Lateblight Help Index

This index contains all of the help topics available for **Lateblight**. To select a topic, click on it with the mouse. Topics are arranged according to the organization of the program. Use the scroll bar to see entries that are not currently visible in the help window.

For more information on how to use help, press F1 or choose Using Help from the Help menu.

Introduction

Late blight is a disease of potatoes and tomatoes caused by the fungus *Phytophthora infestans*. Under favorable environmental conditions, and in the absence of any control measures, this disease can destroy virtually 100% of the above-ground parts of susceptible cultivars. Inoculum produced on infected foliage can be disseminated to the tubers, where infections can also occur. Losses include reduction of photosynthetic area resulting in reduced bulking of tubers (yield loss), blighted tubers (quality loss), and decay of tubers in storage (postharvest loss).

Management of potato late blight begins with reducing the initial inoculum by:

1. Keeping the numbers of infected seed tubers to very low levels by planting only certified seed
2. Crop rotation to reduce the numbers of volunteer plants (which may be infected)
3. Burying or composting cull piles, or at least keeping them far away from the potato fields.

Control of late blight by means of potato varieties with a high degree of resistance to *P. infestans* has not proven to be very practical because of the rapid selection of virulent races of the pathogen. Varieties with moderate levels of resistance, however, have been very useful when combined with other management tactics, particularly the use of fungicides. In most potato growing areas, regular fungicide application is an essential component of late blight management.

Because of environmental concerns, the problem of fungicide resistance, and the high cost of fungicides and their application, potato growers have been forced to reduce their overall use of fungicides and to improve the efficiency of the fungicides they apply. One approach has been to improve the timing and adjust the dose of fungicide applications according to environmental conditions. Various kinds of forecasting systems have been employed to help growers decide when and how much to spray. By using potato varieties that are partially resistant to *P. infestans*, it is possible to markedly reduce the doses and/or frequencies of fungicide sprays.

This version of **Lateblight** was adapted from the simulation originally written by J. A. Bruhn et al. (1980) and modified in various ways over the years by different people working in the research program of W. E. Fry, Department of Plant Pathology, Cornell University. We have retained the original structure of the model wherever possible, but some small modifications have been necessary to enhance its pedagogical value. While the simulation is sufficiently realistic for teaching purposes, this version should not be trusted as a research tool or a management decision making aid.

Weather

Weather plays an important role in the **Lateblight** simulation. The necessary weather variables are read from disk at the beginning of each season. When you select **Run** from the **File** menu, a dialog box will appear asking you to select a weather file.

If you save a **Lateblight** document to disk after the weather file has been read, the weather will be included in the document. When such a document is opened, the season will be in progress, just as it was when the document was saved, and the same weather data will be used.

Five weather data files have been packaged with **Lateblight**:

COOLWET.LWX
HOTDRY.LWX
MODDRY.LWX
MODMOD.LWX
MODWET.LWX

Although these weather data sets are based on central New York weather data, they have been modified for pedagogical purposes. The days on which rain occurs have been adjusted so that beginning with day 50, sprays can be applied at 5-, 7-, 10- or 14-day intervals without occurring on a rainy day. The MODDRY, MODMOD, and MODWET, data sets have the same temperature data, representing a "typical" moderate season in upstate New York, but they have data for rainfall and hours of relative humidity above 90% typical of dry, moderate, and wet seasons, respectively. Since most seasons of high rainfall are also somewhat cooler than normal, and seasons of drought tend to be hotter than normal, data sets for cool, wet and hot, dry weather are also included. You may also use your own weather files, as long as they conform to the format given below. Use of the .LWX extension is strongly recommended.

Although the system of measurement used for user interactions can be switched between American and metric, **Lateblight** expects its weather data files to use the units given below. Each line of the file should contain the weather data for one day (a day for the model runs from noon to noon). The first day corresponds to the day of median emergence of the potato vines. The numbers on a line should be separated by spaces or tabs, and should represent the following, in order:

Rainfall (in inches)
Mean daily temperature (degrees Centigrade) - this is calculated as (maximum temperature + minimum temperature) / 2.
Period of relative humidity greater than or equal to 90% (hours)
Mean temperature during period of relative humidity >= 90% (degrees Centigrade)

Before Running

Before selecting **Run**, you will want to use the **Potato** menu to define the characteristics of the potato cultivar you want to simulate, the **Inoculum** menu to establish the levels of initial inoculum under which to run the simulation, the **Management** menu to initialize the Blitecast forecasting system, and the **Economics** menu to define the values of the economic variables. Otherwise, the simulation will run using the built-in default values, the values read from the STARTUP.LBT file, or the values assigned during the previous season.

To facilitate repeated simulations using the same values for these variables, the initial conditions can be saved in a disk file using the **Save as...** command prior to starting the simulation with **Run**.

During the Season

When you have selected **Run** from the **File** Menu and the graph has appeared, some of the menu commands will be disabled to prevent inappropriate changes in options and parameters. Other items will be enabled to allow you to control how the simulation results are displayed and to control the program itself. The most important control at this point is the scroll bar just below the x-axis. Clicking on the arrow at the right end of this scroll bar will cause the simulation to advance by one day. Clicking the page-up area will advance by one week; and dragging the thumb will allow you to go to an arbitrary date. Just as in the real world, you can't go back in time.

The **Management** menu allows you to spray systemic or protectant fungicides, or, if the epidemic gets out of control, kill the vines and thus immediately end the season. If you chose to use **Blitecast** at the beginning of the season (before selecting **Run**), you can get a Blitecast report. A weather report is always available from the **Environment** menu.

By browsing through the menu system and using the **Help** system, you can learn more about the other available options.

End of Season

At the end of the season, you can get an economic report by clicking on **Show Report** in the **Economics** menu. You can also display other variables on the graph by selecting them in the **View** menu. The entire state of the simulation (including the graphs and economic report) can be saved in a disk file using **Save as...**. A text summary of the key variables can be saved in a disk file using **Log to Disk...**. Start a new simulation using **New** (to initialize the simulation with the same parameters and options as in the previous run) or using **Open...** (to open a document containing different parameter values and options).

Run

Once you have decided on the appropriate options and parameters, select **Run** from the File Menu to begin the simulated season. You will then be prompted to select a weather data file that will provide the season's weather. To advance the progress of the simulation during the season, use the scroll bar beneath the graph.

New

New allows you to begin a new simulation. You may repeat the same problem or change parameters and/or options before running the new season. Any parameters or options not changed will be the same as in the last season. You may want to use the **SaveAs...** command before selecting **New** so that you can recall the current season at a later time.

Open

Open allows you to open a saved **Lateblight** document in which is stored the state of the program at the moment you executed the **Save As** command in a previous run. This includes all program options and parameter values. If the season was in progress when the document was saved, opening it will return you to the day on which it was saved. (This is a good way to explore and compare different management strategies.)

Save As...

Save As creates a **Lateblight** document on disk using the name and extension you provide. Use of the .LBT extension is strongly recommended to distinguish **Lateblight** documents from other types of files. If you add a line for the .LBT extension to the [extensions] section of your WIN.INI file, you will be able to start **Lateblight** simply by double clicking a document.

A **Lateblight** document contains the complete state of the program at the time the document was saved. If you save a document named STARTUP.LBT, **Lateblight** will load it automatically when you start the program. In this way, you can override the default values provided for the various parameters and options.

A document saved before selecting **Run** will contain only the program options and initial parameter values and will take considerably less space on disk. A document saved while a season is in progress will contain all information for that season up to the time when it was saved.

Log to Disk

A plain text record of all parameter values and day-by-day simulation results can be saved to disk using the **Log to Disk...** selection in the **File** menu. This is especially useful for preparing printed reports. Whether you choose **Log to Disk** before a season is started, in the middle of a season, or at the end of a season, the log file will include all initial values and results from the beginning of the season onward. If the log is closed before the end of the season, only the data up to the day when the log was closed will be saved. A single log file can be used to record the results of several successive seasons.

Exit

This selection terminates **Lateblight**. The same thing may be accomplished by double clicking the close box in the upper left corner of the **Lateblight** window.

Resistance Level

Different potato cultivars with differing levels of resistance to *Phytophthora infestans* can be simulated by selecting **Low**, **Moderate**, or **High**.

Harvest Season

To simulate different potato cultivars with differing rates of maturation, select **Early**, **Mid**, or **Late** season maturity.

Yield

To simulate different potato cultivars with different yield potentials, enter the maximum yield (in the absence of late blight) in cwt/acre or kg/hectare.

Length of Season

This variable is the number of days from median emergence of the potato vines to harvest.

Emergence Date

This is the calendar date on which median emergence of the vines occurs. It is used as the basis for the labeling of the x-axis.

Weather Report

A weather report may be requested from the **Environment** menu for any day of the season. The report includes actual temperature and rainfall data from the previous day as well as a forecast of temperature and chance of rainfall for the current day and the next two days. As in the real world, there is a degree of randomness in the forecasts. They are based on the weather data that will actually be used in coming days, with a random component to reflect the inherent difficulty of predicting the weather.

Inoculum

In **Lateblight,** there are two independent sources of inoculum--sporangia and infections. Sporangia can be released all at once as initial inoculum or each day during the course of the epidemic. Infections occur on the potato plants at the time of emergence. Both **Sporangia** and **Infections** can be initialized either by designating the **Number** or by selecting the **Source** of inoculum. Only the values in the checked item are used, and the values in the unchecked item are ignored.

To facilitate repeated simulations using the same values for **Inoculum**, the initial conditions can be saved in a disk file using the **Save as...** command prior to starting the season with **Run**.

See also:

Number of Sporangia
Sources of Sporangia
Number of Infections
Sources of Infections

Number of Sporangia

This is one of two alternative means of setting the number of initial sporangia. Enter the number of sporangia released per hectare or per acre. The number of sporangia indicated will be released all at once on the day of plant emergence or each day of the season, depending on the alternative selected. Typical values are 250,000 sporangia/ha as initial inoculum or 25,000 sporangia/ha each day.

Alternatively, the numbers of initial sporangia can be set by selecting the Sources of Sporangia.

See also:

Inoculum

Sources of Sporangia

As an alternative to setting the Number of Sporangia, you can set the quantities of sporangia contributed by two possible sources, a cull pile (potatoes discarded from a packing line) and a neighboring unsprayed field. To account for dispersal losses, the distance of the field being managed from each of these inoculum sources can be set. Enter the **maximum** sporangia per day released at the source. In the case of the cull pile, the number of sporangia released each day will decrease exponentially from this maximum as the season progresses. A typical value for this maximum is 100 sporangia/day. In the case of the unsprayed field, the number of sporangia released per day will increase logistically from 0.001 to 1.0 times this maximum as the season progresses. A typical value for this maximum is 5 million sporangia/ha. 10 meters is a reasonable distance from the field for either of these sources.

See also:

Inoculum

Number of Infections

This is one of two alternative means of setting the number of initial infections. Enter the number of infections (per hectare or per acre) present at plant emergence. A typical value is 10,000 infections/ha.

Alternatively, the numbers of initial infections can be set by selecting the Sources of Infections.

See also:

Inoculum

Sources of Infections

There are two possible sources of initial infections, infected seed tubers and volunteer potatoes in the field being managed. Enter the numbers of infections per hectare or per acre present at plant emergence. A typical value is 10,000 infections/ha.

Alternatively, the numbers of initial infections can be set by selecting the Number of Infections.

See also:
Inoculum

Spray Systemic

There are two general types of fungicide available; a systemic and a protectant. **Spray Systemic...** applies a fungicide that is absorbed by the plant tissues and is therefore not subject to weathering by subsequent rains. The systemic fungicide also acts to suppress infections that are already established.

Sprays are applied on the day on which the command was given and at the dose given in the Fungicide Application dialog box. Enter the dose of the active ingredient in kg/hectare or lb/acre. Click on **OK** to apply the fungicide on the date given at the top of the dialog box or on **Cancel** to exit the dialog box without applying the spray.

A warning is given if it is currently raining. A spray applied in the rain will not leave the full residue of fungicide on the foliage.

Spray Protectant

There are two general types of fungicide available; a systemic and a protectant. **Spray Protectant...** applies a fungicide that interacts with the fungus only on the plant surface. To be effective, it must be applied prior to infection, and its residues must be maintained on plant surfaces by frequent applications.

Sprays are applied on the day on which the command was given and at the dose given in the Fungicide Application dialog box. Enter the dose of the active ingredient in kg/hectare or lb/acre. Click on **OK** to apply the fungicide on the date given at the top of the dialog box or on **Cancel** to exit the dialog box without applying the spray.

A warning is given if it is currently raining. A spray applied in the rain will not leave the full residue of fungicide on the foliage.

Kill Vines

The order to kill vines immediately defoliates the crop and stops tuber development.

Blitecast

The **Blitecast** program will provide an advisory, based on the weather, of when protectant sprays are necessary.

The **Blitecast** forecasting system (Krause, et al., 1975) sums the "rain-favorable" days and blight severity values for the past week and makes a spray recommendation for the current day. **Blitecast** is invoked in the **Management** menu.

Costs

The costs of potato production can be established before the start of the season (before **Run** is selected) by selecting **Costs...**

For each of the items, enter the cost per acre or per hectare. When all of the items show the desired values, click **OK**.

Price

Enter the market price per cwt. or per kg. for the current season's potato crop and click on **OK**.

Show/Hide Report

At the end of the season, a full accounting can be displayed by selecting **Show Report** from the **Economics** menu. Exit the economic report by double clicking the close box in the upper left corner of the window, or by selecting **Hide Report** from the **Economics** menu.

View Menu Check Items

The **View** menu allows you to select which of the simulation variables will be displayed on the graph as the season progresses. A checked variable will be represented by a line of the same color as the check mark. In this way, the **View** menu doubles as a legend for the graph. In addition, the **View** menu also shows the current scaling factors for all variables.

American/Metric Measure

The American Measure and Metric Measure check items in the **View** Menu allow you to choose which system of units will be used throughout the program. The American system expresses distances in feet and inches, areas in acres, weights in pounds (lbs.) or hundredweight (cwt., 100 lbs.), and temperatures in degrees Fahrenheit. The metric system expresses distances in meters, areas in hectares, weights in kilograms, and temperatures in degrees Centigrade.

Whichever system of measurement you choose will be used consistently in all dialog boxes and other program displays.

Set Colors

The **Set Colors** command allows you to change the colors which are used to represent the various simulation variables on the **Lateblight** graph. In this way, you can be sure the different lines on the graph are readily distinguishable, regardless of what combination of variables you choose to display. The **Color Choices** dialog box shows all of the variables which can be displayed on the graph, along with their currently assigned colors. When the radio button next to a variable is checked, the color for that variable can be changed by clicking on the new color in the palette at the bottom of the dialog. The line next to the variable name will change color immediately to reflect your choice. When a variable is checked in the **View** menu, indicating that it is to be drawn on the graph, the check mark will be the same color as that variable's line on the graph.

Arrange

One of the benefits of the Microsoft Windows environment for a program such as **Lateblight** is that it allows multiple copies (or "instances") of a program to be run simultaneously. In this way, it is possible to do side-by-side comparisons with each instance of **Lateblight** simulating a different situation. The **arrange** command is intended to be used when more than one instance of **Lateblight** is running. Selecting this command from the View menu will cause all non-iconic **Lateblight** windows to be arranged side-by-side to use the full screen without overlapping. This command will arrange any number of **Lateblight** windows, but is really only practical with three or fewer. If there are more than three **Lateblight** windows to be arranged, each gets only a very narrow slice of the display, making viewing very difficult. Note that instances of **Lateblight** which have been minimized and are represented only by icons will not be arranged.

Keyboard Actions

Like most Microsoft Windows applications, **Lateblight** is designed to use a mouse. Although a mouse is strongly recommended, it is not essential. A keyboard interface has been provided for all of the essential features of the program. Even when a mouse is present, there may be times when the keyboard interface is more convenient for certain actions. Wherever possible, we have used the keystrokes that are standard among Windows applications. The following is a brief summary of the keyboard interface of **Lateblight**.

The Main Window

The menu system uses the standard Windows keystrokes; underlined letters in menu items represent hot keys. The <Alt> key followed by the appropriate hot key provides access to a popdown menu. For example, <Alt>, F causes the **File** menu to pop down. The arrow keys move the highlight to different items within the menu. Pressing <Enter> with a menu item highlighted is the same as selecting that menu item with the mouse. Pressing the hot key for a menu item has the same effect. While the **File** menu is pulled down, pressing 'O' invokes the **Open** dialog box.

The window scroll bars also use the standard keystrokes. <PgUp> and <PgDn> operate the vertical scroll bar, while <Ctrl>+<PgUp> and <Ctrl>+<PgDn> operate the horizontal scrollbar. Note the distinction between the horizontal window scroll, which appears at the very bottom of the window when it is displaying a graph that is wider than the window, and the simulation scrollbar, which appears below the x-axis when a season is in progress and is used to advance the date. The simulation scrollbar uses the <+> key to advance one day, or <Ctrl>+<+> to advance one week. <End> is equivalent to dragging the thumb all the way to the right, and advances the simulation to the end of the season.

Dialog Boxes

<Enter> and <Esc> operate the "OK" and "Cancel" buttons, respectively. The <Tab> key shifts the input focus from one control to the next. The control with the input focus is the one that will respond to keyboard actions (other than <Enter> or <Esc>). The input focus is indicated by highlighting of the text in an edit control, or a dotted rectangle around a radio button. When a radio button has the input focus, the spacebar toggles its status. If the button is one of a mutually exclusive group, when it is deselected, the next button in the group will automatically be selected.

The Colors Dialog

The Colors dialog box allows you to reassign the colors that are used to represent the various simulation variables on the graph. It is a little different from most of the other dialog boxes. <Tab> cycles among the currently selected radio button, the color palette, the "OK" button and the "Cancel" button. When the input focus is on a radio button, the spacebar or the arrow keys can be used to select a different button. When the input focus is in the color palette, it is represented by an inverted rectangle on the current color button. The focus is moved from one color button to the next by using the arrow keys. Pressing the spacebar while the input focus is on a color button has the same effect as clicking that color with the mouse; that color is assigned to the variable whose radio button is selected.

Getting Help

Lateblight features a context sensitive help system which provides information about all aspects of the program, To access the help system, press **F1**. This will take you directly to the help item most appropriate for your current situation. If no specific help item exists you will be presented with the help index. Selecting **Index** from the **Help Menu** will take you directly to the help index.

To get help on a menu command, pull down the menu and highlight the command using either the mouse or the arrow keys. While the command is still highlighted (don't let up on the mouse button!), press **F1**. The Help window will appear with the appropriate information.

To get help while in a dialog box. press **F1**.

If you need more general help with the **Microsoft Windows ®** environment, use the **Help Menu** in either the **Program Manager** or **File Manager** window.

To learn more about the help system, press **F1** while the Help window is active, or select **Using Help** from the Help window's **Help Menu**.

About Lateblight

Lateblight is based on the work of **Bruhn *et al.***. The simulation has been refined and adapted to the Microsoft Windows ® environment (ver. 3.0 or higher) by **Barr Ticknor** and **Phil Arneson** , Department of Plant Pathology, Cornell University. **Lateblight** is

Permission is hereby granted for this program to be freely copied and distributed subject to the following terms and conditions:

1. All such copying and distribution must be done **free of charge**.
2. The program and all associated materials **must not be modified** in any way.
3. **All** of the following files must be distributed together :

LATEBLIT.EXE	- the main program
KEYHOOK.DLL	- the keyhook library which supports the context sensitive help system.
LATEBLIT.HLP	- the help file
LATEBLIT.WRI	- the manual in Microsoft Windows Write format
COOLWET.LWX	- the sample weather files
HOTDRY.LWX	
MODDRY.LWX	
MODMOD.LWX	
MODWET.LWX	

4. **If Lateblight is used in the teaching of any academic course, registration is required.** For each course and each semester in which **Lateblight** is used, a copy of the course registration form from the back of the manual must be completed and sent to the address given below before the program is used. In addition, at the end of the course, or at the end of the module in which **Lateblight** is used, each student must be required to complete a copy of the Student Questionnaire at the back of the manual. These questionnaires must be returned promptly to the address below. These requirements are in lieu of any other payment.

Registration forms, student questionnaires, and donations in any amount to support the development of other programs such as this should be sent to:

Department of Plant Pathology
Cornell University
Ithaca, NY 14853
Attn: B. E. Ticknor

References

Bruhn, J. A., R. I. Bruck, W. E. Fry, P. A. Arneson, and E. V. Keokosky. 1980. Lateblight: A Disease Management Game. Computer program and manual, Department of Plant Pathology. Cornell University, Ithaca, NY.

Bruhn, J. A. and W. E. Fry. 1981. Analysis of potato late blight epidemiology by simulation modeling. Phytopathology 71:612-616.

Bruhn, J. A. and W. E. Fry. 1982. A mathematical model of the spatial and temporal dynamics of chlorothalonil residues on potato foliage. Phytopathology 72:1306-1312.

James, W. C., C. S. Shih, W. A. Hodgson and L. C. Callbeck. 1972. The quantitative relationship between late blight of potato and loss in tuber yield. Phytopathology 62:92-96.

Krause, R. A., L. B. Massie, and R. A. Hyre. 1975. Blitecast: A computerized forecast of potato late blight. Plant Dis. Reptr. 59:95-98.