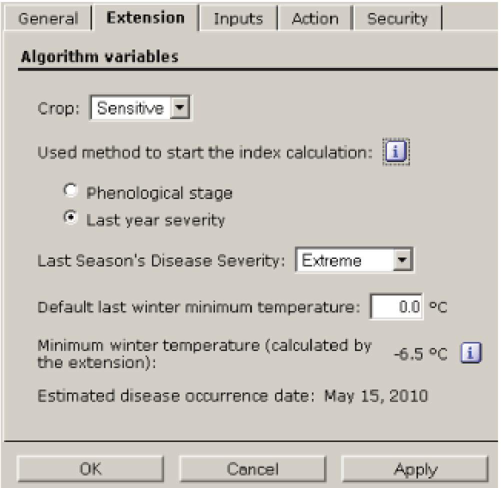
- The reduction or even cessation of the growth of the berries.
- The growth of the pulp volume, the growth of the seeds and, as a consequence, the splitting of the skin of the berries.
- The draining away of the juice as a consequence of splitting, the tendency of the berries to dry.
- The invasion of the berries by certain saprophytic fungi, and in the rainy years even by the parasite fungus *Botrytis cinerea.*
- The appearance of reddish patches on the ripe berries, which leads to their depreciation.

Using the System Against the Powdery Mildew

Powdery mildew has been studied in detail over a long period of years, as well as various methods to optimize the fight against it. Numerous works have been published on the subject (Toma 1964, 1970; Gadoury et al. 1988, 1990; Chellemi et al. 1991; Gubler et al. 1989, 1994; Kast 1991, 1994).

The Kast (OiDiag) model is particularly suitable for the European temperate conditions. You’ll note that you can now choose between two methods for starting the index calculation. Because the model is used for apples and grapes, you can start the calculation based either on the crop’s phenological stage or on characteristics about the previous year’s severity.

Figure 41. Powdery Mildew (Kast OiDiag) Properties Dialog, Extension Tab



Algorithm variables

Crop: Sensitive

Used method to start the index calculation:

○ Phenological stage
● Last year severity

Last Season's Disease Severity: Extreme

Default last winter minimum temperature: 0.0 °C

Minimum winter temperature (calculated by the extension): -6.5 °C

Estimated disease occurrence date: May 15, 2010

As previously explained, it is difficult to model the pathogen itself. By default a **Treatment efficiency** output tag is created. The pressure index helps for a "spray modelization." After you enter a treatment in the database (with a specific duration), the model will "adapt" this duration based on the pressure index value. If the conditions are not favorable to the pathogen, this initial duration will be increased. The maximum duration between two treatment recommendations is set to 21 days by default.

Powdery Mildew (Gubler-Thomas)

The Gubler-Thomas model is used for grapes and strawberries. The model starts at bud break and computes the pressure index until harvest. Right after bud break, the first treatment is issued and simultaneously the index computation is started. The indices are computed once per day, and a corresponding message is inserted in the Events list.

The model observes both the ascospores infections (if the appropriate option was activated) and the conidia infections. The conidial infections are observed based on the rule of at least three consecutive days of at least six hours of temperatures between 21°C (70°F) and 30°C (85°F). The recommended spray intervals are shortened if these conditions remain favorable. The model does not observe the relative humidity conditions, as temperature is considered sufficient to predict secondary infections. If temperatures over 35°C (95°F) are reached, the mildew severity is reduced, leading to a lengthening in the spraying intervals (the index is decreased slightly for each day with maximums over 35°C).

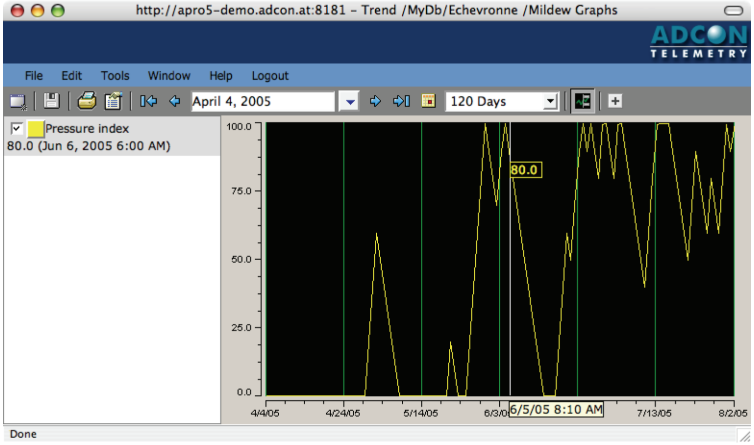
The ascospores infections are observed by using the 2/3 Mills table (used in the apple scab models). If this option is activated, the system will issue warnings for these kinds of infections too. You should determine if such warnings are important for your particular site.

The pressure index can also be displayed and printed graphically, allowing you to observe its evolution over the whole or only part of the season.

You can display and print the risk index graphically as a trend (*Figure 42*), for observations on its evolution over the whole or part of the season.

Field validation studies have shown that the best results are obtained when the sensors are placed as close to the plants as possible in order to get the most accurate model output.

Figure 42. Trend Panel for Powdery Mildew (Gubler-Thomas) Index



http://apro5-demo.adcon.at:8181 – Trend /MyDb/Echevronne /Mildew Graphs

April 4, 2005

120 Days

☑ Pressure index
80.0 (Jun 6, 2005 6:00 AM)

Done

Disease Symptoms and Development

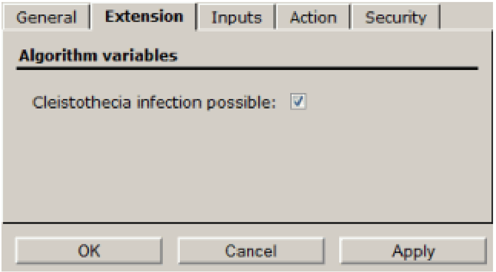
The powdery mildew (*sphaerotheca macularis*) Gubler-Thomas model symptoms first appear as white, powdery-looking patches on the undersides of leaves. As the disease progresses, these patches enlarge to cover the entire bottom of the leaf. Leaf edges commonly roll up at that point. Purple-reddish blotches appear on leaves with older infections. These blotches can appear on either side of the leaves. Infected flowers produce deformed fruit or no fruit at all. Heavily infected flowers can become covered by the fungus and die. Infected green immature fruit can turn bronze, harden, and develop a network of cracks from desiccation as well as have a fine covering of the fungus. Infected ripe fruit look seedy, can develop large cracks, and have powdery, white colonies of the fungus that can produce fungal spores.

The causal organism of powdery mildew can overwinter in the asexual stage on plant refuse. Since the fungal spores are wind dispersed, neighboring fields can be sources of infections. The fungus may also overwinter in the asexual or sexual stage on plants in nurseries. Therefore, new planting material is also a potential source of infection. Dry leaf surfaces, cool to warm temperatures, and high humidity favor infection.

Using the System Against Powdery Mildew

The Gubler-Thomas model was developed for the dry coastal climatic conditions of California.

Figure 43. Powdery Mildew (Gubler-Thomas) Properties Dialog, Extension Tab



Algorithm variables

Cleistothecia infection possible: ☑

The model issues warnings for ascospore infections if the cleistothecia infections option is selected. Ascospore infection conditions are based on average temperatures during extended periods of leaf wetness. A 2/3 Mills Table is used to determine infection risk. In general, at least 12-15 hours of continuous leaf wetness are required when the average temperature is between 10-15ºC.

Conidial infection risk is assessed using a risk index that ranges from 0 to 100. Three consecutive days with at least 6 hours at 21-30ºC is required to trigger the index. The index increases 20 points each day with at least 6 hours at 21-30ºC. The index decreases 10 points on any day with a maximum temperature above 35ºC or fewer than 6 hours at 21-30ºC.

As previously explained, it is difficult to model the pathogen itself. By default a **Treatment efficiency** output tag is created. The pressure index helps for a "spray modelization." After you enter a treatment in the database (with a specific duration), the model will "adapt" this duration based on the pressure index value. If the conditions are not favorable to the pathogen, this initial duration will be increased. The maximum duration between two treatment recommendations is set to 21 days by default.

Bunch Rot (Broome)

Bunch rot is caused by the *Botrytis cinerea* fungus. It appears often in grapes and strawberries.

In grapes, the infections take place on the young shoots of the growing leaves, but the inflorescences, the flowers, floral peduncles, and developing berries are especially affected. Upon these organs the formed spores constitute a reserve and a source for the secondary infections.

CAUTION *The strawberry bunch rot model has been tested only for conditions present in California, USA. Use the model with caution in other areas.*

In strawberries, botrytis fruit rot symptoms are typically restricted to flowers and fruit. Infected flowers can rot before fruit develops or the infection can remain dormant until fruit sugars and environmental conditions favor disease development. Initial symptoms on fruit typically appear on the calyx end of the fruit or on the sides of fruit touching other infected fruit. These lesions can appear on green or red fruit. Lesions initially appear as small, firm, light-brown spots. Lesions sporulate rapidly when conditions are favorable. A velvety, brown coat of fungus rapidly covers the fruit. The fruit eventually mummifies if humidity is not too high.

Disease Symptoms and Development

The disease generated by the *Botrytis cinerea* fungus affects the grape production. Also, the pathogen attacks and damages the graft unions of new grafting stock.

The most damaging is the attack on the fruit. The disease develops on the rachis, berry pedicels, skin, and pulp. For the table varieties much greater damages are recorded than for wine grapes. The fungus is able to develop slowly at 1°C; therefore, table grapes stored at temperatures over 0°C are subject to degradation.

The fungus may also develop on the leaves, a phenomenon more rarely found in nature. When the attack is produced, though, they are characterized by the appearance of spots of variable size, which usually start from the edge of the lamina, extending towards the center. The possibility of the infection evolving from the center towards the edges is not excluded. Initially the spots have a yellowish, chlorotic color, afterwards tending to brick-red. In infected areas, the tissues are necrotic and die; a gray growth forms, consisting of the conidiophores and conidia of the fungus. If the conditions are favorable for the pathogen, the fungus may cover most of the leaf; finally the leaf dries up and falls off the shoot. The attack upon the leaves is important only in that it increases the conidia reserve in nature.

The bunch rot of grapes is a so-called *weak* fungus, because of its relatively reduced penetration capabilities. The penetration points of the pathogen in the different organs of the vine are:

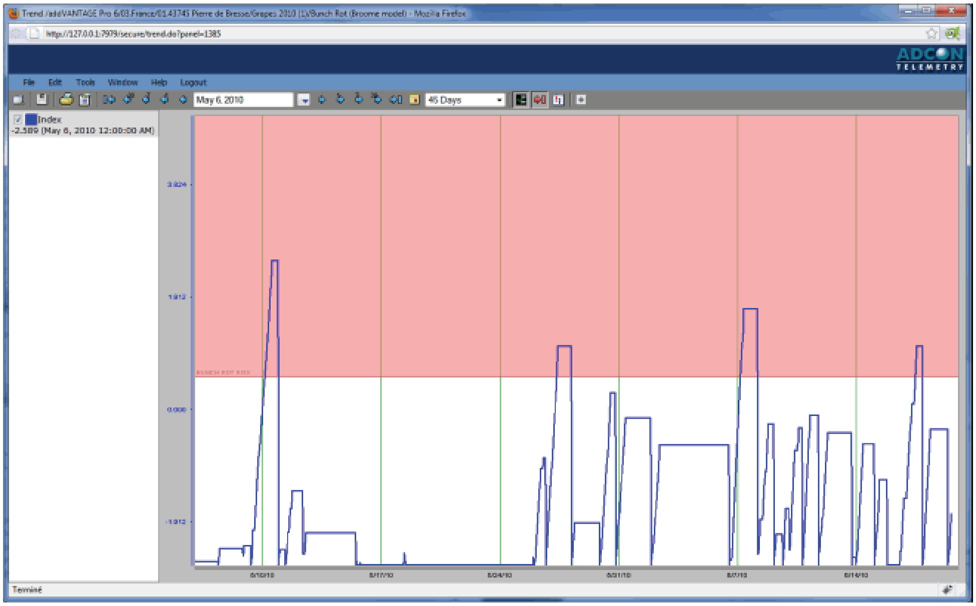
- The lesions produced by the grape moths
- The lesions produced by the downy or powdery mildew
- The mechanical injuries produced by the different labors effected in the vineyard
- The injuries produced by hail
- Flowers

The causal organism of Botrytis fruit rot is typically present in most strawberry fields during the growing season. The fungus survives the off-season in the soil and on plant refuse. It is also capable of surviving on the refuse of many other plant species. Spores on plants can remain dormant for a time or cause immediate infection. Spores that remain dormant can resume activity during the growing season or after harvest on stored fruit. Free moisture and cool temperatures favor development of infections.

Using the System Against the Bunch Rot

The extension implements the model developed by Broome et al. (USA). The Broome model uses a regression to compute a disease index, which serves thereafter to issue warnings. *Figure 44* shows the bunch rot index for grapes in a Trend panel.

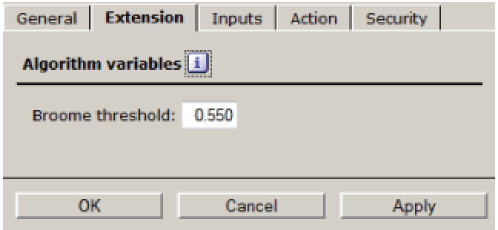
Figure 44. Trend Panel Showing the Bunch Rot Index



The model observes the relationship of the incidence of infection to leaf wetness duration and temperature by means of a multiple regression equation. It initiates the calculation of a disease index whenever leaf wetness is detected. To determine the relative risk of an infection period, the index is compared to some predefined thresholds as follows: under 0.5 – low risk, between 0.5 and 1.0 – moderate risk, and over 1.0 – high risk. Warnings are issued as soon as moderate or heavy risks are recorded. The interruption of the leaf wetness period for more than four hours stops the index calculation.

The model is set by default to trigger an alarm when the index reaches the value 0.55 (0 for Strawberry). You can change this value to suit your particular conditions by altering the respective option in the **Extension** tab of the extension's properties dialog (see *Figure 45*).

Figure 45. Bunch Rot Properties Dialog, Extension Tab



Broome threshold: 0.550

addVANTAGE Pro 6.0 has a new way of computing the index.

When a new infection starts, the initial value of the Broome index is -2.647 (see the references). This value increases with the progression of the infection. If the index values have reached the Broome threshold, an alarm is given.

If an interruption period of the infection occurs (more than four hours without leaf wetness), the Broome index is reset. The previous reset value was 0.

Downy Mildew (Kast PeroDiag)

The downy mildew (*Plasmopara viticola*) Kast PeroDiag model was observed the first time in North America by European colonists, on the wild grape vines, as well as on the cultivated ones. In Europe, it was noticed for the first time in France in 1878 (the Gironde department) by Deluja. The pathogen was brought into the country with the phylloxera resistant root stock material.

In 1879 the newly appeared disease is confirmed to be the downy mildew, caused by the *Plasmopara viticola* fungus. Within two years of being identified, it spread over the whole of Europe. The disease also spread in other continents: South America (Brazil, 1890), Africa (South Africa, 1907), Australia (1916-1917), and New Zealand (1926).

In 1888 Berlese and DeToni established the scientific name that is maintained today: *Plasmopara viticola* (Berk. et Curt.) Berl. et DeToni.

Disease Symptoms and Development

The fungus may establish itself on all the green organs of the vine having stomata: leaves, shoots, tendrils, inflorescences, berries, and clusters.

The leaves are attacked in all phases, from the youngest to the oldest ones. However, the pathogen more easily infects the younger leaves, which are more susceptible; in older leaves, the penetration of the fungus into the tissues is limited and the consequences are less severe. After the infection and towards the end of the incubation period, upon the upper side of the leaves, discoloration spots with a yellow-oily aspect can be distinguished (hence the name of *oil-spots*). In a later phase, specifically after 1 – 2 days, upon the underside of the leaves, a fine white cottony growth appears, representing the sporangiophores and sporangia of the fungus.

Gradually, with the evolution of the disease, the cellular content between the two epidermis layers of the leaf is destroyed by the fungus mycelium. Following the destruction of the tissues, the affected area is subject to necrosis. The necrosed spots grow together, and the leaves finally dry and fall off the shoot. The grape trunk may suffer a partial or total defoliation.

The manifestation of the disease has a negative influence on the healthiness of the entire trunk. Therefore the assimilation surface of the leaves is reduced and, as a consequence, the growth of the shoots decreases, growth is retarded, the berries and the clusters in their ensemble do not develop to their potential in quality or quantity, and the crop suffers a negative influence. Usually, the grape trunks that have experienced a partial or, more seriously, total premature defoliation suffer in the following year, beginning with an increased susceptibility to frost during winter.

The shoots are less affected. When the infection takes place, this occurs in the growth tip areas. The attack may be recognized by the presence of discolored spots, of a more or less elongated shape, upon which a white cottony growth, formed of sporangiophores and sporangia, may appear. The tissues upon which the mycelium has developed turn brown and necrose, the shoot portion curls and dries up, and the shoot is suppressed in its growth.

The tendrils may also be affected; the attack is carried out through a process similar to that of the shoots. Following the attack, marked by the presence of the white cottony growth formed by the conidiophores and conidia, a browning appears, followed by drying up.

The quality of the crop is affected in multiple ways: the sugar content of the berries is much reduced, the alcohol percentage decreases, and acidity increases. The wines produced from the grapes affected by downy mildew are preserved with difficulty as negative phenomena may appear during storage (driveling, cracking, souring, thick vine).

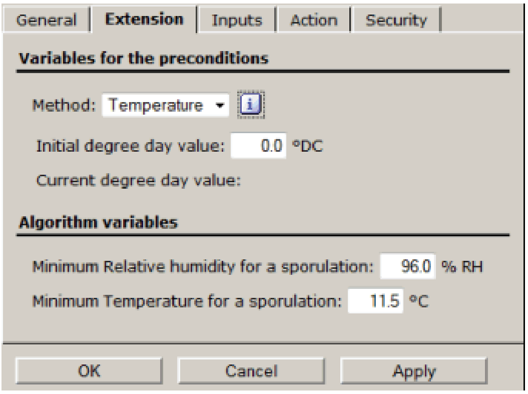
Using the System Against the Downy Mildew

Many researchers worked on the evaluation of optimal methods to fight efficiently against downy mildew (Lalancette et al. 1988, Nieder G. 1992, Bleyer 1993, Hill 1992, Kast 1989, Bläser 1978). The warning for chemical treatments in the rational scientific setting is based most often upon three criteria: ecological, biological, and phenological. The Downy Mildew (Kast PeroDiag) model uses a similar approach by combining the information recorded in the field with the data you supply.

You have three methods for starting the model (see *Figure 46*):

- **Temperature**: Based on the occurrence of a certain degree-day value, computed with a base of 8°C (the default is set for 170 degree-days, computed starting with the first of January),
- **Precipitation**: Based on the first heavy precipitation (more than 10mm of rainfall in 72 hours with an average temperature greater than or equal to 10°C).
- **Combined**: The temperature method is performed first and, if the appropriate conditions are reached, the precipitation method is performed.

Figure 46. Downy Mildew (Kast PeroDiag) Properties Dialog, Extension Tab



Variables for the preconditions

Method: Temperature

Initial degree day value: 0.0 °DC

Current degree day value:

Algorithm variables

Minimum Relative humidity for a sporulation: 96.0 % RH

Minimum Temperature for a sporulation: 11.5 °C

The weather station has to be near but outside the field. The leaf wetness sensor has to be at the same height of the leaves (but not inside the field).

When the limit is reached, the model assumes the possibility that primary infections might occur. The importance of this option is minimal, because the exact outbreak of the primary infections is of little importance. The literature offers different opinions on this subject, so your decision should be based on the local conditions and experience.

The first information issued by the model is *oospores germination possible*. This occurs if the temperature was constantly over 10°C and the total recorded rain was over 10 mm in the last 72 hours. However, this information is not provided if the option to compute the degree-days is used. Instead you will get the *infections possible* message after the specified degree-days limit was reached.

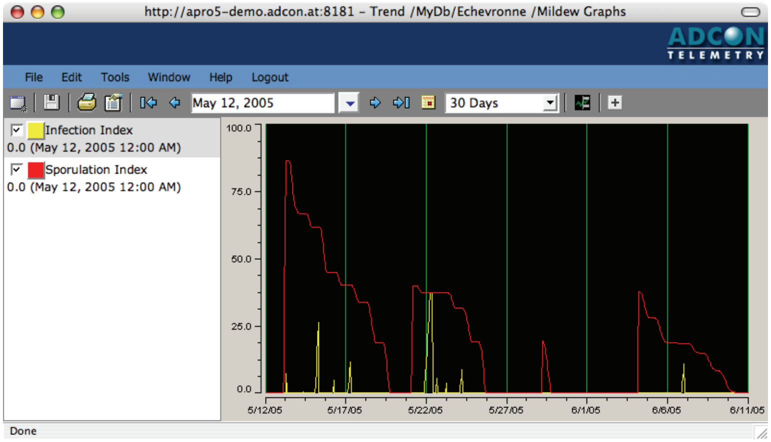
If the specified conditions are met, the model waits for the primary infection conditions, which are computed based on the equations developed by Dr. Kast and used with permission from his original *PeroDiag* model. To be valid, at least the phenological phase, 3 cm leaves must be reached. If all these parameters are met, either day or night, the *primary infection conditions* message is displayed in the Events list.

The model starts computing the incubation according to the Müller table. You can see its daily evolution by observing the event *incubation xx% done*. In the Events lists, you can see that two different events are reported: the incubation duration and the actual stage of the incubation. The incubation process stops when the temperature is outside the Müller table (less than 10°C or greater than 30°C), but it will resume when the conditions are again favorable.

Note: *If the conditions are appropriate, you can have more incubation events running in parallel. All the incubation periods will be shown in the Events list.*

From this point forward, the model constantly computes the sporulation and the infection indices according to the *PeroDiag* equations (the indices are also viewable as trends). *Figure 47* shows a raw data graph with downy mildew information.

Figure 47. Downy Mildew (Kast PeroDiag) Indices in a Trend Panel



http://apro5-demo.adcon.at:8181 – Trend /MyDb/Echevronne /Mildew Graphs

May 12, 2005

30 Days

☑ 🟨 Infection Index
0.0 (May 12, 2005 12:00 AM)

☑ 🟥 Sporulation Index
0.0 (May 12, 2005 12:00 AM)

Done

How the Warnings are Generated

Although Kast recommends a strategy based on both climatic parameters and observation of the disease, the Adcon implementation of the model is somewhat simplified in that it does not account for the plant – pathogen interaction. This is due to the difficulties associated with entering subjective data into the program. Therefore, after explaining how the warnings are issued, we'll cover Kast's strategy, which Adcon strongly recommends that you follow.

The model issues a warning if all of the following are true:

- At least one incubation ended successfully (no treatments).
- The infection index is greater than 0.
- The sporulation index has always been greater than 0 since the last incubation ended.
- The phenological phase is between prebloom and 3 weeks preharvest.

- No treatment is currently active.

Additionally, preventive warnings are issued for sensitive cultivars when the first secondary infection condition is reported, as well as when reaching the prebloom phenological phase.

This loop continues until the end of the vegetation (3 weeks preharvest). Since this process happens only when the right conditions for the fungi are present at the right time, you might have some opportunities for spray reduction.

Normally the primary infections have a reduced importance, so the model issues only a preventive treatment recommendation for sensitive cultivars. Reports from some researchers, notably in Germany, have stated that treating against primary infections may drastically reduce the initial inoculum and lighten the mildew pressure throughout the season. The model recognizes the primary infections and gives the appropriate message (*primary infection conditions*), so if you find that treatments are necessary at this stage based on your experience, you can apply a treatment.

If no treatment was executed two weeks before bloom time, the model recommends a preventive treatment. You have to weigh the necessity of such a treatment, based upon the conditions in the vineyard, the cultivar sensitivity, and whether the mildew pressure is already high, against the known sensitivity of the vine during the bloom period.

The Kast Strategy

Kast recommends that you periodically check the number of spots on the grape leaves in the field, especially when the infection index is greater than 0. Use Table 1 to determine the appropriate measures to be taken:

- A preventive treatment is executed at the end of the first incubation following the warning.
- A curative treatment is executed in the first three days after the warning.

Table 1. Measures to Take for Grape Downy Mildew

	Spots per leaf	Infection index	Action
Before veraison	none	greater than 0	preventive
	less than 5	less than or equal to 50	preventive
	less than 5	greater than 50	curative
	greater than or equal to 5	greater than 0	curative
After veraison	less than 25	greater than 0	preventive
	greater than or equal to 25	greater than 0	curative

Note: *In this context, you must understand that a warning was not issued by the software but was a result of your findings based on the above table.*

A new output tag is now available. The **Active incubations** output tag provides the number of active incubations at the date of calculation.

Downy Mildew (Lettuce Model)

Western Farm Service, in cooperation with the California Lettuce Research Board, developed the lettuce downy mildew extension. The model has been validated in the Central California coastal region and in the Yuma, Arizona area. Environmental and crop management factors affecting disease development have been included in the model. Key among these factors is the role of irrigation in the disease cycle. Users are able to enter the type of irrigation used—sprinkler, furrow, drip, buried drip. The model accounts for the differing effects of these irrigation methods on pathogen and disease development. There is also an option to use soil moisture sensors for detecting irrigation and rain events.

CAUTION *The lettuce downy mildew model has been tested only for conditions present in California, USA. Use the model with caution in other areas.*

Disease Symptoms and Development

The disease (*Bremia lactucae*) normally appears first on older leaves. Light green to yellow spots appear on the upper surfaces of leaves, while white downy fungal growth appears on the lower surfaces. The lesions are interveinal, giving them an angular appearance as they grow. Affected portions of the leaves turn brown and eventually die. Leaves with numerous lesions may die. Occasionally, the infection may become systemic, resulting in darkening of stem tissue.

Bremia lactucae does not seem to survive in the soil. Disease onset appears to begin following the wetting of soils and/or extended periods of leaf wetness starting at **ten days prethin**. Cultivated lettuce, the main host of the fungus, is the likely source of new infestations. Wild lettuces can, however, also serve as hosts. The disease can be introduced from transplants. Cool damp conditions are conducive to the spread of the disease. Fungal spores are spread by wind. Leaf wetness is required for fungal germination and infection of leaves. Moisture is not required for development of the disease once a plant is infected. Drying winds and hot conditions can slow the development and spread of downy mildew.

Model Operation

The model begins calculating downy mildew disease index points when the phenological phase ten days prethin is reached. The software automatically moves the phenological phase to **thinned** once ten days have passed. Index points start to accumulate when irrigations occur or when more than 0.05 inches of precipitation is detected. The number of points accumulated is based on the crop phenological phase and the type of irrigation. Index points can also be accumulated when leaf wetness is detected during morning hours without concurrent irrigation or precipitation. Nighttime winds over 3 mph/ 4.8 km/hr and/or high daytime temperatures (greater than 80ºF/ 26.6ºF) result in disease index points being subtracted.

Field Setup

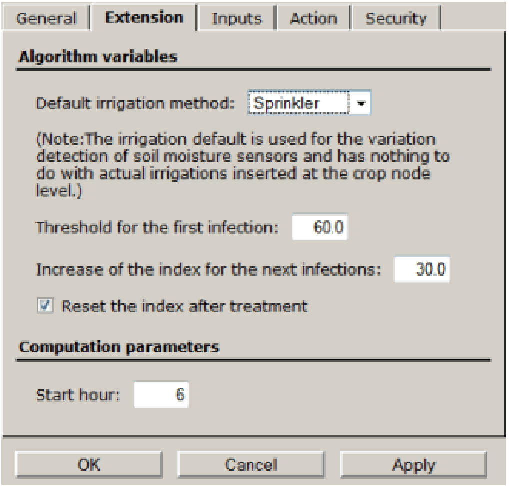
This model has been validated using stations placed both within and outside the crop. Placing the station within the crop appears to increase the accuracy of the model somewhat, but this difference has not been critical. If the station is located outside the crop, place it as close as possible to the field and in conditions as similar as possible to those in the field. Place the combined sensor temperature/RH no more than 1 ft/30 cm from the ground. Place the wind speed and direction sensors approximately 8 - 9 ft/2.5 m above the seedbed. If you use soil moisture sensors, place them in the seedline at a depth that will permit them to detect soil moisture increases from irrigations. Field studies have been conducted successfully with two Watermark sensors placed horizontally at a depth of 2 in/5 cm and with the third sensor placed vertically with the base of the sensor at 6 in/15 cm.

Setup and Operation

Follow these steps to configure each area where you plan to use the extension:

1. In an Explorer, highlight the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 48*.

Figure 48. Downy Mildew (Lettuce) Properties Dialog, Extension Tab



Algorithm variables

Default irrigation method: Sprinkler

(Note:The irrigation default is used for the variation detection of soil moisture sensors and has nothing to do with actual irrigations inserted at the crop node level.)

Threshold for the first infection: 60.0

Increase of the index for the next infections: 30.0

☑ Reset the index after treatment

Computation parameters

Start hour: 6

3. Select the **irrigation method** used in the lettuce field.

4. Enter a number to represent the **Threshold for the first infection**.
5. Enter a percentage for the **Increase of the index for the next infections**.
6. Select the checkbox if you want to **Reset the index after treatment**.
7. Enter the **Start hour**.
8. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.
9. Click the **General** tab and make sure the extension is enabled.
10. Click **OK** to accept any changes you've made and close the dialog.

The extension will generate an output tag called *Accumulated index* that can be viewed in a Trend panel; in addition, the index will be followed as a daily event.

Daily Operation

Following are things you need to do every day:

- Check the raw data to make sure all the data has been downloaded for each RTU.
- Check the Events list for each station. Make sure to thoroughly check and identify any warnings in the controlled areas.
- If an alarm is displayed, enter a chemical treatment, treatment date, and details.
- Enter all treatments into addVANTAGE within the control duration of the treatment.

If you enter irrigation information manually, be sure you enter irrigations the day they occur so as to reflect the proper point values in the mildew index. Use the **Irrigation** tab on the crop's Properties dialog to enter the irrigations.

Note: *You can enter irrigation information into the extension throughout the season. It is critical for proper functioning of the model, however, that user-defined irrigations be entered into the extension with proper application dates, times, and methods before they actually occur. If this is not done, the correlation between the disease index and conditions in the field will be compromised.*

The Model considers these factors for irrigation:

- Soil sensors (WaterMark, Tensiometers, C-Probe....). When a variation of the values is detected but no rain has occurred, the Model assumes that an irrigation took place.
- Irrigation entered manually in the irrigation tab of the crop.

These factors are complementary.

Downy Mildew (Hop Model)

The downy mildew of hop is an infectious disease that has the fungus *Pseudoperonospora humuli* (Miy et Tak.) Wilson as the pathogen agent.

The disease is widespread in all the countries in which hops are cultivated. The fungus was observed for the first time in 1905 in Japan, by Miyabe and Takahorhi, and it was later recorded in the USA (Davis, 1908). In Europe the presence of the pathogen was noticed in 1920 (in England).

Disease Symptoms and Development

The first symptoms of the attack are recorded during spring even from the beginning of growth of the hop plants—infected shoots spring out from the stems infected during the autumn. Characteristics are:

- The appearance of the “cereal spike” shaped shoots
- The shortening of the internodes of the canes
- The discoloration of the shoots to grayish-green
- The limiting of the growth of the leaves, their twisting and crowding in bunches at the top end of the cane (hence the name of “cereal spike” shaped)

The following symptoms are a consequence of the aggravation as a result of the succession or even superposition of the infections:

- The growth in length of the infected shoots is limited.
- The attacked shoots turn brown and eventually die.
- The affected canes develop inflorescences slowly and infrequently; such inflorescences have browned bracts and finally dry out.
- The attacked shoots develop few to no cones. The cones that do appear turn brown, dry out, and fall off.
- The attacked cones, even if they do not dry out, lose weight, reduce their contents in alpha acid, which causes a bitter taste of the beer and damages its preservability.
- The stem thickens, hindering and even shortening its ramification.

The infections on the leaf, which during full vegetation of the hop plant primarily ensure the biological reserve of the pathogen, have the following characteristics:

- Certain irregular, angular spots appear in the vein area.
- The hop plant attacked by *Pseudoperonospora humuli* presents spots that have on the underside a violet downy mass and on the upper side a green-yellowish color.
- The tissues in the contaminated area are destroyed and, as a consequence, both sides of the leaf turn brown. Later, in the respective area, the leaves become crumbly and dry up in the end.

The literature mentions (Smith et al. 1988) that the losses due to the downy mildew alone in Germany surpassed 30 million German Marks in 1926. In the USA the damages produced by the fungus led to a change in the strategy of hop growing by moving it from areas with heavy rainfalls to states with a more arid climate like Washington and Idaho.

Using the System Against the Downy Mildew (Hop)

The current model implementation is based on a multiple regression analysis equation derived experimentally and published by Royle and Kremheller (1975, 1979). Alternatively, the use of spore traps, where available, may improve the quality of the warnings.

The model observes the leaf wetness caused by rain and the daytime temperature. Dew has no effect on the model. According to Royle and Kremheller (1981), dew is thought to be inefficient for three reasons:

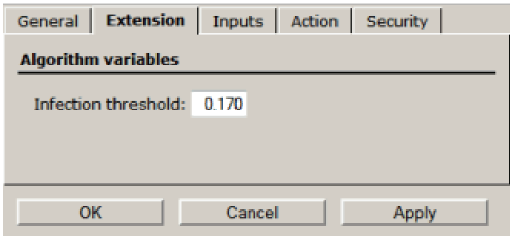
- Dew starts to form in the dark when zoospores do not respond to stomata.
- Inoculum that is splash-dispersed by rain dries after daily release.
- Longevity of dry-deposited inoculum is reduced during the interval between release and wetting by dew, especially in the dry weather commonly associated with dewy nights.

Setup and Operation

Follow these steps to set up the Hop downy mildew extension on an area:

1. In an Explorer, highlight the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 49*.

Figure 49. Changing the Default Infection Threshold



Infection threshold: 0.170

3. Enter the **Threshold**.

   The index may take values between -0.2 and 1.0, where negative values mean virtually no risk while 1 represents an extremely high infection potential.
4. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.
5. Click the **General** tab and make sure the extension is enabled.
6. Click **OK** to accept any changes you've made and close the dialog.

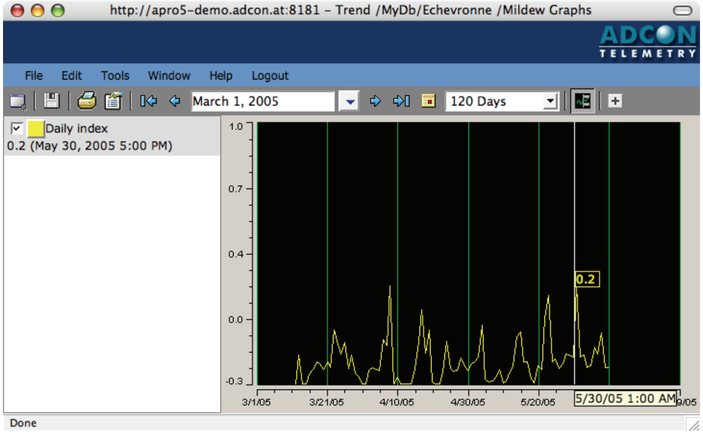
The model starts computing an index each day, searching for rain-generated leaf wetness, as soon as the phenological phase **First pair of leaves unfolded** is reached. The index is recorded in the events list every day. As soon as the preset threshold is reached, and if during the last 24 hours the temperature average was over 8°C and no maxima over 29°C were recorded, a treatment warning is issued.

If a warning is recorded, a treatment should be performed as soon as possible. When assessing the necessity of a treatment, as previously mentioned, spore traps may be very helpful in evaluating the existing airborne reserve.

You can display and print the index graphically as a trend (see *Figure 50*), for observations on its evolution over the whole or part of the season.

Note: *The station has to be outside the field with sensors at the standard 2 m height. The leaf wetness sensor has to be at the same height of the leaves.*

Figure 50. Downy Mildew (Hop) Index in a Trend Panel



http://apro5-demo.adcon.at:8181 – Trend /MyDb/Echevronne /Mildew Graphs

March 1, 2005

120 Days

☑ Daily index
0.2 (May 30, 2005 5:00 PM)

Done

During the season, check the software daily. If a treatment recommendation is issued, assess its necessity. Having spore traps installed in the field can make your decision easier. Do not leave a warning uncared for because the model virtually stops (no more warnings will be issued). You must either treat or use the **Ignore warning** facility (see *"More about Treatments" on page 17*).

Hop Powdery Mildew

From Oregon State University:

http://plant-disease.ippc.orst.edu/disease.cfm?RecordID=603

Cause

Powdery mildew is caused by a fungus, *Podosphaera macularis* (formerly *S. humuli*), which can persist either as bud infections or as chasmothecia (formerly cleistothecia, sexually produced overwintering structures).

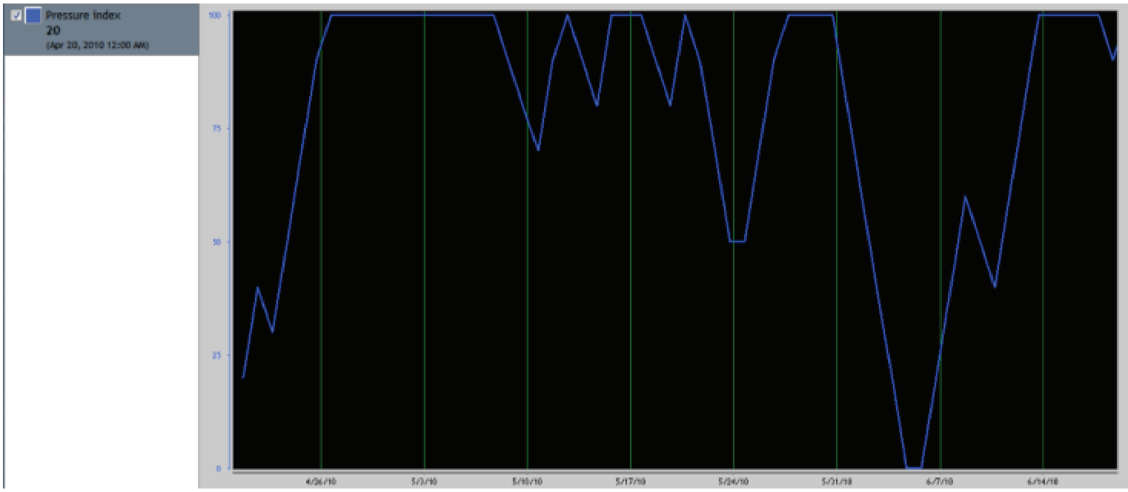
Once a yard is infected with powdery mildew, the disease usually reoccurs the following season. Spore movement within the field is the greatest threat for disease spread but some spread will occur between fields.

Symptoms

In the spring time, new shoots can be covered with the powdery mildew fungus and the entire shoot might appear white. These “flagshoots” produce conidia that initiate secondary infections. Secondary infections on susceptible leaves appear as whitish, powdery spots on either the upper or lower leaf surface. Entire leaf surfaces can be covered with powdery mildew. Depending on the hop variety and leaf age, initially a small blister might form before observation of the fungus. The fungus becomes visible as conidia (spores) are produced, around 5 to 10 days after infection.

Younger leaves are the most susceptible because it is more difficult for infection to occur as the leaf matures. Flowers and cones can be infected in susceptible varieties. If a variety is susceptible, cones appear to be susceptible to infection throughout most of their development. Generally, growth stops in the infected area. Infected cones are stunted, malformed, and mature rapidly, leading to cone shatter and uneven crop maturity. Infections at the burr stage can lead to flower abortion. Powdery mildew usually is visible on infected cones but sometimes can be found “hiding” under overlapping bracts. Infected areas on cones become red to blackish if chasmothecia are produced.

Figure 51. Powdery Mildew (Hop) Index in a Trend Panel



Note: *This extension provides no treatment recommendations and has no options. The extension only gives a pressure index.*

Late Blight

The disease *Phytophtora infestans* (Mont.) deBary originated in South America; its penetration into North America and in Europe apparently took place approximately in the same period, namely, the first half of the 19th century.

addVANTAGE Pro 6.0 has the following three disease models for Late Blight:

- Ullrich-Schrödter
- Ullrich-Schrödter (modified)
- Winstel

The Ullrich-Schrödter models affect only potatoes, while the Winstel model affects both potatoes and tomatoes. The models are discussed separately below. All models have their merits and you should use the one that has given best results under your conditions. Alternatively, you can run the Ullrich-Schrödter and Winstel models in parallel (e.g. by creating a second area and using the same input tags).

Disease Symptoms and Development for Potatoes

Late blight affects the leaves, shoots, stems, and plant tubers. Nevertheless, two aspects are evident:

- The attack on the aerial parts may cause, in the favorable years and in the absence of an efficient protection, the premature drying up of the foliage, shoots, and stems, causing a drastic reduction of the crop.

- The attack on the tubers leads to losses and difficulties during storage as well as to the supply of the primary infections for the following year.

The disease symptoms are much more obvious and easy to recognize on the leaves. The fungus, by developing its mycelium, destroys the tissues completely. Consequently, the initial spots turn brown and the areas in which the tissues have been destroyed eventually die.

The infections on the shoots and stems develop similarly to the leaf infections. They appear as yellow spots that eventually turn brown.

In the initial phase of the attack, the contaminated tubers are similar in appearance to the healthy ones. Later, though, as the disease advances, the surface of the tubers develops brown or grayish-brown spots of various sizes with slight depressions.

The infection of the tubers takes place in the field, but the healthy potatoes can also be contaminated by the infected potatoes during storage. Storage at a temperature over 4°C and humidity of over 70% favors the development of the blight as well as contamination of various bacteria of the infected potatoes.

Disease Symptoms and Development for Tomatoes

Tomato late blight affects leaves, shoots, stems, and fruit. Symptoms on leaves initially appear as irregular water-soaked patches. Those areas enlarge and become brown and papery. A ring of grayish-white mildew may appear on the lower leaf surface under these spots. Entire leaves may die. Infections on shoots have a similar development to those on leaves. Infections on fruit appear as large, irregularly shaped, greenish-brown lesions. Fruit lesions remain firm and have an oily appearance. Secondary infections on fruit, particularly rots, may affect the appearance of the fruit.

Tomato late blight can develop over a wide temperature range, i.e. 6°C to 30°C (43°F to 86°F). Leaf wetness or high humidity is required for infection. The disease has a short incubation time, which allows epidemics to develop rapidly.

Model Descriptions for Late Blight

The following sections describe the three methods used for the late blight disease model.

The Ullrich-Schrödter Model

The Ullrich-Schrödter method is relatively well known and described in the literature. Many authors report good results in using it to anticipate the first outbreak of the disease (Winstel 1992, Schiessendoppler 1992, Faber 1993, Lücke 1993). An extension to the original model was proposed by Hansen, who tested a combination of the Ullrich-Schrödter model to predict the first outbreak and the Fry et al. model (1983) for the rest of the vegetation period. Basically, the Fry method computes the daily indices using the same table from Ullrich-Schrödter (1957) to assess the short- and long-term evolution of the disease pressure.

The model starts after activating the phenological phase **Emergence**, when it starts to compute the daily index using the Ullrich-Schrödter table. By using this index, the model assesses the period of time when no infection of economic importance can occur (hence the *negative forecast* term used in conjunction with this model).

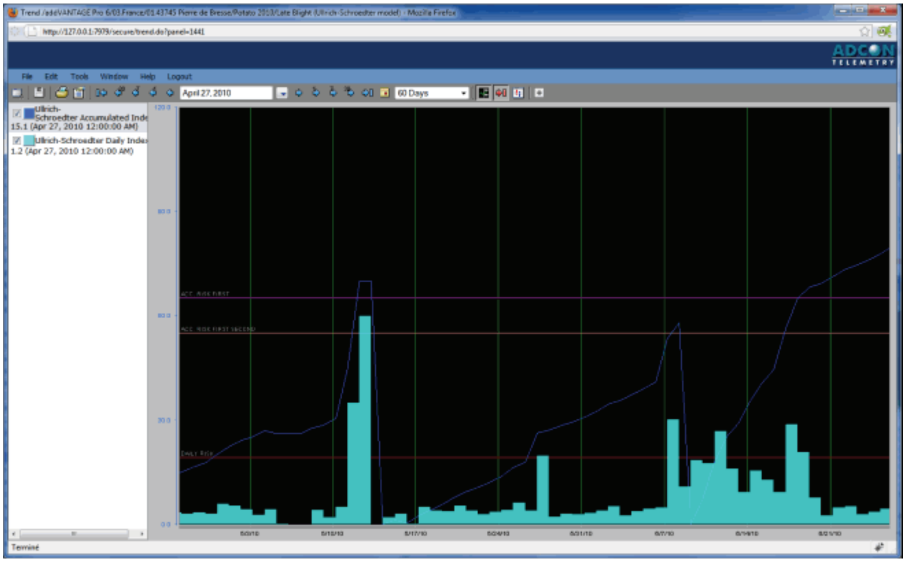
After enabling the model, the event *Potato blight – Ullrich-Schrödter index x*, where x is the actual index, is generated daily in the Events list. The index is the result of an elaborate equation based on the relative humidity and temperature. The values are totaled to give the index since emergence. Ullrich and Schrödter stated that significant losses can’t occur before the index’s sum reaches the value 160.

The model was used with success in many places; however, some users have adapted this limit to the local conditions. The default value in the current implementation is 160, but you can change it by altering in the extension’s Properties dialog box as described above.

After the critical value is reached, a warning is issued the very first day when a rise of at least 8 units/day is recorded. If a treatment is applied, the index is reset to zero and the system issues warnings based on the Fry at al. method. The same index using the Ullrich-Schrödter table is computed, giving a daily index. This index is compared against the default limit values, depending on the sensitivity of the cultivar. If the limits are exceeded and the daily index has a value of at least 8, a new warning is issued. If a treatment is applied, the index is again reset and the cycle starts over. You can also change these limits via the extension’s Properties dialog box.

You can display and print the Ullrich-Schrödter index graphically in a Trend panel (*Figure 52*), for observations on its evolution over the whole or part of the season.

Figure 52. Potato Blight Indices in a Trend Panel (Ullrich-Schrödter)



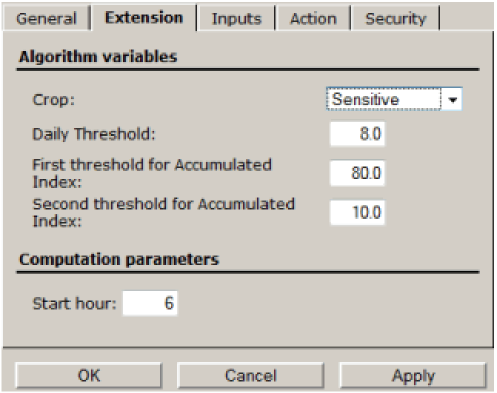
If the user must enter irrigation information manually, this parameter must be entered the day of the irrigation to reflect the proper point values in the Ullrich-Schrödter index. This is done via the extension’s Properties dialog box, the **Irrigation** tab. Depending on the irrigation type, the model might interpret it with its equivalent in natural precipitation and consequently issue a washoff warning. Only the irrigation type **Sprinkler** has such an effect.

Setup and Operation

Follow these steps to set up the disease model on a crop:

1. In an Explorer, select the disease model and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 53*.
3. Select the sensitivity level for the **Crop**.
4. Adjust the **Daily Threshold**, as needed.
5. Adjust the **First** and **Second** thresholds, as needed.
6. Enter the **Start hour**.
7. Click the **Inputs** tab and make sure all of the extension’s inputs are connected to a valid sensor.

Figure 53. Late Blight (Ullrich-Schrödter) Properties Dialog, Extension Tab



Algorithm variables

Crop: Sensitive

Daily Threshold: 8.0

First threshold for Accumulated Index: 80.0

Second threshold for Accumulated Index: 10.0

Computation parameters

Start hour: 6

8. Click the **General** tab and make sure the extension is enabled.
9. Click **OK** to accept any changes you've made and close the dialog.

Changing the Hour of Computation

Note: *In the original US model, the hour of computation was set at 6:00 AM. You can now change this default.*

You can now set the hour of computation. Adcon allows this action to help you to avoid an issue some users have found in this extension. This extension computes daily and does not store the state at the end of each computation. This means that all daily computations are independent of the previous ones. For example:

- A dew period starts at 2:00 AM and stops at 10:00 AM. If the calculation start hour is 6:00 AM, the dew period is split between two days of computation:
  - On day *d*, the period from 2:00 AM to 6:00 AM is counted.
  - On day *d+1*, the period from 6:00 AM to 10:00 AM is counted.

With such a computation, the considered periods are probably not long enough to provide a risk of infection.

However, if you set the calculation hour to 10:00 AM, the complete dew period is counted (from 2:00 AM to 10:00 AM), and the dew period is long enough to provide an infection risk.

To determine the best hour for the computation, determine when the morning dew period usually stops in your area (RH< 90% or LW < 3). For example, if the morning dew period stops at 6:00 AM, set the hour of computation to 7:00 AM.

This problem does not occur in Late blight with the Ullrich-Schrödter modified model because Adcon stores the status of the various parameters at the end of the extension. With the modified model, you can also make computations several times per day.

Ullrich-Schrödter Model (Modified)

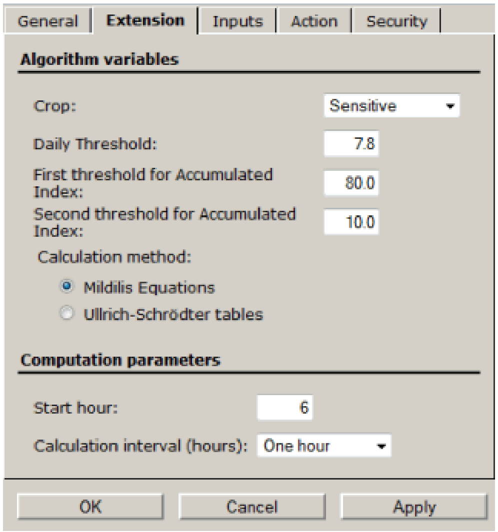
The Ullrich-Schrödter Model (modified) is a variation of Ullrich-Schrödter that allows:

- more than one calculation per day
- Mildilis equations instead of the Ullrich-Schrödter tables

Follow these steps to set up the disease model on a crop:

1. In an Explorer, select the disease model and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 54*.

Figure 54. Late Blight (Ullrich-Schrödter Modified) Properties Dialog, Extension Tab



Algorithm variables

Crop: Sensitive

Daily Threshold: 7.8

First threshold for Accumulated Index: 80.0

Second threshold for Accumulated Index: 10.0

Calculation method:

● Mildilis Equations

○ Ullrich-Schrödter tables

Computation parameters

Start hour: 6

Calculation interval (hours): One hour

3. Select the sensitivity level for the **Crop**.
4. Adjust the **Daily Threshold**, as needed.
5. Adjust the **First** and **Second** thresholds, as needed.
6. Select whether to use the **Mildilis Equations** or the **Ullrich-Schrödter tables**.
7. Enter the **Start hour**, that is, the hour of the day to start calculation.
8. Select the **Calculation interval** to indicate how frequently you want to run the calculation.
9. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.
10. Click the **General** tab and make sure the extension is enabled.
11. Click **OK** to accept any changes you've made and close the dialog.

The Winstel Model

Note: *The tomato late blight model has been tested only for conditions present in California, USA. Use the model with caution in other areas.*

Although in general the negative forecast had shown good results, there were some cases where the disease outbreak occurred earlier than this method predicted. Therefore, Winstel (1992) developed an alternative model, based on long-term observations over several seasons, analyzing the correlation between temperature, humidity, leaf wetness, and the first disease manifestation. The current model implementation follows the basic rules to identify the Winstel events (called by the author *event A* and *event B*). Moreover, it brings an extension to the model in that it applies the same rules not only to identify the first critical phase of the season, but also to issue warnings throughout the whole growing season.

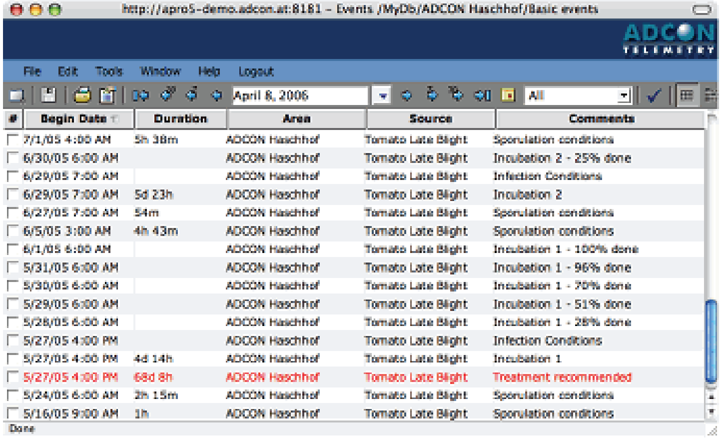
The model starts after the emergence phase is activated, and it tries to detect the Winstel event A, which is defined as at least 10 hours with temperatures over 10°C and relative humidity over 90%, or leaf wetness. If such an event is detected, the next step is to detect the Winstel event B, defined as at least two successive days with maximum recorded temperatures between 23°C and 30°C. The B event must happen at least 24 hours from the A event, but not later than 10 days after an A event.

The model permanently searches for events of the A type, but the B type is cared for only if there is at least one active A event. After the successful detection of a A event – B event sequence, the model issues a treatment warning.

Thereafter, an incubation is activated and calculated using the standard Mueller incubation table. The incubation has only an informative value because it generates no change in the algorithm’s functionality. If a treatment is applied, the model enters into the controlled phase, but still looks for A and B events. The A events are displayed always, even during the controlled state, for information. In any case, the presence of such an event, outside the controlled period, signals that an infection could occur in the next several days if the climatic conditions are appropriate.

Figure 55 shows a list of Late Blight Events for the Winstel model.

Figure 55. Winstel Late Blight Events List



http://apro5-demo.adcon.at:8181 – Events /MyDb/ADCON Haschhof/Basic events

#	Begin Date	Duration	Area	Source	Comments
☐	7/1/05 4:00 AM	5h 38m	ADCON Haschhof	Tomato Late Blight	Sporulation conditions
☐	6/30/05 6:00 AM		ADCON Haschhof	Tomato Late Blight	Incubation 2 - 25% done
☐	6/29/05 7:00 AM		ADCON Haschhof	Tomato Late Blight	Infection Conditions
☐	6/29/05 7:00 AM	5d 23h	ADCON Haschhof	Tomato Late Blight	Incubation 2
☐	6/27/05 7:00 AM	54m	ADCON Haschhof	Tomato Late Blight	Sporulation conditions
☐	6/5/05 3:00 AM	4h 43m	ADCON Haschhof	Tomato Late Blight	Sporulation conditions
☐	6/1/05 6:00 AM		ADCON Haschhof	Tomato Late Blight	Incubation 1 - 100% done
☐	5/31/05 6:00 AM		ADCON Haschhof	Tomato Late Blight	Incubation 1 - 96% done
☐	5/30/05 6:00 AM		ADCON Haschhof	Tomato Late Blight	Incubation 1 - 70% done
☐	5/29/05 6:00 AM		ADCON Haschhof	Tomato Late Blight	Incubation 1 - 51% done
☐	5/28/05 6:00 AM		ADCON Haschhof	Tomato Late Blight	Incubation 1 - 28% done
☐	5/27/05 4:00 PM		ADCON Haschhof	Tomato Late Blight	Infection Conditions
☐	5/27/05 4:00 PM	4d 14h	ADCON Haschhof	Tomato Late Blight	Incubation 1
☐	5/27/05 4:00 PM	68d 8h	ADCON Haschhof	Tomato Late Blight	Treatment recommended
☐	5/24/05 6:00 AM	2h 15m	ADCON Haschhof	Tomato Late Blight	Sporulation conditions
☐	5/16/05 9:00 AM	1h	ADCON Haschhof	Tomato Late Blight	Sporulation conditions

Done

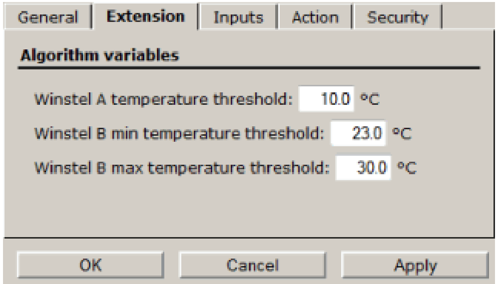
The model requires a combination sensor (temperature, relative humidity, leaf wetness) placed two meters high. In California, where moisture levels are often higher at ground level than at two meters, the model has worked well with the combo sensor placed at canopy height. Consult local recommendations to determine the appropriate placement for specific sites. Be sure that the combination sensor is out of direct sunlight, away from spray strips, and relatively free of the canopy. Do not let leaves lie on top of the leaf wetness sensor. Place the precipitation sensor so that overhead objects do not interfere with the collection of rainfall.

Note: *Do not let a warning go uncared for because the model virtually stops (no more warnings will be issued). You either have to treat or use the "Ignore warning" facility.*

Follow these steps to set up the disease model on a crop:

1. In an Explorer, select the disease model and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 56*.

Figure 56. Late Blight (Winstel) Properties Dialog, Extension Tab



Algorithm variables

Winstel A temperature threshold: 10.0 °C
Winstel B min temperature threshold: 23.0 °C
Winstel B max temperature threshold: 30.0 °C

3. Adjust the **temperature threshold**, as needed, for Winstel event A and Winstel event B.

You'll be able to view trends between event A and event B.

4. Click the **Inputs** tab and make sure all of the extension's inputs are connected to a valid sensor.
5. Click the **General** tab and make sure the extension is enabled.
6. Click **OK** to accept any changes you've made and close the dialog.

Winstel A and Winstel B can now also visualized as outputs.

Using the System Against Late Blight

The performance of the model is conditioned by the data you supply. At the season's start, check all options and parameters. During the season, be sure to update the treatments executed in the field (including those not requested by the system).

After installing the disease model on the applicable crops (it is installed by default for potato and tomato), you have to configure the initial parameters. Depending on the starting date, you have to check the crop's phenological phases.

Following is some general information on the development of late blight:

- The disease develops over a considerable temperature range: 6°C to 30°C.
- The fungus needs high relative humidity or leaf wetness to generate infections.
- The incubation period is relatively short, so the disease can reach epidemic proportions in a short time.
- The most important cause of propagation of the fungus from one season to the next is by infected tubers. Eliminate as many of the attacked tubers as possible before planting.

DSV

The DSV extension calculates the Disease Severity Values on several crop pathogen systems. Two primary models are implemented (Tom-Cast for black mold of tomato and late blight of tomato and potato), but you can use the extension for other crops as well. Based on the work of Fry, the DSV model has been useful in assessing disease risk for a variety of crop diseases including black mold on tomato, *Alternaria* on carrot, and *Septoria* on celery. In addVANTAGE Pro 6.x, the DSV extension is automatically applied to the Tomato and Potato crops.

Tom-Cast

Tom-Cast was designed to help decide when to apply fungicides to control tomato fungal diseases. It calculates DSV as a function of duration in hours of leaf wetness and average temperature during leaf wetness. These values are calculated daily from noon to noon, and then totaled to generate an accumulated DSV.

A spray is recommended when the accumulated DSV reaches the threshold you predefined. Define this threshold according to the susceptibility of the variety. After you apply a treatment, the index is reset and accumulates until the next time the threshold is reached.

The following guidelines have been used to initiate spray control for the tomato black mold:

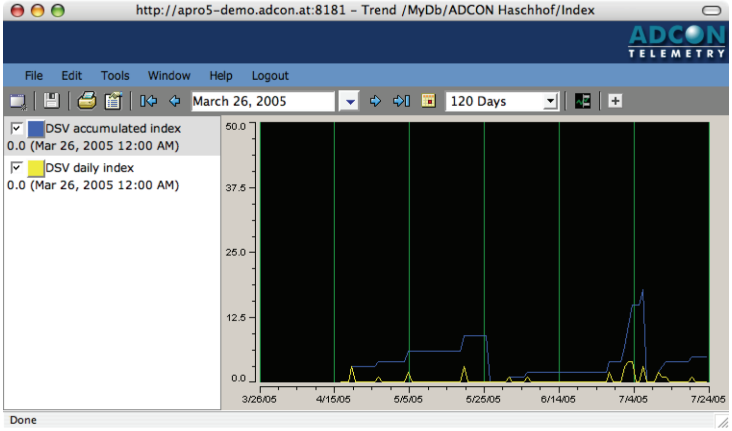
- Susceptible: 12 – 14 DSVs
- Intermediate: 14 – 16 DSVs
- Tolerant: 16 – 18 DSVs

Tom-Cast Wisdom

Also known as Blight-Cast, this model has two stages. It calculates DSV using duration in hours of high relative humidity and average temperature during the high relative humidity. Points are accumulated each day until the pre-programmed threshold is reached (typically 18 in total). At that point, the onset of disease is expected for the first time.

A spray is recommended and, if a treatment is applied, the index is reset to 0. The model enters its second cycle. It calculates the accumulated DSV based this time on the leaf wetness and the daily average temperature, noon to noon, according to the Tom-Cast model. A second threshold is now used. Each time the accumulated DSV reaches it, a warning is issued. The index is reset if a treatment is applied. *Figure 57* shows a DSV index in a Trend panel.

Figure 57. DSV Extension Output Tags in a Trend Panel



http://apro5-demo.adcon.at:8181 – Trend /MyDb/ADCON Haschhof/Index

☑ 🟦 DSV accumulated index
0.0 (Mar 26, 2005 12:00 AM)

☑ 🟨 DSV daily index
0.0 (Mar 26, 2005 12:00 AM)

March 26, 2005

120 Days

Done

The recommended value for the second threshold depends on the history of the attack’s severity:

- 30 for light history
- 20 for moderate history
- 15 for severe history

Manitoba

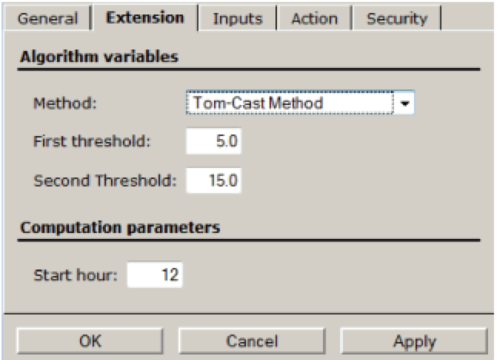
This method is an alternative of Tom-Cast that uses tables provided by an agricultural service in the Manitoba region of Canada.

Setup and Operation

Follow these steps to set up a DSV extension on an area:

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 58*.

Figure 58. DSV Properties Dialog, Extension Tab



Algorithm variables

Method: Tom-Cast Method

First threshold: 5.0

Second Threshold: 15.0

Computation parameters

Start hour: 12

3. Select the calculation **Method**.
4. Adjust the **First** and **Second** threshold, as needed.
5. Enter the **Start hour**.
6. Click the **Inputs** tab and make sure all of the extension’s inputs are connected to a valid sensor.
7. Click the **General** tab and make sure the extension is enabled.
8. Click **OK** to accept any changes you’ve made and close the dialog.

Fire Blight (Cougarblight model)

Fire blight[1] is a contagious disease affecting apples, pears, and some other members of the family Rosaceae. It is a serious concern to producers of apples and pears. Under optimal conditions, it can destroy an entire apple or pear orchard in a single growing season.

Dissemination

Fire blight is a systemic disease. The term “fire blight” describes the appearance of the disease, which can make affected areas appear blackened, shrunken and cracked, as though scorched by fire.

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[1] Fire Blight definition from Wikipedia, the free encyclopedia (*http://en.wikipedia.org/wiki/Fire_blight*)

Primary infections are established in open blossoms and tender new shoots and leaves in the spring when blossoms are open.

Honeybees and other insects, birds, rain and wind can transmit the bacterium to susceptible tissue. Injured tissue is also highly susceptible to infection, including punctures and tears caused by plant-sucking or biting insects. Hailstorms can infect an entire orchard in a few minutes, and growers do not wait until symptoms appear, normally beginning control measures within a few hours.

Once deposited, the bacterium enters the plant through open stomata and causes blackened, necrotic lesions, which may also produce a viscous exudate. This bacteria-laden exudate can be distributed to other parts of the same plant or to susceptible areas of different plants by rain, birds or insects, causing secondary infections. The disease spreads most quickly during hot, wet weather and is dormant in the winter when temperatures drop. Infected plant tissue contains viable bacteria, however, and will resume production of exudate upon the return of warm weather in the following spring. This exudate is then the source for new rounds of primary infections.

The pathogen spreads through the tree from the point of infection via the plant's vascular system, eventually reaching the roots and/or graft junction of the plant. Once the plant's roots are affected, the death of the plant often results. Over pruning and over fertilization (especially with nitrogen) can lead to watersprouts and other midsummer growth that leave the tree more susceptible.

Model Structure

Temperatures and Wetness: The key Fire Blight process that must be modeled is the potential for bacterial growth on the stigma tip surfaces of apple and pear flowers. This growth is mostly temperature dependent, so dependable prediction of infection risk requires the use of a measurement method that most accurately reflects the growth of Erwinia amylovora colonies. There is disagreement among modelers is how this should be done.

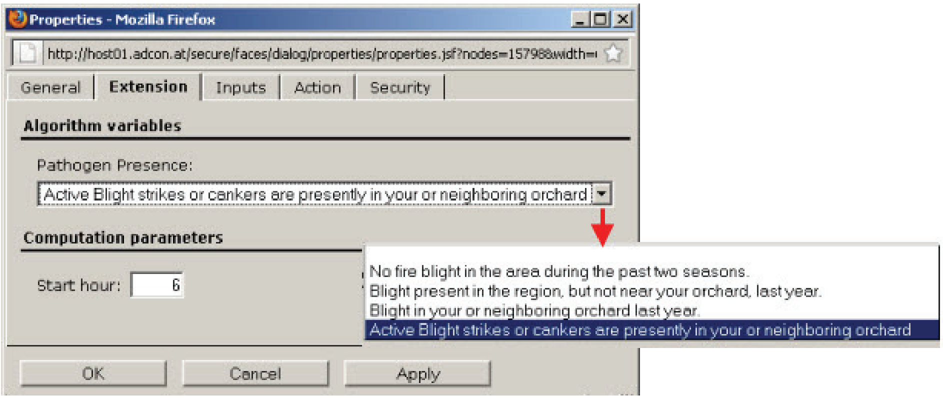
The Cougarblight model estimates bacterial growth rate from 50°F/ 10°C to 92°F/33.3°C using degree hours based on a specific growth rate curve. This growth curve is based on a study of the growth rate of E. amylovora bacteria on stigma tips held under various temperatures. At higher temperatures in the orchard, the effect of the heat on the flower quickly becomes very important in the potential infection process. At very high temperatures, the flower becomes much less likely to be infected due to its rapid development. The bacterial growth rate curve was blended with this high temperature effect to set “risk values” for any day, dependant on the high temperature. The daily risk values increase as temperatures rise from 50F/10°C to the high-80's/ 26.6°C, decline rapidly at higher temperatures, and reach zero for any hour with temperatures over 104°F/40°C. The model user does not actually calculate these values, but uses daily high temperatures and a look-up chart to assign daily risk values. Estimated daily risk values can be found on this look-up chart. These “risk values” were developed using degree hours, but they are not “degree hours” or degree days.

Blossom wetting is critical to the infection process. Wetting is the “trigger” that may induce infection if temperatures have been high enough, long enough. Practically, wetting is often difficult to assess. Moisture measuring and monitoring devices are relatively untrustworthy over time, and, even if they were perfect, it is not possible to place them in every microclimatic condition in an orchard. It is possible to determine that wetting occurred at the monitoring station, but not possible to determine that it did NOT occur in all areas of an orchard region being represented by that station.

Rain is the most common form of wetting. Observation of infections occurring in the absence of rain, and a high level of infection occurring only in low areas of orchards with poor air drainage indicates that dew alone will provide the wetness necessary to transport the E. amylovora stigma colony into the flower nectary. It is possible that duration of wetting makes a great difference to a successful infection. Fire blight outbreaks have occurred in some localities without measurable rain occurring during the 10 days to two weeks preceding symptom expression. Data recorded on remotely monitored leaf wetness sensors indicated that likely infection events coincided with leaf wetness readings of three or more hours, and perhaps as few as two. So, whenever possible, growers are advised to monitor leaf wetness, and consider leaf wetness readings of two or more hours as qualifying as sufficient blossom wetting in a potential infection event.

Apple and pear flowers are very often wetted by high volume sprayers during pest control, blossom thinning, or plant growth regulator applications, without any documented instance of resultant fire blight infection in the lower humidity of the western USA. It appears that this short-term wetting does not trigger fire blight infection in Western USA orchards, even when temperatures have been conducive to the development of large E. amylovora stigma colonies.

Figure 59. Options for Fire Blight (Cougarblight Model)



Properties - Mozilla Firefox

http://host01.adcon.at/secure/faces/dialog/properties/properties.jsf?nodes=15798&width=

Algorithm variables

Pathogen Presence: Active Blight strikes or cankers are presently in your or neighboring orchard

Computation parameters

Start hour: 6

Available options:

- last year severity

Outputs:

- Rain event
- Leaf wetness event
- Hourly index
- Daily index
- Risk index

The model does not give treatment recommendation but a risk level. An Alarm is written to the database when the risk is equals to 3 or 4.

Fire Blight (Maryblyt Model)

Maryblyt™ for addVANTAGE is an adaptation of the predictive model for fire blight management developed by Paul Steiner and Gary Lightner. This version of the model is based on the “Operational algorithms for Maryblyt™, version 4.3” as provided by the model authors. The University of Maryland owns the legal rights for this model. Gempler's, Inc. holds the distribution rights by contract with the University of Maryland. Maryblyt for addVANTAGE was produced and distributed with the express permission of both parties. The application of the Maryblyt, version 4.3, algorithms in any predictive program for fire blight without authorization by the University of Maryland is expressly prohibited.

General Considerations

Maryblyt for addVANTAGE provides the same predictive results as Maryblyt 4.3. The primary difference between Adcon’s version and Maryblyt 4.3 is that the addVANTAGE version functions as an addVANTAGE Pro 6.0 extension and, therefore, uses inputs from Adcon's automated measuring devices. Parameters such as temperature, precipitation, leaf wetness, wind, and hail are automatically downloaded from Adcon hardware in the field. Users are given the option of having wind and hail trauma events determined automatically or entering them manually. Mechanical injury to the crop from other causes must be input manually.

Disease Symptoms

Fire blight symptoms can appear on leaves, green shoots, mature branches, fruit, and blossoms. Four types of fire blight have been defined including blossom blight, canker blight, shoot blight, and trauma blight. Blossom blight is limited by definition to direct infections of open flowers. Canker blight involves the systemic movement of bacteria from active canker sites into adjacent shoots and limbs. It is distinct from early, pre-bloom canker activity resulting in the extrusion of bacterial ooze to canker surfaces. Shoot blight results from direct infections of vegetative shoot tips (terminals, water sprouts, root suckers) and is distinct from secondary infections related to vascular movement of the pathogen from other infection sites. Trauma blight involves many tissues (blossoms, fruit, leaves, shoots) and is associated with injurious incidents of wind, hail or late frosts, etc. (Steiner, 1990).

Infections often develop in two phases:the primary blossom blight phase and the secondary shoot blight phase. Initial symptoms typically appear on blossoms. Affected blossoms wither and die. Viscous bacterial ooze can seep from blossoms and fruit under humid conditions. Bark with active infections appears reddish and water-soaked. Affected branches develop brownish bark, which dries and develops fissures. Callus often forms around fissures. The branch could become girdled and die during summer months. Infected pear leaves and twigs turn black, while on apples they tend to turn brown. Infections of suckers can spread to roots and the trunk. Infection of the trunk can lead to death of the tree.

Disease Development

The causal organism overwinters in infected bark of apple and pear trees. Other hosts can also serve as overwintering sites. In springtime, the bacteria ooze to the surface of cankers when humidity is high. The bacteria may be spread to susceptible tissue by rain splash, or insect vectors. Wind and birds can also be involved in the spread of the pathogen. Once initial infections occur, insects and rain can spread the bacteria to other blossoms. Stoma, lenticels, and fresh wounds serve as routes of infection for other tissues.

Model Function

Maryblyt is a comprehensive model that predicts specific infection events and the development of disease symptoms for several types of symptoms. The symptom types tracked are blossom, canker, shoot, and trauma blight. Model validation studies have been conducted in pome fruit growing regions of California, Michigan, West Virginia, and Ontario, among other areas. The model is currently used in at least 36 countries, including 32 US states. The model uses information on the crop species (apple or pear), phenological phase, daily maximum and minimum temperatures, moisture (precipitation, dew, or leaf wetness) and injury to the crop (freezing, wind, or hail) to predict the risk of the four types of fire blight symptoms. All calculations are done at 8:00 am and are based on the previous 24 hours (8:15 am - 8:00 am). Daily maximum and minimum temperatures are used for heat unit calculations. The calculations are done using a sine wave function with a 90°F (32°C) upper development threshold and various lower developmental temperature thresholds.

Beginning at the phenological phase green tip, cumulative degree-days >40°F (4.4°C) (blossom clock DD 40°F/4.4°C) and >55F (12.8°C) (disease clock DD 55°F/12.8°C) are complied. The blossom clock (DD 40°F/4.4°C) is used to forecast bud development, percent bloom, and insect vector availability. The disease clock (DD 55°F/

12.8°C) is used to predict and monitor symptom development after infection.

At the phase bloom, the program starts to accumulate degree hours >65°F (18.3°C) (pathogen clock DH 65°F/18.3°C). The pathogen clock (DH 65°F/18.3°C) is used as an indirect measure of relative epiphytic infection potential (EIP) by estimating bacterial pathogen colonization. EIP is calculated using pathogen clock (DH 65°F/18.3°C) values accumulated from a moving window of the previous 80 DD 40°F/4.4°C for apples and the previous 120 DD 40°F/4.4°C for pears. EIP is an indication of relative infection risk based upon a threshold of 198 DH 65°F/18.3°C. When EIP <100, few infections occur, an EIP 100-150 can indicate the possibility of blossom blight epidemics, EIP values >200-250 indicate that a large number of infections can be expected with any wetting event.

Note: *In this version of Maryblyt for addVANTAGE 6.0, the calculation is made on the exact window of 80 DD 40°F/4.4°C. Some existing models (included old version of Maryblyt for addVANTAGE 3.45) did this calculation on the day those 80 DD 40°F/4.4°C occurred.*

Algorithm Description

This section of the model description details several blight infections and discusses how the model can be used to forecast events.

Blossom Blight Infection Events

Blossom blight symptoms (BBS) are the result of direct infections of open flowers and are distinct from secondary infections due to systemic invasion of blossom spurs by bacteria from nearby infection sites (Steiner, 1990). The Maryblyt model assumes that disease inoculum is present in the orchard. The risk for BBS is reported as low, moderate, high, or infection conditions exist, depending on how many of four risk factors are met.

The risk factors are as follows:

- open flowers (phenological phase = bloom)
- accumulation of at least 198 DH 65°F/18.3°C within the appropriate window for the crop (the previous 80 DD 40°F/4.4°C for apples, 120 DD 40°F/4.4°C for pears)
- a wetting event (leaf wetness, 0.01 inch/0.25 mm rain, or 0.10 inch/2.5 mm rain the previous day)

Note: *Irrigation could be integrated in the model—an irrigation is considered a wet event.*

- average daily temperature >60°F (15.6°C)

The level of infection risk reported by the model depends on the number of risk factors that occur on a given day.

The risk levels are as follows:

- 1 factor (bloom) indicates a low risk.
- 2 factors indicate a medium risk. (You are prompted to use the model's prediction mode.)
- 3 factors indicate a high risk. (A treatment recommendation is issued. Use of the prediction mode is also appropriate.)
- 4 factors indicate than an infection has started. (A treatment recommendation is issued. Use of the prediction mode is also appropriate.)

At bloom stage, a treatment recommendation is issued.

Calculations also begin for predicting the appearance of blossom blight symptoms. These calculations are reported as a percentage of the symptom threshold. The symptom threshold is calculated by adding 103 DD 55°F/12.8°C to the total value for that parameter at the time of the infection event. Maryblyt for addVANTAGE tracks the development of multiple BBS events separately. The individual BBS events are identified by a number at the end of the message in the Events List.

Canker Blight Infection Events

Canker blight infection is defined as the renewed infectious activity of the pathogen around the margins of over wintered cankers. It is associated with two symptom events. Those two events are canker margin symptoms (CMS) and canker blight symptoms (CBS). Notice of CMS is given when the threshold value of 196 DD 55°F/12.8°C has accumulated after green tip has begun. Notice of CBS is given at 103 DD 55°F/12.8°C after CMS. Progress towards CMS is reported as a percentage of the threshold. Once the CMS percentage has reached 100%, progress towards CBS is reported as a percentage of its threshold.

Shoot Blight Infection Events

Shoot blight infections develop following the direct infection of young shoot tips by the pathogen. The model predicts only the first occurrence of shoot blight, since secondary shoot blight infections seem to be a random event for which the causal factors are not completely known. The following factors are used to predict the first occurrence of shoot blight symptoms (SBS):

1. A threshold of 103 DD 55°F/12.8°C is calculated after the first occurrence of BBS or CBS, whichever occurs first.
2. The average daily temperature is >60°F (15.6°C).
3. This factor is optional and concerns the availability of insect vectors. The model provides the ability to predict the appearance of winged adult white apple leafhoppers to serve as vectors. Accumulation of >675 DD 40°F/375 DD 4.4°C after green tip is given as a default threshold in the model.

Maryblyt™ for addVANTAGE gives you the option of using the availability of insect vectors as a factor in predicting SBS. You can also define custom threshold levels for the availability of insect vectors, based on local information. See *"Setup and Operation" on page 101* for information about setting these options.

Trauma Blight Infection Events

Trauma blight is defined as infections that occur as the result of epiphytic bacteria entering wounds caused by trauma events, such as frosts (≤28°F/-2.22°C), or mechanical damage (hail, high wind, and so forth). Several factors are involved in the appearance of trauma blight symptoms (TBS):

- At least 198 DH 65°F/18.3°C need to accumulate after green tip
- An injurious (trauma) event after accumulation of at least 198 DH 65°F/18.3°C after green tip
- An average daily temperature of >60°F (15.6°C)

Once the above conditions occur, the TBS threshold is set at 103 DD 55°F/12.8°C greater than the DD 55°F/12.8°C on the date the conditions are met. The progress towards appearance of TBS is reported as a percentage of the TBS threshold. Maryblyt™ for addVANTAGE tracks the development of multiple TBS events separately. The different TBS events are identified by a number at the end of the message in the Events List.

Forecasting

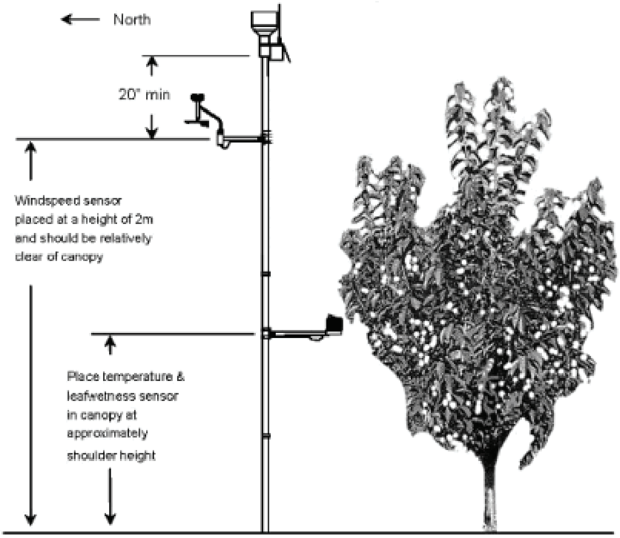
The Maryblyt model provides a function for using current conditions, predicted weather, phenological events, and trauma events to forecast incidence of fire blight. Predictions are reported as percentages of the various thresholds. Maryblyt for addVANTAGE allows predictions to be made for up to seven days in advance. You can manually enter the predictions.

Field Hardware Configuration

The temperature, relative humidity, and leaf wetness sensors should be placed within the fruiting canopy of the trees about shoulder height. Make sure that the sensors are out of direct sunlight and away from herbicide strips, and that no leaves are on the leaf wetness sensor. Wind speed sensors should be placed at 2 m (6 ft.) and should be relatively clear of canopy. Place the precipitation sensor where the canopy does not interfere with the collection of rainfall. *Figure 60* illustrates the proper field configuration.

Note: *Placing the station directly inside the orchid is not necessary. The best place could be at the end of a row.*

Figure 60. Sensor Placement in the Field

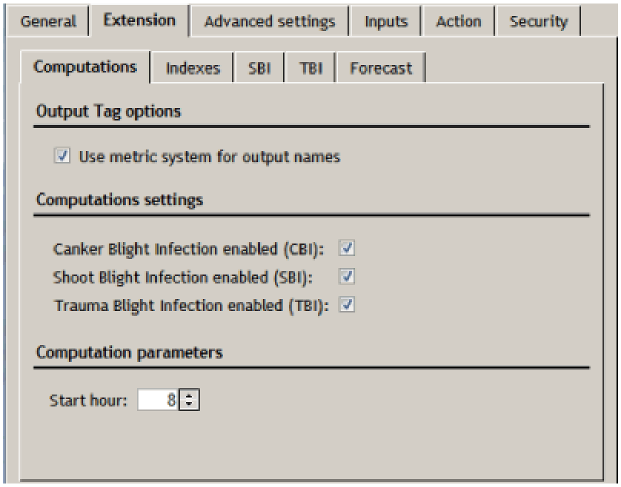


Setup and Operation

Follow these steps to set up a Fire Blight (Maryblyt) extension on an area:

1. In an Explorer, select the extension and click **Properties**.
2. Click the **Extension** tab to display the dialog shown in *Figure 61*.

Figure 61. Maryblyt for addVANTAGE Extension, Computations Tab



Output Tag options

☑ Use metric system for output names

Computations settings

Canker Blight Infection enabled (CBI): ☑
Shoot Blight Infection enabled (SBI): ☑
Trauma Blight Infection enabled (TBI): ☑

Computation parameters

Start hour: 8

Computations Tab

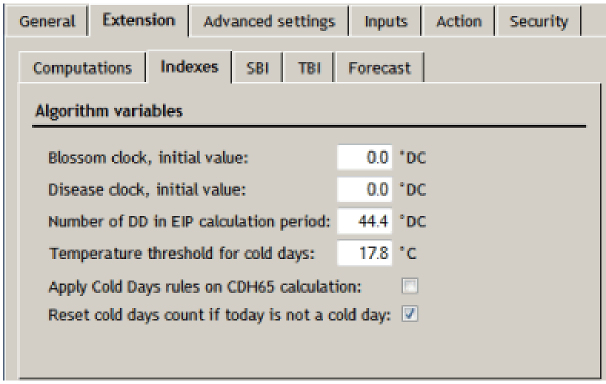
Make the following selections on the Computations tab:

1. Select whether to **Use metric system for output names**. If this checkbox is not selected, the system will use imperial names.
2. **Blossom** events are always included, but you can select whether to include **Canker**, **Shoot**, or **Trauma** blight infection events. Adcon recommends that you do not select these boxes if the infections are uncommon in your area.
3. Enter the **Start hour**, that is, the hour of the day to start calculation.

Indexes Tab

Use this tab (*Figure 62*) to set default value for the different index calculations discussed earlier in this model's description.

Figure 62. Maryblyt for addVANTAGE Extension, Indexes Tab



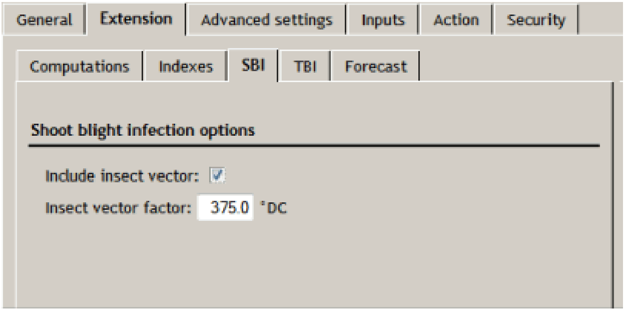
Algorithm variables

Blossom clock, initial value: 0.0 °DC
Disease clock, initial value: 0.0 °DC
Number of DD in EIP calculation period: 44.4 °DC
Temperature threshold for cold days: 17.8 °C
Apply Cold Days rules on CDH65 calculation: ☐
Reset cold days count if today is not a cold day: ☑

SBI Tab

Use this tab (*Figure 63*) to set up the insect vector option.

Figure 63. Maryblyt for addVANTAGE Extension, SBI Tab



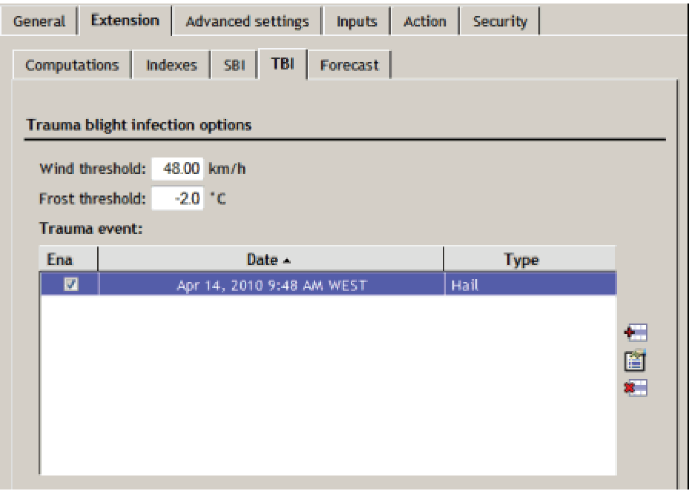
Shoot blight infection options

Include insect vector: ☑
Insect vector factor: 375.0 °DC

TBI Tab

Use this tab (*Figure 64*) to set thresholds for various possible trauma events or enter them manually.

Figure 64. Maryblyt for addVANTAGE Extension, TBI Tab



Trauma blight infection options

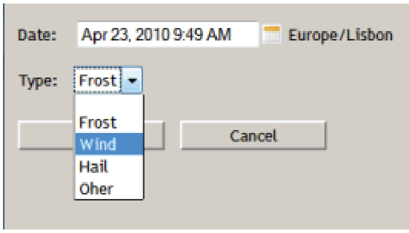
Wind threshold: 48.00 km/h

Frost threshold: -2.0 °C

Trauma event:

Ena	Date ▴	Type
☑	Apr 14, 2010 9:48 AM WEST	Hail

If you click the **Add** button to add a Trauma event manually, use the dialog shown below to select the type of event and the date/time it occurred.



Date: Apr 23, 2010 9:49 AM Europe/Lisbon

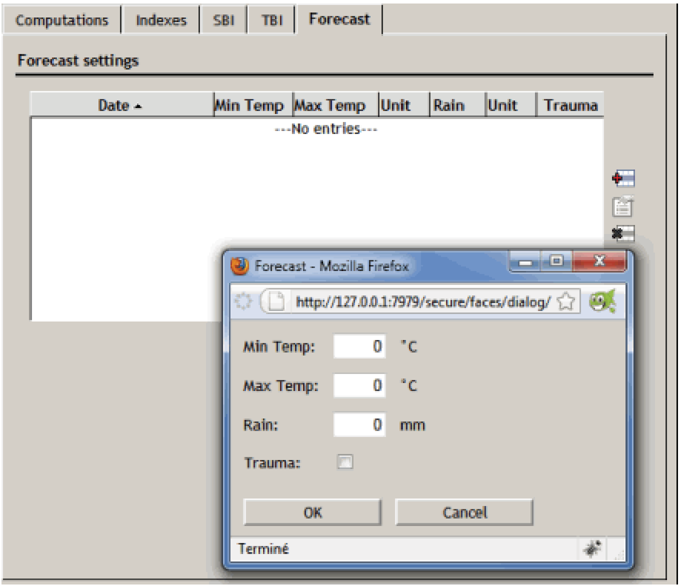
Type: Frost

Forecast Tab

Use this tab (*Figure 65*) to enter the min/max temp, the rain and whether it causes a trauma. The forecast date is set automatically from today. When the forecast is no longer valid (real data have overwritten the forecast) the forecast entry is deleted from the list automatically.

No. The forecast gives a possibility to enter the weather forecast of the next days. Therefore you can calculate the index values of the next days. The forecast consists in 3 parts: RAIN, TEMP (min/max), TRAUMA. A trauma could be a certain type (heavy wind, hail,...) which leads to wounds on the tree, where spores can enter. In fact it is only interesting: "is there a trauma to be expected or not". The rain / temp info is additional info to calculate the index

Figure 65. Maryblyt for addVANTAGE Extension, Forecast Tab



Date	Min Temp	Max Temp	Unit	Rain	Unit	Trauma
---No entries---						

Min Temp: 0 °C

Max Temp: 0 °C

Rain: 0 mm

Trauma: ☐

Troubleshooting

The word *Maryblyt* precedes the following messages:

- ...treatment recommended: Indicates that a treatment should be made to control an imminent outbreak. The message will remain active as long as no treatment (or Ignore warning) is entered.
- ...degree days - blossom clock: Gives the numeric value of degree days >40°F (4.4°C) that have accumulated since the phenological phase green tip was entered into the extension.
- ...degree days - disease clock: Gives the numeric value of degree days >55°F (12.8°C) that have accumulated since the phenological phase green tip was passed.
- ...degree hours - pathogen clock: Gives the numeric value of degree hours >65°F (18.3°C) that have accumulated within a moving window (80 DD40°F apple/120 DD40°F pear) since the phenological phase bloom was passed.
- ...Epiphytic Infection Potential: Gives numeric value of the Epiphytic Infection Potential (EIP) accumulated within a moving window (80 DD40°F apple/120 DD40°F pear) since the phenological phase bloom was passed.
- ...trauma event: Gives notice that a trauma event has been recorded and lists the type of trauma event.
- ...blossom infection risk: Gives the level of blossom infection risk (low, medium, high) based on the number of risk factors on a given day. Use of the prediction mode is recommended when the blossom infection risk level is medium or high. Consideration of a

treatment is recommended when the blossom risk infection level is high.

- ...blossom infection: Indicates that all four blossom infection risk factors exist. A treatment is recommended when this occurs. Calculations for predictions of the appearance of blossom blight symptoms (BBS) begin at this point.
- ...canker margin symptoms: Gives the percentage of the threshold reached for the appearance of canker margin symptoms (CMS) on a given date.
- ...canker blight symptoms: Gives the percentage of the threshold reached for the appearance of canker blight symptoms (CBS) on a given date.
- ...shoot blight infection: Gives the percentage of the threshold reached for the appearance of shoot blight symptoms (SBS) on a given date.
- ...trauma blight infections: Notifies the user that conditions for trauma blight infections exist. Consideration of a treatment is recommended. A number at the end of the `trauma blight infection conditions exist` message identifies each individual trauma infection event since the beginning of the season.
- ...look for early Canker Margin symptoms (CMS): Appears when the threshold for canker margin symptoms (CMS) has been reached (100%). Calculations for predicting the appearance of canker blight symptoms (CBS) begin at this point.
- ...look for and remove active cankers now (CBS): Appears when the threshold for canker blight symptoms (CBS) has been reached (100%). Prompts you to remove active cankers from the crop.
- ...blossom infection percent: Gives the percentage of the threshold reached for the appearance of blossom blight symptoms (BBS) on a given date for each blossom infection event. A number at the end of the `blossom infection` message identifies the associated blossom infection event.
- ...trauma infection event: Gives the percentage of the threshold reached for the appearance of trauma blight symptoms (TBS) on a given date. A number at the end of the `trauma infection` message identifies each blossom infection event since the beginning of the season.
- ...look for early shoot blight symptoms - Appears when the threshold for shoot blight symptoms (SBS) has been reached (100%) and the insect vector threshold has been reached or passed. If the insect vector threshold option is not used, the message appears when the threshold for shoot blight symptoms (SBS) has been reached (100%). You set the insect vector threshold on the *"SBI Tab" on page 102*.
- ...insect threshold reached: Appears when the threshold for the appearance of shoot blight insect vectors has been equaled or surpassed. Recommends that you consider an insecticide treatment. You set the insect vector threshold on the *"SBI Tab" on page 102*.

- ...look for early Blossom Blight symptoms (BBS): Appears when any of the blossom infections being tracked reaches 100% of the threshold for the appearance of blossom blight symptoms (BBS).
- ...look for early Trauma Blight symptoms (TBS): Appears when any of the trauma infections being tracked reaches 100% of the threshold for the appearance of trauma blight symptoms (BBS).

Appendix. References

This appendix contains reference information for the calculation extensions and disease models discussed in this book.

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