INTRODUCTION TO PLASMO MODEL

The model, called Plasmo (Plasmopora Simulation Model), simulates grapevine downy mildew biological cycle on the basis of agrometeorological parameter, allowing the best timing for fungicide treatments. The model reliability was evaluated during several years of research, comparing the results obtained by applying traditional methods of crop management with those planned according to model simulation.

Plasmo was implemented by collaboration among several institute of Florence: Institute of Agrometeorology and Environmental Analysis for Agriculture (IATA) – National Research Council (CNR); Department of Agronomy and Land Management (DISAT) – University of Florence; Centre for the Application of Computer Science in Agriculture (Ce.SIA) – Accademia dei Georgofili.

THE MODEL

The model simulates the infection cycle development and diseased leaf area. This one represents a topic step, because it is related to the economic threshold of fungicide application. Data required for the simulation, temperature, relative humidity, rainfall, leaf wetness, can be collected from standard agrometeorological station with hourly step. In such a way the obtained information is related to the real pathogen development and it allows to identify the most suitable protection techniques. The initial system status is described by bud break date. This can be easily observed in the field when more than 50% of buds are broken showing little leaves. As an integration of bud break date, it is possible to insert, at any time during the growing season, the leaf area and the disease intensity measured in the field. The model simulates the most important phases of biological cycle of pathogen and determines the timing and the intensity of each infection. The results are expressed in percentage terms, indicating the leaf area covered by the typical lesion determined by the downy mildew, called oil spot.

THE CD-ROM

The interested people can request to the authors a demo version of the software on CD-ROM.

The CD-ROM Plasmo is organised in two directories. In the first (Program) there is the version 3.2 of Plasmo, implemented in Visual Basic 5.0, and all necessary files to run the program. In the second (Demo) some example of input data file. Plasmo needs the operating system Windows 95 or later version.

To install the program, you can copy the directories of the CD-ROM in your hard-disk and before running you have to control that computer operating system uses the point as decimal separator.

To run the program push the icon of Plasmo.exe in the directory where you have copied it.

HOW PLASMO WORKS

INPUT DATA FILE

Before to run the program you need to prepare the file with input data, an example of this is present in the CD-ROM (*demo.txt*).

Fig.1-Example input data file.

You can prepare it with a spreadsheet like Excel filling the column as explained down and saving the file as .txt delimited by tabulation.

The input file has to be prepared with hourly time step (Fig.1):

the Julian day in the first column;

the hourly of the day in the second column;

the hourly temperature (°C) in the third column;

the hourly relative humidity (%) in the fourth column;

the hourly rain fall (mm) in the fifth column;

the hourly leaf wetness (0=dry, 1=wet) in the sixth column.

As it is shown in figure 1, you can use the seventh column to input the observed disease intensity (%) in the field. It is necessary to input this data at 13:00 of the observation day. These values are not used by the model to run the simulation, but they can be useful to calc ulate the statistical indexes of validation (see **Calculate** window). Disease intensity is expressed as a percentage and

it represents the ratio between the area covered by the downy mildew typical lesions (oil spots) and the total leaf area. The degree of attack can be visually estimated in the vineyard, indicating the percentage of damaged leaf area on a sample of at least 100 leaves.

Now you are ready to run Plasmo.

PLASMO START WINDOWS

When you push the icon of Plasmo.exe you will see in the first window four different buttons (Fig.2): *Data set management*; *Calculate*; *Exit*; *About Plasmo*.
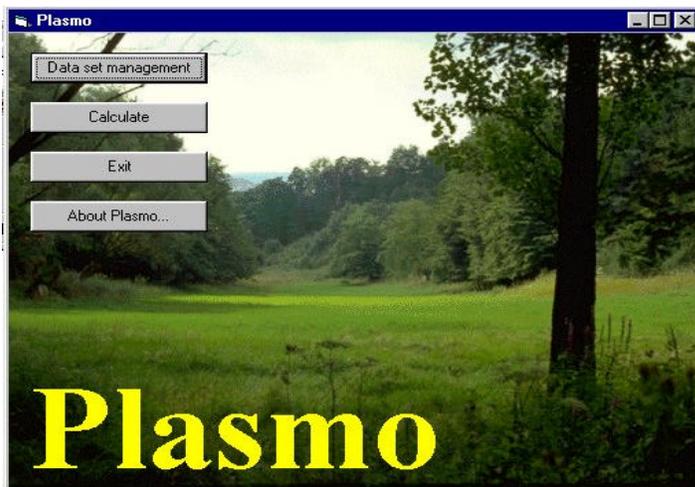

Fig.2-Plasmo start window

DATA SET MANAGEMENT

This button allows you to load the input data from the file prepared before and to manage the start conditions and parameters used by the model (Fig.3). The program can load and utilise at the same time until four different input data series. To load a data set just push the button *Add data* present in the *Data set management* window, and chose the file you wish to load.
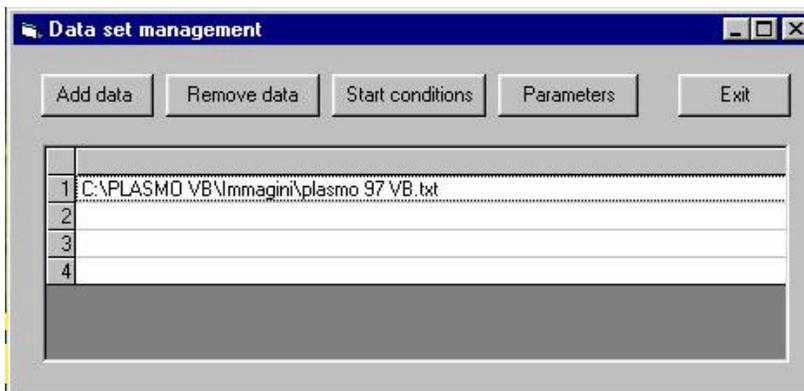

Fig.3-Data set management window

Now you have to set the start conditions and the parameters before to run the simulation. Two additional files are present in the CD-ROM, containing the start conditions (*demo.txt.ini*) and parameters (*demo.txt.par*) related to the input data file. These files are saved by the program with

the same name of the input data file, with the extension *.ini* for the start conditions and *.par* for the parameters file. The program automatically reads these files when you open the input data file if they are saved in the same directory. If they are saved in a different directory or if you open a new input data file that doesn't have related files, the program automatically opens the ***Parameters*** window (Fig.4). You can chose or to load an existing parameters file or to manually input all the parameters. Every time that you will change a parameter the program will save the parameters file relating it to the input data file open at the moment.

However, in this version of the program you have the possibility of changing only the first four parameters, so for the first time you use a new input data file, you have to load a pre-existing parameters file.

Fig.4-Parameters window

After you have set the parameters the program opens the ***Start conditions*** window. In this case you can't open a pre-existing file, but you just have to manually set the start conditions (Fig.5).
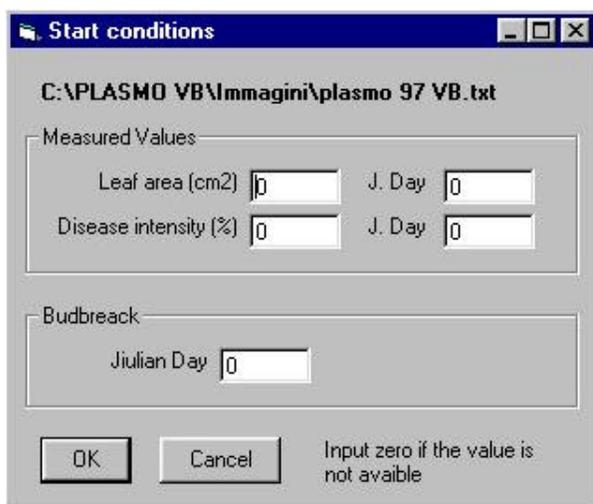

Fig.5-Start conditions window

In this version of Plasmo you can only set the first four parameters, by double clic king on the parameter name.

Here their functions are explained:

S_F0 (sporulation parameter).

Increasing its value you can increase the disease intensity

V_F1 (spore vitality parameter).

Increasing its value you can increase the spore mortality and so you reduce the disease intensity

M_F2 (oil spot vitality parameter).

Increasing its value you can increase the oil spot necrosis and so you reduce the disease intensity

AF_MAX (leaf area max parameter)

This parameter indicates the maximum leaf area per shoot in cm^2 (including primary and secondary leaves) of the considered grapevine variety.

When you enter in the **Start conditions** window you can set three different conditions. The measured leaf area, the observed disease intensity and the budbreak day.

Budbreak day is required by the model to start the simulation. It can be easily observed in the field when more than 50% of buds are broken and show little green leaves. As an alternative to bud break date, it is possible to insert, at any time during the growing season, the leaf area measured in the field with the day of the year. This datum can be directly obtained by using a leaf area meter or can be estimated by applying existing geometrical relationships between the area of each leaf and its dimensions. The unit is square cm per shoot.

The measure of disease intensity represents an optional input for the model together with the day of the year. This measurement must be performed, as explained before, during primary infection, but can be repeated during the growing season to re-calibrate the model in order to obtain better simulation results.

The disease intensity date must follow the date of budbreak or eventually of leaf area measurement.

The date of budbreak or eventually of leaf area measurement must follow the date of the first day of the input data file.

You can also set parameters and start conditions by pushing the buttons present in the **Data set management** window.

After you finish to set all parameters and start conditions you are ready to simulate the development of *Plasmopora viticola* using Plasmo program. To do that just return to **Plasmo start** window and push the **Calculate** button.

CALCULATE WINDOW

Pushing the button **Calculate** in the **Plasmo start** window you will open the **Calculate** window. Here you can see the **Calculate** button, the **Graphic** button, the **Export** button, the **Print** button and an output gird (Fig.6).

Pushing this button you run the simulation for the input data file chosen, and the progress bar at the bottom of the page will move forward. At the same time the program will fill the output grid with the results of the simulations.

The grid can provide useful information about the result of simulation and the comparison with observed trend of the infection. Moreover statistical indexes of validation are automatically calculated.

	Day	DI Obs	DI Sim	(O-S)	(O-S)/O	Abs(O-S)	Abs(O-S)/O
0 VB\nuovi dati\plasmo 96 VB.txt	162	0.147	0.147	0.000	0.000	0.008	0.080
	166	0.200	0.122	0.078	0.389	0.078	0.389
	171	0.537	0.102	0.435	0.811	0.435	0.811
	174	0.500	0.092	0.408	0.817	0.408	0.817
	177	0.500	0.259	0.241	0.481	0.241	0.481
	180	0.695	0.243	0.452	0.650	0.452	0.650
	187	0.958	0.311	0.648	0.676	0.648	0.676
	191	1.590	0.465	1.125	0.708	1.125	0.708
	200	2.443	0.434	2.009	0.823	2.009	0.823
	208	2.500	0.419	2.081	0.832	2.081	0.832
	215	1.780	0.413	1.367	0.768	1.367	0.768
	222	0.991	0.409	0.582	0.587	0.582	0.587
	233	0.763	0.631	0.132	0.173	0.132	0.173
	240	0.798	1.788	-0.989	-1.239	0.989	1.239
	average			0.612	0.453	0.753	0.640

Fig. 6-Calculate window

In the grid you can find eight columns.
The first column, the grey one, reports the name of the input data file analysed. In the second column you can read the Julian day of the field observations of disease intensity. The observed and simulated values of disease intensity are shown in the third and fourth column. The other columns are used to report the following statistical indexes: real error, real relative error, absolute error, absolute relative error. At the end of each column the average value is presented for each input data file.

Graphic window

Pushing the **Graphic** button in the **Calculate** window you will open the **Graphic** window. You can chose to plot four different variables and the scale to use in the graph for each variable. The program allows you to plot the course of the observed and simulated disease intensity, the leaf area and the leaf infected area. If in the input data file the date of the last value of observed disease intensity is preceding the end date of the other input data, in the graphic the observed disease intensity line will go to the zero after the date of the last observed value.

Export button

The **Export** button in the **Calculate** window allows you to export in a text file with column separated by tabulation the entire calculate matrix used by the program during the simulation. Down here a legend of the most important columns of the export file is reported. The other columns represent computing variables.

day	Julian day - Input data
hour	Day hour (0-23) – Input data
temp	Air temperature (°C) – Input data
rh	Air relative humidity (%) - Input data
rain fall	(mm) – Input data

leaf wetness	(0=dry, 1=wet) - Input data
observed disease intensity	(%) - Input data
rh corrected	
leaf area computing	
leaf area	Calculated leaf area per shoot (cm^2)
infected leaf area	Calculated infected leaf area per shoot (cm^2)
night time	
oil spot survival computing1	
oil spot survival computing2	
oil spot survival computing3	
oil spot survival computing4	
sporulating leaf area	Calculated sporulating leaf area per shoot (cm^2)
sporulation computing1	
sporulation computing2	
sporulation computing3	
sporulation computing4	
sporulation computing5	
sporulation computing6	
sporulation event	Calculated intensity of sporulation (cm^2)
spore survival computing1	
spore survival computing2	
viable spore	Calculated viable spores (cm^2)
inoculation computing1	
inoculation computing2	
inoculation computing3	
inoculation computing4	
inoculation computing5	
inoculation computing6	
inoculation event	Calculated intensity of inoculation (cm^2)
incubation computing1	
incubation computing2	
oil spot apparence	Calculated intensity of oil spot appearance (cm^2)
simulated disease intensity	Calculated disease intensity (%)
infection event	Calculated intensity of infection (cm^2)

Print button

The ***Print*** button presents in the ***Calculate*** window allows you to print the output grid displayed in the same window. Automatically the program uses the default printer.

About Plasmo

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