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## **SPREADSHEET MACROS FOR HANDLING DATA COLLECTED FROM THE LI-6200™ PORTABLE PHOTOSYNTHESIS SYSTEM**

### **MACROS DE PLANILHAS ELETRÔNICAS PARA TRATAMENTO DE DADOS COLETADOS DO SISTEMA PORTÁTIL DE FOTOSSÍNTESE LI-6200™**

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- SHORT NOTE -

#### **SUMMARY**

Spreadsheet macros were developed for processing the information obtained from the LI-6200™ Portable Photosynthesis System using standard software (LOTUS 1-2-3 and EXCEL). The program was developed as a tool to assist in organizing the amount of data collected from that equipment. Data processing by the macros greatly facilitates the analysis and the production of graphics and tables.

**Key words:** data page, information processing, data collection

#### **RESUMO**

Rotinas de programação (macros) para uso em planilhas eletrônicas (LOTUS 1-2-3 e EXCEL) foram desenvolvidas para o processamento das informações obtidas através da utilização do instrumento LI-6200™ Portable Photosynthesis System. O programa foi produzido devido a necessidade de ter uma ferramenta para auxiliar na organização da grande quantidade de dados coletados através deste equipamento. O uso dos macros para o processamento de dados facilita sobremaneira a sua análise, como também a confecção de gráficos e tabelas.

**Palavras-chave:** página de dados, processamento de informações, coleta de dados

#### **INTRODUCTION**

The LI-6200 Portable Photosynthesis System™ is a commercially available equipment for making gas exchange measurements. It has been widely used in agrometeorology and plant physiology research to measure photosynthesis and stomatal resistance. This system is also capable to provide readings of several different parameters, such as leaf and air temperature, relative humidity in the chamber, vapor pressure and intercellular and atmosphere CO<sub>2</sub> concentrations.

In general, at the end of a measurement session, the collected data are transferred to a host computer through an interface with help of a proprietary software supplied by LICOR (PC6200). The data, organized in a specific configuration named Data Page, are downloaded in standard ASCII (American Standard Code for Information Interchange). Using similar methodology as reported by MARUR et al. (1996), when uninterrupted measurements were taken during all day, it is possible to gather approximately 130 Date Pages.

Due to the massive amount of data that can accumulate during any measurement period, the data analysis is a time-consuming process. Furthermore, the difficulties in having the collected Data Pages in a simple format may often lead to poor utilization of all available data. For instance, after downloading the data to the host computer, some researchers print the data in the original format to select the parameters that will be used in further analysis, and later re-enter them through keyboard. Besides being a tedious and arduous

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process, the probability of error increases each time the data are transcribed.

Also, some users adjust the equipment in such a way to collect just one observation per Data Page. This is a questionable procedure because if any disturbance happens with the system at the beginning of a measurement it will invalidate the Data Page. Therefore, it is advisable to configure the equipment for collecting at least 3 observations per Data Page. In case of any dubious data, it will be still possible to eliminate that specific element and preserve the remaining Data Page. However, because of the large output volume of a Data Page with 3 observations (Table 1), treatment of the raw data becomes increasingly difficult.

Spreadsheet softwares have been largely used for data treatment and graphics presentation. Operation routines in spreadsheets, also called macros, have been developed by WULSTER (1993), LYON et al. (1993) and TRUDGILL et al. (1994) mainly to ease data processing and calculation.

This paper describes a program developed for personal computer, which was written with the macro languages of LOTUS 1-2-3™ and later adapted to work with EXCEL™ for WINDOWS™, to provide a quick and easy alternative to LICOR Portable Photosynthesis System users to process the large amount of data collected through this equipment.

### DESCRIPTION

The program was developed for use on the IBM® PC with Excel for Windows and has been used in our research program for the past year. It requires less than 30 Kb of memory and is presented in two versions, PPS-E.xls (English) and PPS-P.xls (Portuguese), which can be loaded into the xlstart directory within Excel and run by simple selecting the file name.

**Table 1.** Original output format of the data downloaded from LI-6200 Portable Photosynthesis System.

PAGE	TIME		SYSTEM							
38	12 MAY 09:54:30		0							
P(mb)	Vt(cc)	Vg(cc)	A(cm2)	BC(mol)	STMRAT	Fx(umol)	Kabs	A8	A9	
949.9	1140.	130.0	8.880	1.300	1.000	1030.	1.100	0.0	0.0	
TREATMENT		PLANT								
2		1								
OB	TIME	QNTM	TAIR	TLEAF	CO2	FLOW	RH	EAIR	DE/DT	DC/DT
1M	5.620	1704	25.23	24.91	361.5	582.1	58.11	18.66	.0272	-.5153
2M	17.58	1775	25.59	25.36	355.6	583.1	57.71	18.93	.0309	-.4996
3M	29.52	1726	25.78	25.39	349.7	582.4	57.90	19.21	.0206	-.5103
1R	7.200	68.77	.2977	.3749	3.735	1.811	.4928	.1987	.0065	.0144
2R	7.100	15.04	.1786	.1235	3.484	2.717	.1232	.2409	.0047	.0146
3R	7.200	96.71	.0893	.1609	3.647	.9417	.1232	.1426	.0039	.0060
OB	PHOTO	COND	CINT	RS	CS					
1	1.077	1.767	319.3	.2168	4.612					

The program consists of 3 spreadsheets. All the necessary information to execute the operations to handle the data is comprised in the first spreadsheet, named **INSTRUCTIONS**.

The spreadsheet **ORDERING** contains the macro that performs the primary arrangement of the data stored in the Data Pages. When this macro is started by the command key **<Control+a>**, the data will be treated in such a way that any observation regarded as an outlier can be easily detected by a simple verification of the resulting output (Table 2).

After that, the data are transferred to the third spreadsheet (**MEAN**), where a command key **<Control+m>** is entered to start another macro. With this macro the means of the various parameters collected by the equipment are computed. Subsequently, the data are grouped by the auxiliary data treatment and plant number in a format that greatly facilitates the production of graphics and tables (Table 3). The equipment indicates the time of the measurements in hours and minutes. This macro converts both parameters in a single one (decimal format) to facilitate the production of graphics.

**Table 2.** Output format after running the macro in the spreadsheet ORDERING.

PAG	DAY	TIME	trt	plnt	PAR	TAIR	TLEAF	CO2	FLOW	RH	EAIR	DE/DT	DC/DT	PHOTO	COND	CINT	RS	CS
38	12	0954	2	1	1704.	25.23	24.91	361.5	582.1	58.11	18.66	.0272	-.5153	1.077	1.767	319.3	.2168	4.612
					1775.	25.59	25.36	355.6	583.1	57.71	18.93	.0309	-.4996	1.040	1.718	313.8	.2226	4.490
					1726.	25.78	25.39	349.7	582.4	57.90	19.21	.0206	-.5103	1.070	1.693	306.7	.2258	4.428

**Table 3.** Final output after running the macro in the spreadsheet MEAN.

PAG	DAY	TIME	trt	plnt	PAR	TAIR	TLEAF	CO2	FLOW	RH	EAIR	DE/DT	DC/DT	PHOTO	COND	CINT	RS	CS
37	12	9.87	0	1	1343	26.06	25.43	357	582.9	57.1	19.25	-0.018	-0.369	0.801	1.33	318.6	0.29	3.486
35	12	9.5	0	3	1455	21.75	21.71	362	582.7	67.4	17.53	-0.012	-0.515	1.125	2.56	327.4	1.05	6.613
38	12	9.9	2	1	1735	25.53	25.22	356	582.5	57.9	18.93	-0.026	-0.508	1.062	1.73	313.3	0.22	4.51
36	12	9.55	2	3	1419	21.9	21.78	360	582.6	66.8	17.54	-0.013	-0.377	0.826	2.46	333.1	0.16	6.351
39	12	9.93	4	1	1578	25.61	25.69	364	582.7	57.3	18.81	-0.014	-0.315	0.682	1.19	327.1	0.32	3.113
40	12	9.98	4	2	1423	24.88	24.79	352	580.8	62.7	19.7	-0.025	-0.281	0.619	1.63	324.8	0.24	4.243

Using the software as discussed in this paper requires programming the LI-COR Portable Photosynthesis System through function 41 and function E8, according to the scheme shown in Table 4. As a result, the equipment will prompt for the treatment name (i.e., a number) and for the plant number just after each measurement. The number of observations must be programmed using function 42.

If an output distinct of the one presented in

**Table 4.** Instructions to program the functions E8 and 41.**- function E8**

LAB: any one

NUM: 5

1:E6 (clear pad)

2:E9 (LOG mode)

3:4A (Ask leaf area)

4:AA (prompt for TREATMENT #)

5:AB (prompt for PLANT #)

**- function 41**

the first two auxiliary data prompts must be:

pr1= TREATMENT

pr2= PLANT

Table 1 (i.e., different number of observations and/or number of auxiliary data) is required, the macro in the spreadsheet ORDERING is programmed to automatically accept it. The default for number of auxiliary data is two: treatment and plant; therefore, if the user wants to program the instrument with a different number of auxiliary data, this parameter must be modified in the spreadsheet.

The macro in the spreadsheet MEAN sorts all data by the key columns treatment and plant. If necessary, the user can also select different columns to sort by changing the instruction written in line 9 of this macro. After completing all operations, the results should be saved in a new file.

**OBTAINING THE PROGRAM**

The program discussed in this paper is available for downloading from the Áreas Técnicas - Ecofisiologia section of the IAPAR World Wide Web site located at [www.celepar.br/iapar](http://www.celepar.br/iapar) or by sending a self-addressed diskette to CJM.

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