



EasyGrapher v4.5: Software for Graphical and Statistical Evaluation of DSSAT v4.5 Outputs

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1. Introduction

- EasyGrapher is a software package designed by Agriculture and Agri-Food Canada for graphical and statistical evaluation of the DSSAT model (Decision Support System for Agro-technology Transfer).
- EasyGrapher calculates statistics, such as Residual Mean Square Error (RMSE) to evaluate the simulated results with the measured data and the results are displayed by MS Excel.
- EasyGrapher v4.5 can graph many DSSAT v4.5 outputs, including various plant and soil outputs (i.e. nitrogen, carbon, water, temperature) and summary outputs.
- For an example of its graphing efficiency, it can plot PlantGro.OUT (i.e. output from UFGA8101.SBX) within one minute, including 47 Time-course graphs, 16 XY-graphs and numerous evaluation statistics.

2. Program design

EasyGrapher is written using *Microsoft Visual Basic (.NET). It functions by automatically calling a *Microsoft Excel application to perform a series of data handling and graphing tasks. Description of data flow, interfaces and system requirements follows.

2.1 Input and output

Three types of files from the DSSAT model are used as input files for EasyGrapher: (i) time-series outputs (.OUT file), such as PlantGro.OUT; (ii) measured data files (T file), such as UFGA8101.SBT; (iii) DSSAT code label file, DATA.CDE (Tsuji et al. 1994; Hoogenboom et al., 1999). The main outputs from EasyGrapher are displayed in an Excel application in data sheets and graph sheets (Fig. 3, 4, 5, 6). There are also many inter-charts available for viewing (Fig. 1).

2.2 Interface design

Five main interfaces are designed for EasyGrapher:

- (1) A main startup screen with initial start options (Fig. 2a); Additional functionality is added at run-time (i.e. re-graph capability for multiple runs of EasyGrapher).
- (2) An "Open Output File" dialog box displays DSSAT45 crop folders (by default); output files can be selected in the common dialogue box (Fig. 2b, 2c).
- (3) A "Select Data to Display" interface allows users to select Y-variables, treatment numbers (i.e. RUN) and X-variables from three dialogue boxes (Fig. 2d, 2e).
- (4) A "Progress" interface appears on the screen while the program is running (Fig. 2f).
- (5) "MS Excel" program appears on the screen when EasyGrapher ends.

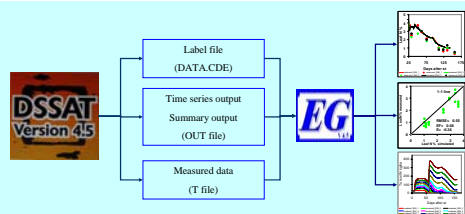


Fig. 1. I/O flow between DSSAT v4.5 and EasyGrapher v4.5

3. Quick steps to run EasyGrapher

1. Click Start – Programs - DSSAT45 - EasyGrapher. When running the EasyGrapher, the first interface will appear on your screen (Fig. 2a).
2. Click **Next** button, then click the DSSAT45\Soybean folder. A common "open file" dialogue box appears (Fig. 2b).
3. Click one output file (i.e. PlantGro.OUT), click **Open** button (Fig. 2c).
4. Select graph variables. Option 1: click **Select All RUN** button, then click Y- axis variable check box; (i.e. leaf number and growth stage), then click **Graph** button (Fig. 2d). Option 2: click **Select All** button to select all RUNs and all Y-variables, then click **Graph** button (Fig.2e). A "Graph running" interface appear while the program is running (Fig.2f)
5. Click **Exit** button to close the program; click **Re-graph** button to graph the same output or click **Next** button to graph a new output.

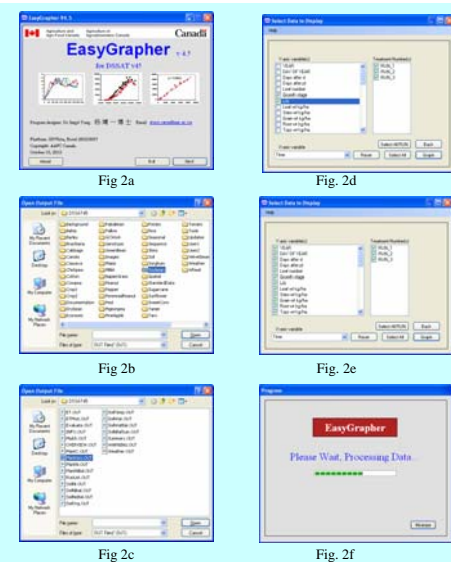


Fig. 2. EasyGrapher v4.5 interfaces

6. View graphs from Excel sheets.

- "Time-Graph" was graphed from "Simulated" and "Measured" data. Only selected Y-variables were graphed.
- "XY-Graph" was graphed from "XY-Graph-Data". All Y-variables in the "Measured" data and the selected RUNs in the "Simulated" data were graphed.
- "Simulated" data is DSSAT 4.5 output
- "Measured" data is the DSSAT 4.5 measured T file
- "CDE" data is DSSAT 4.5 "DATA.CDE" label file.
- "Chart 1" to "Chart n" are intermediate graphs
- If no measured data (T file) in the output file folder, only "Time-Graph" was graphed.

4. Time-series graph

4.1 DSSAT time-series output structure

EasyGrapher uses only four pieces of information in the search engine for opening DSSAT files to graph (see a fragment of DSSAT v4.5 outputs below). Four keywords can be seen in bold letters.

```
*GROWTH ASPECTS OUTPUT FILE
*RUN 1 : IRRIGATED
MODEL : 1 : CHN0800 - SOYBEAN
EXPERIMENT : UFGA7801 SB UFGA7801SB BRAGD, IRRIGATED & NON-IRRIGATED
TREATMENT 1 : IRRIGATED
*YEAR DOY DAS DAP L(EG) GSTD LAID LHAD SHAD GHAD SHAD CWAD CBAD CWGD
1978 166 0 0 0.0 0 0.0 0 0.0 0 0.0 0 0.0 0 0.0
```

EasyGrapher first searches for run numbers, e.g. "RUN 1", then searches for a measured data file name, e.g. 'UFGA7801 SB'. After this, EasyGrapher searches for an ampersand, @, the first letter of the data headers line, and assumes that the letters following in this line are headers, and that each header ends with one or more spaces. The next lines are assumed to be the data-block. Please view "input file" (Table 1) in EasyGrapher help menu for details (Yang and Huffman, 2004).

4.2 Time graph example

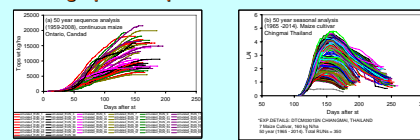


Fig. 3. Time-series graphs with simulated data; (a) Top dry weight against crop age (an example of 50 year sequence analysis, Woodlee, Ontario, Canada); (b) leaf area index against crop age (an example of 50 year seasonal analysis, Changmai, Thailand).

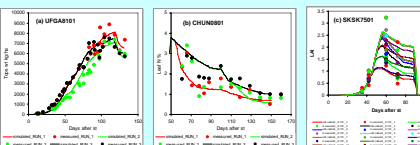


Fig. 4. Time-series graph with measured data; (a) top dry weight against crop age (soybean experiment, UFGA, US, 1981); (b) leaf N(%) against crop age (maize experiment, Changchun, China 2008); (c) leaf area index against crop age (spring wheat experiment, SK, Canada, 1975)

5. XY-graphs & evaluation

Six difference statistics are calculated by EasyGrapher using both measured and simulated data.

$$\begin{aligned}
 1. RMSE &= \sqrt{\sum(y_i - x_i)^2 / n} & 4. EF &= 1 - \sum(y_i - x_i)^2 / \sum(y_i - y_j)^2 \\
 2. MAE &= \sum |y_i - x_i| / n & 5. EF_1 &= 1 - \sum |y_i - x_i| / \sum |y_i - y_j| \\
 3. E &= \sum(y_i - x_i) / n & 6. C &= \sum |y_i - x_i| / n |y_i| = MAE / y
 \end{aligned}$$

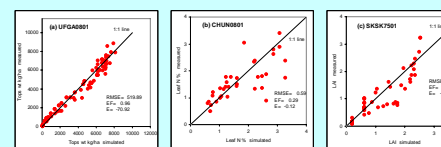


Fig. 5. Validation-graph and statistics; (a) the measured tops dry weight against the simulated data (soybean, UFGA, USA, 1981); (b) the measured leaf N (%) against the simulated data (maize, Changchun, China, 2008); (c) the measured leaf area index against the simulated data (spring wheat, SK, Canada, 1975).

6. Summary graph

EasyGrapher v4.5 can graph DSSAT summary output file. EasyGrapher opens the summary.OUT and produce an intermediate summary file which it uses to graph in MS Excel. The Summary graph is displayed by a line-graph with scatter points (Fig. 6).

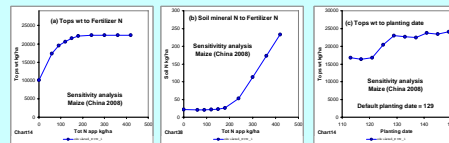


Fig. 6. Examples of EasyGrapher output with DSSAT summary file as input. Fig 6a and 6b are sensitivity analysis of biomass and soil mineral N to fertilizer N rates, respectively. Fig. 6c is sensitivity analysis of aboveground biomass (tops wt) to planting date.

7. EasyGrapher v4.5 help

EasyGrapher help menu was developed in 2004 using Help and Manual package, and it has been updated to the current version. The help contains contents, index and search capabilities, similar to all other help software. It is easy to be invoked by clicking the F1 key from the keyboard when EasyGrapher v4.5 runs.

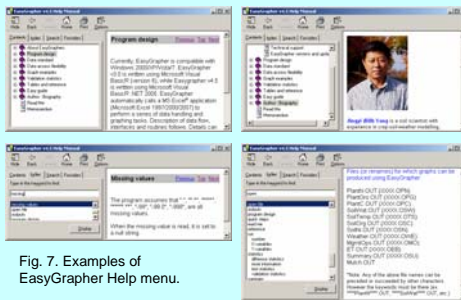


Fig. 7. Examples of EasyGrapher Help menu.

8. Program limitation

EasyGrapher v4.5 is an independent program from DSSAT4.5. There is no internal integration of the I/O data between the EasyGrapher v4.5 and DSSAT v4.5. When using EasyGrapher to graph DSSAT outputs, we recommend that the users set up daily output (i.e. set up FROPT=1 in X file) so that EasyGrapher can easily match the measured outputs without missing.

9. System requirements

Windows XP/Vista/7
Microsoft Excel 2002/2003/2007

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