TIP: a Flexible Tool for Integrated Agriculture

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Introduction

Over the last decades, integrated agriculture has become a main issue in the EU. In particular, crop protection strategies deeply changed thanks to both knowledge and technology improvements. Challenges regard the preservation of food safety, quality and production, minimizing the negative impacts resulting by the management of agroecosystems, such as environmental pollution and development of resistance to pathogens. Ultimately, almost every agroecosystem still rely on pesticide use; therefore, these challenges can only be met through the optimization of plant protection strategies.
Phytopathological modelling was initially developed for the very reason of supplying an informative tool to support decision makers in crop protection choices and empower knowledge on pathogenetic systems (Cossu et al., 1996). Therefore, models can be used to forecast disease outbreaks and summarizing the complex interactions of four systems (pathogen, crop, environment and agricultural practices) in few, clear and easy to understand indexes.
Despite of this, an extensive use of models is limited by several difficulties related to input data management, models implementation and calibration, and reliability of results for decision purposes.
On a regional basis, several Italian phytosanitary services already use models to forecast disease outbreaks; however, most of these models are black box that cannot be modified nor parameterized by users and require developer assistance for both calibration and validation. For these reasons, a software platform to run models for integrated agriculture at the regional level has been developed.

Methods

TIP (Tool for Integrated Plant protection) is a software platform aimed at managing pest and disease models developed at DI4A-University of Udine in collaboration with the Regional Agency for Rural Development of Friuli Venezia Giulia (ERSA-FVG). TIP is a flexible, freeware, user-friendly tool working under Windows OS, which allows several levels of model management (model use, model calibration and model development), according to user's role and knowledge (Table 1 and Figure 1.A).

Table 1. Different users and user's objective considered by the TIP platform.

Role	People involved	Objective
End-Users	Farmers and technical advisors	Run models to obtain information on disease progress and infection risk and to set up the protection strategy
Testers	Territorial agency experts and technicians	Test the model local reliability through calibration of parameters and validation of simulation result using field data. They can perform handy calibration from the TIP shell or use the more sophisticated automatic calibration procedure of SemRun* (Danuso et al., 2014)
Modelers	Researchers or others professionals with basic knowledge of principles of system dynamics	Develop and modify the models written in the SEMoLa language. They can also perform simulation, calibration and validation, but they are mainly focused on the design of model's releases and on the upgrade of TIP set of models distributing executable setup for other type of users

* SemRun is an independent application of the SEMoLa package, included even in the TIP installation software.

TIP gives the users an almost complete access to models management, leaving them the right to:
1. choose their own set of models, because model installation is independent on TIP platform;
2. perform procedures of calibration and validation by themselves;

3. modify model equations directly working on source code. This last option requires basic knowledge of System Dynamics principles and SEMoLa language, the installation of the software used for models development (SEMoLa; Danuso et al., 2014) and the PBCC PowerBasic commercial compiler for building executables.

Results and Discussion

TIP has a dialogue window (Figure 1.B) to assist users in both preparation of input files and simulation runs. Simulation results are displayed on a graphical window, reporting the most significant weather variable (upper part) and models outputs (lower part). Results are also stored in "csv" format, if needed. Simulation procedure is simple and straightforward, and require to:

1. select crop and pest or disease from a drop down menu in the upper part of the window;
2. select the name of the pest/disease and then select the model to be used;
3. select weather data. TIP platform is already linked to the FVG regional weather service from which it can automatically download weather data, just selecting location and year of simulation. However, data from other weather stations can also be imported and procedure to download data from other weather regional agencies can be easily implemented as a text file;
4. set the user's measurable parameter, if required by the models;
5. click on "Simulation" button to generate the simulation results. TIP procedure and commands are reported in the dialogue box under the graphical window.

Simulation can be run for a single site or for all the regional weather stations at once. In the latter case, TIP can spatialize simulation results and draw the risk map. Currently, models for *Diabrotica virgifera, Ostrinia nubilalis, Lobesia botrana,* and *Plasmopara viticola* are available in the TIP platform.

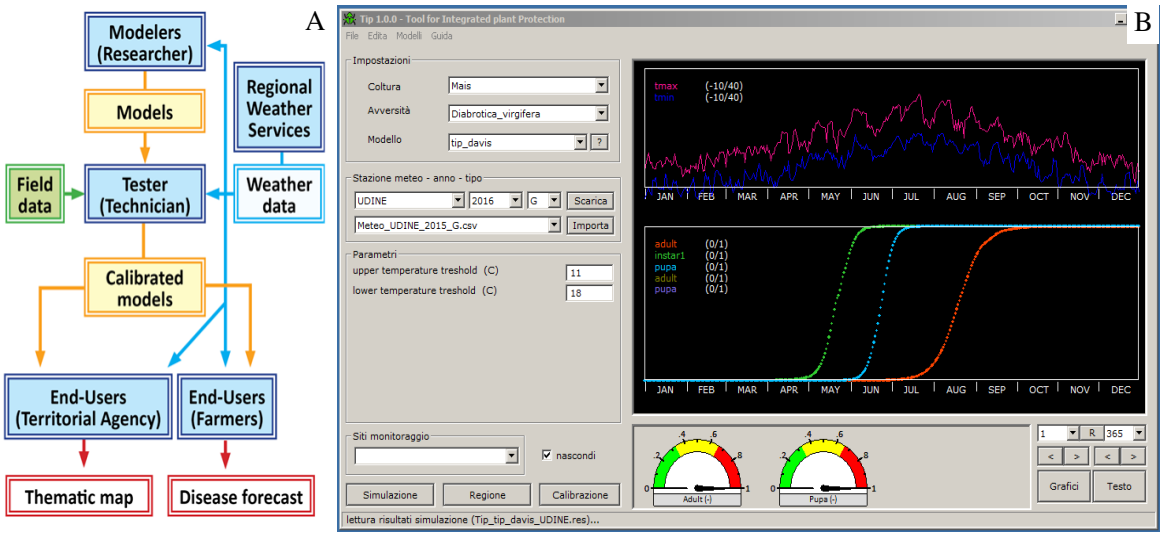

Figure 1. Interaction between TIP users (**A**), TIP dialogue windows running Davis models (Davis et al, 1996) for *Diabrotica virgifera* (**B**).

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