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A Visual Interactive version of CERES-Maize

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A Visual Interactive version of CERES-Maize

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SUMMARY

The computerized model of the growth and development of maize (*Zea mays L.*), CERES-Maize by Jones and Kiniry (1986), provides a powerful means to studying this crop. V/I CERES-Maize considerably improves the capabilities of CERES-Maize by providing monitoring of and interaction with the simulation as it proceeds, and also providing a more flexible parameter input. Daily graphical display of important variables and graphs of soil water and soil nitrate profiles on screen allow the user to monitor the simulation. The user interacts with the model by halting the model on any day and controls the simulation with a small set of simple commands.

CITATION

Hargreaves,J.N.G., and McCown,R.L. (1988). V/I CERES-Maize: A Visual Interactive version of CERES-Maize. CSIRO Aust. Div. Trop. Crops and Past., Trop. Agron. Tech. Mem. No. 62.

Keywords

Simulation model, crop growth, maize growth, interactive modelling.

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1. INTRODUCTION

"CERES-Maize, A Simulation Model of Maize Growth and Development" (Jones and Kiniry 1986) provides documentation and software for two versions of CERES-Maize; one simulates the effect of weather, soil water and cultivar on crop growth (Standard version) and the other additionally simulates the effects of fertilizer nitrogen and important soil and plant nitrogen transformations (Nitrogen version). V/I CERES-Maize is a version developed to make the CERES-Maize simulation model (a) more versatile and (b) capable of operating in an interactive mode. This manual documents the enhancements to the software and is written to be used in conjunction with the CERES-Maize documentation. It assumes that the user is familiar with CERES-Maize.

1.1 Rationale for Changes

The Standard and Nitrogen versions are written in Fortran source code and, as is usual with models written in this language, run in a batch mode. In this mode, the user sets up the input files, runs the program, and examines the output files, repeating the process for each change made to the input parameters. For some applications this mode of operation is ideal. However, for others there is a need for the user to interact with the simulation as it progresses. This concept, known as Visual Interactive Simulation (VIS) and discussed by Bell and O'Keefe (1987), besides providing a simple portrayal of the simulation with animation, more importantly provides interaction with the running simulation. A convenient means of monitoring changes and pausing the simulation at any point is needed to facilitate such interaction. At a pause the user needs to be able to take action, e.g. examine output and current variable values, change parameters, progress rapidly to a future point, or return to an earlier point.

Except for the additional code for nitrogen dynamics, code of the Nitrogen version is essentially that of the Standard version. Thus future changes to the common code in either version need to be duplicated in the other. In V/I CERES-Maize this complication is avoided by having only the code for the Nitrogen version with a switch to by-pass the nitrogen sub-model for when the effects of N are not accounted.

For every set of conditions to be simulated by CERES-Maize, a separate parameter file containing one set of input parameter data is needed. This can result in a proliferation of small parameter files containing mostly duplicated parameter data and wasted disk space. Duplication of input parameter data and the inconvenience of many small data files can be avoided by storing many input parameter sets in one file and identifying the sets with flags. Thus input parameter data can be organized into logical groups and stored in fewer and larger files.

1.2 The "minimal-disruption" strategy used in modification of CERES-Maize.

V/I CERES-Maize is an enhancement of the Nitrogen version in which changes have been made in such a way as to minimize deviation from the original. An interactive "front end" interfaces with the existing model with little change to the original modules. The operation of the model, the input parameter data, and the output remain as documented in the original publication unless the user specifically invokes an enhancement. Users of CERES-Maize can run V/I CERES-Maize without making any changes to their input files or their method of operation. Using default options, V/I CERES-Maize operates as CERES-Maize Nitrogen version. The majority of new code has been added as new modules and new subroutines; users familiar with the code of the Nitrogen version will find minimal change to the original modules. Conformation of Fortran source code to ANSI Fortran 77 Standard and avoidance of machine dependent software features has been retained. This allows the model to be run on a wide range of computers and compilers.

1.3 Features of V/I CERES-Maize

1.3.1 Increased versatility:

i. The ability to put all or some input parameter data into an auxiliary file and to select required input parameter data sets using flags in the main file.

ii. The ability to perform multiple simulation runs during a single execution of the model. A flag is provided to allow the weather data file to be rewound before the current simulation run. The simulation run using the next input parameter set can either continue on in the weather file or start at it's beginning.

iii. The ability to specify the input parameters of the CERES-Maize input parameter file in a free format command mode. This eliminates errors of incorrect format, and makes it easier to check parameter settings.

iv. Provision of a switch to turn off the nitrogen subroutines, thus allowing the one program to be used both for when N is limiting and when it can be assumed that it is not.

v. Capability to operate at any latitude, in either the northern or southern hemisphere. (The factor ALX, used in the soil temperature curve in subroutine SOLT is shifted by six months when a southern latitude is specified.)

(An early version of CERES-Maize, obtained from J.Kiniry, contained concepts similar to features i-iv, but these did not appear in Jones and Kiniry (1986))

1.3.2 Interactive mode option:

In this mode the user can -

i. Monitor daily changes of selected variables by the dynamic display of their names, current values and bar graphs. Display (or not), scale and threshold value for highlighted display can be altered for each variable individually.

ii. Save variable and array values for the current day and/or at regular intervals so that, at a later day, simulation can be restarted from a saved day. This allows iteration over a chosen period to examine the effects of input or parameter changes.

iii. Display input parameter names and values to review current settings.

iv. Change specified input parameters at any suitable time.

v. Proceed rapidly in the simulation to a nominated day number or the beginning of a nominated phenological stage by suppressing daily screen displays.

vi. Display a graph of the current soil water profile, in the context of LL, DUL and SAT, along with the water profile of the day last graphed. LL is lower limit of plant-extractable soil water, DUL is drained upper limit of soil water content and SAT is saturated water content.

vii. Display a graph of the current soil nitrate profile along with the nitrate profile of the day last graphed.

viii. Display a nominated output file to review current output.

ix. Output to all or nominated files on days additional to the intervals assigned at initialization.

x. Display a help screen.

2. INPUT FILE STRUCTURE

The model has two input modes (standard and command) and two operational modes (batch and interactive). Modes are selected by a special character in column one of the title record (line 1) of the parameter input file. If there is no special character found, the program runs with no special modes (i.e. standard input, batch mode) and operates as the Nitrogen version in Jones and Kiniry (1986). The special characters used to select input and operation modes are -

Operational mode	Input mode	
	standard	command
batch	'any other'	=
interactive	+	#

2.1 Standard input mode

The data in the parameter file can be classified into eight types as follows -

i. line 1 - title record
ii. line 2 - various management, input and output controls
iii. line 3 - genetic data
iv. line 4 - measured data
v. line 5 - soil data
vi. line 6 to line with 000 - soil layer data
vii. line following to next line with 000 - irrigation data
viii. line following to next line with 000 - fertilizer data

For brevity in this document, these data types shall be referred to by the underlined words above. In this file, which contains one parameter set, each data type contains a data sub-set, the combined sub-sets making a complete data set.

Table 1 is an example of a standard parameter input file as described in Jones and Kiniry (1986) p.15, with the number of irrigation and fertilizer applications reduced to two each. The data types are identified in this table by the names in brackets to the right of the data. When V/I CERES-Maize reads this parameter file, it will operate as CERES-Maize Nitrogen version.

TABLE 1 - A standard input parameter file

```
FLO,SC 81  SW=$PEC, IRR, FERT                                            (title)
097 07.10 04.00 34.00 0001 07 14 05 07 07 01.0 1.10                      (management)
PIO 3382          200. .700 800. 650.0 08.50                             (genetic)
156 210 011550 .276 418.5 0000 04.2 23800. 010954 1.62 0248 0158         (measured)
.14 5.00 0.60 60.0 16.8 20.0 060 00500 10.0 80.0 00200 45.0              (soil)
10.0 .075 .210 .250 1.00 .189 0.30 1.55 6.00 02.0 05.0                   (layer)
21.0 .100 .240 .290 0.80 .228 0.17 1.67 6.20 02.0 05.0
30.0 .210 .310 .350 0.40 .310 0.01 1.54 6.50 02.0 05.0
30.0 .210 .320 .360 0.10 .320 0.01 1.54 6.70 01.0 02.0
25.0 .180 .280 .320 0.10 .280 0.01 1.68 6.80 01.0 02.0
0000
121 013.7                                                                (irrigation)
133 004.3
000
090 66.70 10. 01                                                         (fertilizer)
139 66.70 10. 01
000
```

The format of this data, described in Jones and Kiniry (1986), has the following enhancements -

i. The management record (line 2) has two extra fields -

	Column	Format	Variable	Description
a)	53	A1	ISWNIT	Nitrogen switch. Blank or 1 = nitrogen on. 0 = nitrogen off.
b)	55	I1	KWETH	Weather file flag. Blank or 0 = weather file not rewound. 1 = weather file rewound.

ii. Other than the title record, any data sub-set may be read from an auxiliary data file called 'CERESM.DAT' or, if this file is not found, the user is prompted for the file name. If a line in the parameter file begins with a negative number (-1 to -32000) which is called a data sub-set flag, the data sub-set for the type expected on that line is read from the auxiliary data file.

Table 2 is the example parameter file of Table 1, converted to make use of the auxiliary data file shown in Table 5. In this example, V/I CERES-Maize reads each line of the parameter file in turn, and finding a data sub-set flag on the line, locates the data type of the line in the auxiliary file, and then locates the data with sub-set flag number just read (-45 in each case here). In the parameter file, any characters may follow the flag and here the type of record has been entered as a comment. The program ignores this comment.

TABLE 2 - A standard input mode parameter file containing data sub-set flags for an auxiliary file.

```
FLO,SC 81  SW-SPEC, IRR, FERT
-45 MANAGEMENT
-45 GENETIC
-45 MEASURED
-45 SOIL
-45 LAYERS
-45 IRRIGATION
-45 FERTILIZER
```

iii. The parameter file may contain more than one parameter set. Each set of input parameters is separated by a line beginning with a "-" character which may be optionally followed by any character other than a number (Table 3). In the example in Table 3, V/I CERES-Maize reads the first set of parameters, reading the nominated data sub-sets from each data type and runs the simulation until the crop matures. It then reads the second set of parameters and begins a new simulation. The first parameter set selects a management data sub-set (-45) in the auxiliary file that specifies application of irrigation, and the second set selects a new management sub-set (-50) that specifies no irrigation. A new measured values sub-set is also selected. Additionally, the new management data sub-set rewinds the weather file before the next run. These specifications will cause a simulation run on the same data and same season with no irrigation. In the second set, the irrigation line is omitted, just as the data sub-set would be omitted in a CERES-Maize parameter file when no irrigation is specified.

When maturity of the second crop is reached, the program finds there are no more parameter sets and continues water balance simulation to the end of the climate file.

TABLE 3 - A standard input mode parameter file of two parameter sets containing data sub-set flags for an auxiliary file.

```
FLO,SC 81  SW=$PEC, IRR, FERT                  (first
-45 MANAGEMENT                                 parameter
-45 GENETIC                                    set)
-45 MEASURED
-45 SOIL
-45 LAYERS
-45 IRRIGATION
-45 FERTILIZER
------------------------
FLO,SC 81  SW=$PEC, NO IRR, FERT               (second
-50 MANAGEMENT                                 parameter
-45 GENETIC                                    set)
-50 MEASURED
-45 SOIL
-45 LAYERS
-45 FERTILIZER
```

The standard parameter file can also have a mixture of parameter data and data sub-set flags. The example in Table 4 illustrates this, where the measured values and irrigation parameters are in the parameter file. In this table, the comments following the flags have been omitted, to illustrate that they are not needed by the program.

TABLE 4 - A standard input mode parameter file containing some parameter data and some data-set flags.

```
FLO,SC 81  SW=SPEC, IRR, FERT
-45
-45
156 210 011550 .276 418.5 0000 04.2 23000. 010954 1.62 0248 0158
-45
-45
121 013.7
133 004.3
000
-45
```

iv. In the auxiliary data file, each data type is preceded by its name (in capitals) and terminated by a line beginning with a "-" character and optionally followed by one or more non-numeric characters (Table 5). When a data sub-set flag is encountered in the input parameter file, the appropriate data type (MANAGE, GENETIC, MEASUR, SOIL, LAYER, IRRIGAT and FERTIL) is searched for, and when found, the data sub-set flag is searched for within the type.

TABLE 5 - auxiliary data file (CERESM.DAT) for the parameter files in Tables 2, 3 and 4.

```
MANAGEMENT
-45
097 07.10 04.00 34.00 0001 07 14 05 07 07 01.0 1.10
-50
097 07.10 04.00 34.00 0001 07 14 05 07 07 0000 1.10 0 1
--------------------------------------------------------
GENETIC
-45
PIO 3382         200. .700 800. 650.0 08.50
-50
PIO 3383         210. .705 815. 660.0 09.00
----------------------------------------------------
MEASURED
-45
156 210 011550 .276 418.5 0000 04.2 23800. 010954 1.62 0248 0158
-50
170 220 012000 .295 421.5 0000 04.5 24100. 011005 1.68 0253 0164
----------------------------------------------------
SOIL WATER AND NITROGEN
-45
.14 5.00 0.60 60.0 16.8 20.0 060 00500 10.0 80.0 00200 45.0
-50
.13 5.30 0.66 62.0 17.3 22.0 060 00515 10.0 75.0 00210 43.0
----------------------------------------------------
LAYERS
-45
10.0 .075 .210 .250 1.00 .189 0.30 1.55 6.00 02.0 05.0
21.0 .100 .240 .290 0.80 .228 0.17 1.67 6.20 02.0 05.0
30.0 .210 .310 .350 0.40 .310 0.01 1.54 6.50 02.0 05.0
30.0 .210 .320 .360 0.10 .320 0.01 1.54 6.70 01.0 02.0
25.0 .180 .280 .320 0.10 .280 0.01 1.68 6.80 01.0 02.0
0000
-50
10.0 .075 .215 .260 1.00 .000 0.35 1.55 5.00 02.0 05.0
21.0 .110 .255 .300 0.70 .000 0.27 1.67 5.20 02.0 05.0
30.0 .215 .325 .360 0.30 .000 0.11 1.54 5.50 01.0 02.0
30.0 .215 .330 .370 0.20 .000 0.05 1.54 5.70 01.0 02.0
25.0 .185 .290 .330 0.10 .000 0.02 1.68 5.80 01.0 02.0
0000
----------------------------------------------------
IRRIGATION
-45
121 013.7
133 004.3
0000
----------------------------------------------------
FERTILIZER
-45
010 66.70 10. 01
139 66.70 10. 01
000
-50
090 66.70 10. 03
139 66.70 10. 03
000
```

The structure of the auxiliary data file in Table 5 is as follows -

```
type                                            } _  repeated for
flag         } _  repeated for                  }    each data type
data         }    each data sub-set             }
terminator                                      }
```

where -

"type" is one of MANAGE, GENETIC, MEASUR, SOIL, LAYER, IRRIGAT, FERTIL. These may be followed by any other characters as shown in Table 5.

"flag" is a negative integer number which is matched with the value of the flag in the parameter file.

"data" is the appropriate data sub-set in the standard fixed format as described in the original publication.

"terminator" is a line beginning with a "-" and optionally followed by one or more non-numeric characters. e.g. ------

2.2 Inputs in command mode

Data can be read from the parameter file in the command form -

$$\text{parameter}_1\text{=value}_1\text{,parameter}_2\text{=value}_2\text{, etc.}$$

where "parameter" is mostly the same as a parameter name, and "value" is the value to which the parameter is to be set. (In addition, suitable commands such as JPDATE can be read from the parameter file to facilitate interactive use). This portion of the file is in free format and commands can be in any order. Both the form and the content of the commands are identical to that for interactive use which is fully described in Sections 3 and 4.

When the first character of the title record is "=" or "#" the model expects the parameters in this mode. A blank line terminates this mode.

e.g.

=FLO,SC 81 SW=SPEC, IRR, FERT

or

#FLO,SC 81 SW=SPEC, IRR, FERT

Each of these title records would initiate command input mode.

An example of the standard input file in Table 1 converted to command input mode is shown in Table 6.

TABLE 6 - The same file as Table 1 changed to command format.

```
=FLO,SC 01  SW=SPEC, IRR, FERT
ISOW        = 97  , PLANTS= 7.1  , SDEPTH = 4    , LAT    = 34
      DMOD  = .01 , KOUTGR= 7    , KOUTMN = 14   , KOUTNB = 5
      KOUTNU= 7   , KOUTWA= 7    , IIRR   = 1    , INSOIL = 1.1
NAME = PIO 3382   , P1    = 200  , P2     = 0.7  , P5     = 800
      G2    = 650 , G3    = 8.5
ISLKJD      = 156 , MATJD = 210  , XYIELD=11550  , XGRWT  = 0.276
      XGPSM =418.5, XGPE  = 0    , XLAI   = 4.2  , XBIOM  = 23800
      XSTRAW=10954, GRPCTN= 1.62 , XTOTNP= 248   , XGNUP  = 158
SALB        = 0.14, U     = 5    , SWCON  = 0.6  , CN2    = 60
      TAV   = 16.8, AMP   = 20   , JDATE  = 60   , STRAW  = 500
      SDEP  = 10  , SCN   = 80   , ROOT   = 200  , RCN    = 45
DLAYR       = 10.0,       = 21.0 ,        = 30.0 ,        = 30.0 ,   = 25.0
LL          = .075,       = .100 ,        = .210 ,        = .210 ,   = .180
DUL         = .210,       = .240 ,        = .310 ,        = .320 ,   = .280
SAT         = .250,       = .290 ,        = .350 ,        = .360 ,   = .320
WR          = 1.00,       = 0.80 ,        = 0.40 ,        = 0.10 ,   = 0.10
SW          = .189,       = .228 ,        = .310 ,        = .320 ,   = .280
OC          = 0.30,       = 0.17 ,        = 0.01 ,        = 0.01 ,   = 0.01
BD          = 1.55,       = 1.67 ,        = 1.54 ,        = 1.54 ,   = 1.68
PH          = 6.00,       = 6.20 ,        = 6.50 ,        = 6.70 ,   = 6.80
NH4         = 02.0,       = 02.0 ,        = 02.0 ,        = 01.0 ,   = 01.0
NO3         = 05.0,       = 05.0 ,        = 05.0 ,        = 02.0 ,   = 02.0
JDAY        = 121 ,       = 133
AIRR        = 13.7,       = 4.3
JFDAY       = 90  ,       = 139
AFERT       = 66.7,       = 66.7
DFERT       = 10  ,       = 10
IFTYPE      = 1   ,       = 1
```

In the example in Table 6, parameters are in free format command mode and are set out in a particular manner for ease of reading. The attributes of this layout are -

i. Parameters are arranged in columns, separated by commas.
ii. Parameters are in the same order as in the standard format (Table 1).
iii. The parameter that occurs first in the standard format lines is set out to the left margin.

Table 7 shows the parameter file in Table 4 converted to command input mode. Here the parameter layout is a simple free format with no special arrangements for ease of reading.

TABLE 7 - An example of the input file in Table 4, containing flags, converted to command input mode.

```
=FLO,SC 81  SW=SPEC, IRR, FERT
KMAN=-45, KGEN=-45, KSOIL=-45, KLAYR=-45, KFERT=-45
ISLEJD=156, MATJD=210, XYIELD=11550, XGRWT=0.276, XGPSM=418.5
XGPE=0, XLAI=4.2, XBIOM=23800, XSTRAW=10954, GRPCTN=1.62
XTOTNP=248, XGNUP=158
JDAY=121, =133, AIRR=13.7, =4.3
```

3. PROGRAM OPERATION

3.1 Using commands

In V/I CERES-Maize, an important feature of operation is the use of commands. This is the basis for command mode input and is essential to the interactive operational mode. In many instances these commands are the same as variable names in the program, some of these variables being input parameters read from the parameter input file. Commands that are variable names cause the program to set or change the value of the variable or parameter of the same name. These take the form

parameter=value

e.g. ISOW=30

and as described in Section 2.2, there may be many to a line, separated by commas. In some cases the value is not mandatory, and when not specified, a specific action is then taken or a default value is used.

e.g. ISOW
or KOUTGR

These actions are described fully in Section 4, where the values that are not essential are enclosed with square brackets ([]).

Commands that are not variable names generally affect the screen reporting in some way or control the execution of the program during interactive use.

e.g. PLOT
or JPDATE=60

These commands have the form

command=value

where the value, if present, is used to modify the action taken. Again, there may be multiple commands to a line separated by commas as described in Section 2.2.

All commands are capable of being used at any stage; they can be put in the parameter file when in the command mode or used interactively from the keyboard during a simulation. However some commands are not useful at some stages, and others that change particular input parameters can cause incorrect results when used after the initialization stage. These are described in Section 4.

Assuming the user is familiar with CERES-Maize, we shall discuss the commands that affect the input parameters described in Table 2.4 (pp 31-35) of Jones and Kiniry (1986), and then the commands that affect the new facilities added for versatility and interactive control. Some of the input parameters can and may need to be set or changed interactively during the simulation. e.g. fertilizer, irrigation and sowing parameters.

3.1.1 Commands that set or change CERES-Maize input parameters.

Variables described in Table 2.4 of Jones and Kiniry (1986) for the Nitrogen version can be set or changed by the command mode of the parameter file or interactively from the keyboard. These variables are listed in Section 4 and their current values can be displayed by use of the SHOW commands (Section 4). The commands to set or change these parameters take the same form, whether used in the input parameter file (Section 2.2) or interactively. To illustrate this flexible format, consider the following examples.

a. To set the depth of sowing (SDEPTH) to 5 cm, the response to the "Next Command ->" prompt is

```
SDEPTH=5
```

b. To change both depth of sowing (SDEPTH) to 5 cm, and day of sowing (ISOW) to day of year 30, type

```
SDEPTH=5, ISOW=30
```

When parameters are arrays, subscripts are enclosed in brackets or separated from the array name by a blank. When no subscript is specified, a "1" is assumed. Thus the following three commands to set the first element of the irrigation day number array (JDAY(1)) are identical -

```
JDAY(1)=3
JDAY 1=3
JDAY=3
```

In altering multiple values in an array the command need not be repeated for consecutive subscripts, so commands such as

```
JDAY(2)=6, JDAY(3)=15, JDAY(4)=30
```

can be abbreviated as

```
JDAY(2)=6,=15,=30
```

When a command changes a variable's value, the command is usually the same as the variable's name, for simplicity. In some instances, this type of command has an additional effect. These commands are listed below.

a. ISOW without a value, sets the variable ISOW to the next day's day number.

b. KOUTxx commands (KOUTGR, KOUTWA, KOUTMN, KOUTNB, KOUTNU), when used during the simulation stage, reset the frequency counters causing output to the relevant files at the end of the current day. The frequency of output is not affected unless a value is specified. The command KOUT has the same effect as specifying the five KOUTxx commands individually. Here, if a value is specified, the five output frequencies are set to this value.

c. IRR (or +) and FERT don't correspond to a variable name, but alter associated variable values. These two commands when not followed by a value, set JDAY(1) and JFDAY(1) to the following day's day number, causing irrigation and fertilization respectively to take place on the following day, using amounts specified by other parameters. However, IRR=n or FERT=n will result in AIRR(1) or AFERT(1) being set to "n" mm water or Kg/ha fertilizer (of the type specified by the parameter IFTYPE(1).

d. NLAYR, NIRR and NFERT commands reset the number of soil layers, irrigation events and fertilizer events respectively. The variables of the same names are set automatically when the associated arrays are input. These can be changed to smaller values if the user wishes to eliminate some or all of the values input into the associated arrays.

3.1.2 Commands that set or change new parameters for program versatility.

The new parameters added for program versatility can be set or changed with the following commands -

a. ISWNIT turns nitrogen simulation on or off. For example, ISWNIT=0 prevents nitrogen simulation.

b. KWETH controls positioning the weather file before a simulation. For example, KWETH=1 causes the weather file to be rewound before the next simulation run.

c. KGEN, KIRR, KSOIL, KMAN, KLAYR, KMEAS and KFERT set the data sub-set flags for control of the auxiliary data file. For example, KFERT=-45 would cause the data sub-set labelled "-45" in the FERTILIZER data type to be read from the auxiliary data file.

3.1.3 Commands for control of interactive execution and screen display.

These commands enable flexible control of halting and resumption of simulation and form and timing of reporting. For example, the "jump" commands cause progression of the simulation, uninterrupted by daily screen reports, to a nominated day or growth stage. The command STORE, saves all program variables on a given day or days. These can be retrieved in response to BACK or "jump" commands in order to reinitiate program variables and resume simulation from that date, with altered input parameters. To illustrate the use of a command to scale a bar in the graph on the standard PLOT screen, consider the command HLFWT=50 . This would scale the leaf weight bar (LFWT) between 0 and 50.

3.2 Running the program

Start the program running by typing -

CERESVI

The first two prompts are -

TYPE IN PARAMETER FILE NAME

and

TYPE IN WEATHER FILE NAME

to which the user answers with the appropriate file names. This is described on page 154 of Jones and Kiniry (1986).

3.2.1 Auxiliary file

If flags denoting data sub-sets occur in the parameter file, the program looks for an auxiliary file named 'CERESM.DAT'. If this file is not found an additional prompt asking for the auxiliary file name is displayed.

e.g. TYPE IN AUXILIARY FILE NAME

The user replies with the name of the file containing the data.

3.2.2 Using Batch Mode

This is the non-interactive mode, allowing the model to run to completion without any interruption or displays. The program operates as described in Jones and Kiniry (1986). This mode is selected if the first character of the title record contains any character other than "+" or "#". While the simulation is running, at the start of each stage, the stage name is momentarialy displayed at the top of the screen.

If the first character of the title record is "=", then the parameters in the parameter file are read in command mode.

3.2.3 Using Interactive Mode

In this mode the program produces screen reports, at the end of which it pauses, and awaits a command. During the initialization stage, the reports consist of the parameters just read from the input parameter file. During the simulation stage, the reports consist of a daily screen report as shown by the PLOT command (Section 4), or other specific reports displayed by the PLOTSN, PLOTSW, and the various forms of SHOW commands. The program indicates it is awaiting a command by the prompt

Next Command ->

which is displayed below the screen report. At this point appropriate commands may be entered, and the program progresses to the next screen report only after a lone carriage return (<cr>) is pressed in response to the prompt.

The program is controlled by a series of simple commands which allow manipulation of the input parameters, screen displays and progress of the simulation. These commands (described in Section 4) may be entered one to a line or more than one per line. V/I CERES-Maize reads each line of commands and then acts upon each one at a time. If it cannot interpret a command it displays a message indicating the command causing the problem. In this event, commands following on the same line are lost.

3.2.3.1 Initialization stage

When the interactive mode has been specified, information is displayed on the screen as the parameter data is read, and the user is given opportunities to change the parameter data after each data type is read and before other variables are initialized from the input parameters. The input summaries that are written to the general output file (OYLD.DAT) are also displayed on the screen.

After the datafile names have been entered, the program reads the management, genetic, measured and soil parameters from the parameter file and displays the SHOW screen (Section 4). Below this the user is then informed that this data is read and is given the opportunity to change those parameters after the following prompt -

```
Parameter and genetic data read.
  You are in command mode and may alter parameters now.
Next Command->
```

When there are no more changes or commands to be entered, <cr> in response to the 'Next Command->' prompt will cause the first summary to be displayed. This is shown below -

```
CERES MAIZE (NITROGEN VERSION) RUN FOR
  FLO,SC 81  SW-SPEC, IRR, FERT        PROGRAM BEGINS DAY  60

CULTIVAR PIO 3382              POPULATION (PLANTS/M2)   7.10

                         GENETIC CONSTANTS
   P1 200.00     P2 0.70      P5 800.00     G2 650.00     G3  8.500

Next Command->
```

A <cr> entered after this summary allows the program to continue and read the layer data sub-set. When this is read, the SHOWS screen is displayed (Section 4). The user is informed that the layer data is read and given the opportunity to change it after the following prompt -

```
Soil Layer data read.

  You are in command mode and may alter parameters now.
Next Command->
```

After making any changes, <cr> will allow the program to proceed to read in the irrigation parameters. When read, the SHOWI screen (Section 4) is displayed, followed by the following prompt -

```
Irrigation data read.
  You are in command mode and may alter parameters now.
Next Command->
```

After making any changes, <cr> will display the soil layer and irrigation summaries, an example being shown below -

DEPTH-CM	LL	DUL	SAT	ESW	SW	WR	NH4	NO3
0.- 10.	0.075	0.210	0.250	0.135	0.189	1.000	2.00	5.00
10.- 20.	0.075	0.210	0.250	0.135	0.189	1.000	2.00	5.00
20.- 41.	0.100	0.240	0.290	0.140	0.228	0.800	2.00	5.00
41.- 71.	0.210	0.310	0.350	0.100	0.310	0.400	2.00	5.00
71.- 101.	0.210	0.320	0.360	0.110	0.320	0.100	1.00	2.00
101.- 126.	0.180	0.280	0.320	0.100	0.280	0.100	1.00	2.00
126.- 151.	0.180	0.280	0.320	0.100	0.280	0.100	1.00	2.00
TOT PROF	25.2	42.1	48.4	16.9	41.5		43.	82.

IRRIGATION (MM)

	1	2	3	4	5	6	7	8	9	10	11	12
DAY	121	133	139	146	153	160	162	168	170	174	177	201
AMOUNT	14.	4.	14.	14.	6.	11.	27.	27.	27.	26.	26.	28.

	13
DAY	205
AMOUNT	27.

```
Next Command->
```

A <cr> allows the program to continue and read the fertilizer parameters. The *SHOWF* screen (Section 4) is displayed with the following prompt below it -

```
Fertilizer and nitrogen data read.
  You are in command mode and may alter parameters now.
Next Command->
```

After any changes are made, the fertilizer summary is displayed, an example being shown below -

	1	2	3
DAY	90	139	153
AMOUNT	66.7	66.7	66.7
SOURCE	CO(NH2)2	CO(NH2)2	CO(NH2)2

```
Next Command->
```

A <cr> after this will allow the program to begin the simulation stage.

3.2.3.2 Simulation stage

Unless otherwise instructed, the program in this stage (a) computes output for the next day, (b) displays the standard PLOT screen and (c) awaits the next command. A lone carriage return will cause the program to write results for that day, if required, to output files and the simulation to proceed. The user can proceed one day at a time with successive <cr>'s or can switch the daily display off by issuing a "jump" command. In this case, the simulation will progress to the specified day number or stage number before displaying the standard PLOT screen. During the simulation stage the user may control the model run with the commands described in Section 4.

Example of daily report of standard PLOT screen

```
75% SILKING
  6/ 9/81    JDATE=160    STAGE=4.00
SOLRAD  513.       TEMPMX  34.0          TEMPMN  22.3
PRECIP 11.20 pppppp     '           <  LN      21.00 nnnnNNNNNNNNNNNNNNNN   <
CRAIN   156. cccc                   <  LAI     3.750 aaaaaaaaaaaaaaaaaaaaaaaa/
RUNOFF  0.00                        <  BIOMAS   797. bbbbbbbbbb             <
DRAIN   0.00                        <  LFWT    44.69 111111111111111111111  <
CDRAIN  7.18 tttt                   <  STMWT   53.17 ssssssssssssssssssssssss/
ET      5.36 sssppppppppppp         <  RTWT    32.82 rrrrrrrrrrrrrrrr       <
EO      5.36 oooooooooooooo         <  GRNWT     0.0                        <
PESW 1 2.037 1111111111111111.      <  1-SWDF  0.000                        <
PESW 2 1.559 2222222222        .    <  CSD2     0.00 122                    <
PESW 3 3.683 3333333333       .     <  TIMOB    0.05 b                      <
PESW 4  9.12 444444444444444.       <  TOTN    128.4 nnnnnnnnnnnnnnn        <
PESW 5  9.42 555555555555555.       <
PESW 6 7.067 666666666666666.       <
PESW 7 7.049 777777777777777.       <
PESW   39.93 pppppppppppppppp -     <


Next Command->
```

To help understand using the commands interactively, consider the following example in which a user examines the effect of irrigation during grain filling (phenological stage 6).

```
JPSTAG=4 <cr>                                                    (line 1)
<cr>                                                             (line 2)
AIRR=11.2,=27.2,=27.2,=27.4,=26.4,=25.9,=27.7,=27.4<cr>          (line 3)
JDAY=160,=162,=168,=170,=174,=177,=201,=205<cr>                  (line 4)
STORE, KOUT, JPSTAG=6 <cr>                                       (line 5)
<cr>                                                             (line 6)
BACK<cr>                                                         (line 7)
NIRR=0, KOUT, JPSTAG=6<cr>                                       (line 8)
<cr>                                                             (line 9)
```

In line 1, the crop growth stage at which the simulation is to pause is set (grain filling). The lone carriage return on line 2 causes the simulation to run without daily screen displays until the first day of grain filling (phenological stage 4) occurs. Up to this point the program runs according to the parameter values previously set from the parameter file and the keyboard. Lines 3 and 4 set the irrigation arrays AIRR and JDAY to the amounts of irrigation and the day of year of application respectively. i.e. 11.2 mm will be applied on day 160, 27.2 mm applied on day 162 and so on.

Line 5 contains three commands (alternatively, these could be on separate lines). The first (STORE) causes the program to save all critical variables and parameters to a temporary file. The second (KOUT), causes output to be written to all output files regardless of set frequencies, and the third (JPSTAG=6) sets the point at which the next pause is to take place. The <cr> on line 6 causes the program to continue simulation until the first day of phenological stage 6 is reached. The standard PLOT screen is then displayed and the user notes the values of critical variables (this could be done by a "screen dump"). Line 7 (BACK) causes the program to restore all the previously stored variable values (from the STORE command). It is now ready to recommence simulation from the day the STORE command was executed.

Line 8 contains three commands (again, these could be on separate lines). The first (NIRR=0) turns irrigation off, by setting the number of irrigations to zero. The next two commands (KOUT and JPSTAG=6) cause the same actions as previously described. The lone carriage return in line 9 lets the program continue simulation until phenological stage 6 is reached, at which point the standard PLOT screen is displayed and the new results can now be compared with the previously recorded ones. The output files will contain a full record of the entire session.

4. DESCRIPTION OF COMMANDS

This section provides a full documentation of all commands and is intended to be used as a reference section. The commands are grouped by utility and the following conventions are observed.

i. Square brackets ([]) enclose optional values not necessary for execution of the command.

ii. Uppercase elements must be entered as they appear in the documentation.

iii. Lowercase elements describe information to be filled in by the user, such as the letter "n" to indicate a user specified numeric value.

Commands can be entered at any of three stages in the program -

i. From the parameter file, using the command mode. (F - File input).

ii. From the keyboard just after each type of data is read from the parameter file but prior to initialization of other variables dependent upon the parameters read. (I - Initialization).

iii. From the keyboard during pauses in simulation. (S - Simulation).

The program allows any command to be used at any stage, but some combinations will serve no useful purpose and others, whose values are used for initialization of other variables, can cause erroneous results. Recommendations on program stage are provided in conjunction with command description.

4.1 Commands that set or change CERES-Maize input parameters.

These commands are fully described in Table 2.4 of Jones and Kiniry (1986).

Command	Program Stage	Description
(a) Management and switches for input control. (Line 2)		
ISOW[=n]	F,I,S	Sowing date (day of year). If "n" is absent, taken as tomorrow's day number.
PLANTS=n	F,I,S	Plant population (plants/m^2)
SDEPTH=n	F,I,S	Sowing depth (cm).
LAT=n	F,I	Latitude of location (degrees, negative for south).
DMOD=n	F,I	Weighting factor for humus mineralization rate.
IIRR=n	F,I	Switch describing irrigation.
INSOIL	F,I	Indicator for initial soil water.

(b) Output frequency controls. (Line 2)

KOUTGR[=n]	F,I,S	Frequency of growth output (days).
KOUTMN[=n]	F,I,S	Frequency of N mineralization output (days).
KOUTNB[=n]	F,I,S	Frequency of detailed N balance output (days).
KOUTNU[=n]	F,I,S	Frequency of plant N output (days).
KOUTWA[=n]	F,I,S	Frequency of water balance output (days).
KOUT[=n]	F,I,S	Frequency of all five outputs above (days).

These commands cause output to the appropriate file at the end of the current day, and then at "n" day intervals. If "n" is not specified, the current value of "n" is used. They are documented in Jones and Kiniry (1986) as input parameters in line 2 of the nitrogen version, with the exception of KOUT. This command causes output to take place to all output files. If "n" is specified, the other five KOUT variables are set to a new output frequency of "n" days. When these commands are issued, the first write to file at the end of the current day is preceded by a line of the form

+++ n

where "n" is the number of days since the last write to that file. This identifies the line specially requested, and shows the length of the interrupted period the means are taken over.

(c) Genetic information. (Line 3)

NAME=x	F,I,S	Cultivar name.
P1=n	F,I,S	Growing degree days from seedling emergence to end of juvenile stage.
P2=n	F,I,S	Photoperiod sensitivity coefficient (1/hr).
P5=n	F,I,S	Growing degree days from silking to maturity.
G2=n	F,I,S	Potential kernel number (kernels/plant).
G3=n	F,I,S	Potential kernel growth rate (mg/kernel/d).

(d) Measured values. (Line 4)

ISLKJD=n	F,I,S	50% silking date (day of year).
MATJD=n	F,I,S	Maturity date (day of year).
XYIELD=n	F,I,S	Grain yield (kg/ha at 15.5% moisture).
XGRWT=n	F,I,S	Kernel dry weight at maturity (g/kernel).
XGPSM=n	F,I,S	Grain number at maturity (grains/m^2).
XGPE=n	F,I,S	Grain number at maturity (grains/ear).
XLAI=n	F,I,S	Maximum leaf area index (m^2/m^2).
XBIOM=n	F,I,S	Above-ground biomas at maturity (kg/ha).
XSTRAW=n	F,I,S	Stover dry weight at maturity (kg/ha).
GRPCTN=n	F,I,S	Grain N concentration at maturity (%).
XTOTNP=n	F,I,S	Crop N content at maturity (kg/ha).
XGNUP=n	F,I,S	Grain N content at maturity (kg/ha).

(e) Soil information for whole profile. (Line 5)

SALB=n	F,I,S	Soil albedo (unitless).
U=n	F,I,S	Stage 1 soil evaporation coefficient (mm).
SWCON=n	F,I,S	Whole-profile drainage rate coefficient.
CN2=n	F,I	Runoff curve number.
TAV=n	F,I,S	Mean annual air temperature (^{o}C).
AMP=n	F,I	Difference between highest and lowest mean monthly air temperatures (^{o}C).
JDATE=n	F,I	Day of year of first day of weather data.
STRAW=n	F,I	Residue weight (kg/ha).
SDEP=n	F,I	Depth of residue incorporation (cm).
SCN	F,I	Residue C:N ratio (kg C/kg N).
ROOT=n	F,I	Root dry weight of previous crop (kg/ha).
RCN	F,I	Root C:N ratio (kg C/kg N).

(f) Soil layer information.

DLAYR(i)=n	F,I	Layer thickness (cm).
LL(i)=n	F,I	Lower limit of plant-extractable water (cm/cm).
DUL(i)=n	F,I	Drained upper limit (cm/cm).
SAT(i)=n	F,I	Water content at saturation (cm/cm).
WR(i)=n	F,I	Weighting factor for root distribution (unitless).
SW(i)=n	F,I	Initial water content (cm/cm).
OC(i)=n	F,I	Organic carbon concentration (%).
BD(i)=n	F,I	Moist bulk density (g dry soil/cm^3 moist volume of soil).
PH(i)=n	F,I	Soil pH in 1:1 soil:water slurry.
NH4(i)=n	F,I	Initial soil ammonium concentration (mg elemental N as NH_4/kg dry soil).
NO3(i)=n	F,I	Initial soil nitrate concentration (mg elemental N as NO_3/kg dry soil).
NLAYR=n	I	Number of layers read into above arrays. This is set automatically when the soil layer information is read. The user can alter this variable to control the number of layers used for the run.

(g) Irrigation information.

JDAY(i)=n	F,I,S	Irrigation date (day of year).
AIRR(i)=n	F,I,S	Irrigation amount (mm).
NIRR=n	I,S	Number of irrigation dates read into above arrays. This is set automatically when the irrigation information is read. The user can alter this variable to control the number of irrigations used for the simulation. e.g. NIRR=0 turns irrigation off.
IRR[=n] +[=n]	S S	Both of these instruct irrigation to take place on the next day. The amount being "n" mm, if specified, the default being the amount in AIRR(1). This command actually changes the value of AIRR(1) to "n" and JDAY(1) to the following day's number.

(b) Fertilizer information.

JFDAY(i)=n	F,I,S	Fertilization date (day of year).
AFERT(i)=n	F,I,S	Fertilization amount (kg elemental N/ha).
DFERT(i)=n	F,I,S	Fertilization depth (cm).
IFTYPE(i)=n	F,I,S	Fertilizer type code (0-5).
NFERT=n	I,S	Number of fertilization dates read into above arrays. This is set automatically when the irrigation information is read. The user can alter this variable to control the number of fertilizations for the simulation. e.g. NFERT=0 turns fertilization off.
FERT[=n]	S	This command instructs fertilizing to take place on the following day. The amount being "n" kg, if specified, the default being the amount in AFERT(1). This command actually changes the amount in JFDAY(1) to the following day's number and AFERT(1) to "n". The type of fertlizer stored in IFTYPE(1) and the depth in DFERT(1) are used. These may be altered before fertilizing takes place.

4.2 Commands that set or change new parameters for program versatility.

Command	Program Stage	Description

(a) Program and input control.

ISWNIT=n	F,I	Switch to indicate if nitrogen simulation is to take place. 0 = Nitrogen simulation not done, assumes that there is no effect of nitrogen availability. 1 = Nitrogen simulation carried out.
KWETH=n	F,I	Switch to indicate if weather file is to be rewound before this simulation begins. 0 = Weather file <u>not</u> to be rewound. 1 = Weather file to be rewound.

(b) Data sub-set flag numbers.

KMAN=-n	F	Flag number (negative) in the management data type
KGEN=-n	F	Flag number (negative) in the genetic data type
KMEAS=-n	F	Flag number (negative) in the measured data type
KSOIL=-n	F	Flag number (negative) in the soil data type
KLAYR=-n	F	Flag number (negative) in the soil layer data type
KIRR=-n	F	Flag number (negative) in the irrigation data type
KFERT=-n	F	Flag number (negative) in the fertilizer data type

These flag numbers identify the data sub-set to be selected from the corresponding data type in the auxiliary data file.

4.3 Commands for control of interactive execution and screen display.

4.3.1 Online help

HELP   I,S   displays memory aids on the screen.

HELP screen.

```
<cr>            Continue to next part or day.
variable=value,...    or    Array(n)=value,...    Set to value
xvariable=value  Set threshold if x="T" or highest if x="H"
Oxxx            List output file (OWAT,OYLD,OBIO,OMIN,ONIS,ONIP)
SHOW            Display miscellaneous variable values
SHOWx           Display values : x = S - soil parameters,
                I - irrigation,       F - fertilizer,
                B - bar threshold and highest values
STORE(=n)       Save today's variables and at "n" day intervals
BACK(=n)        Restore nth last saved variables
PLOT            Display today's standard screen
PLOTSW          Display today's SW by depth + last displayed
PLOTSN          Display today's NO3 by depth + last displayed
JPDATE(=n)      Run to JDATE  "n" before bar display. -n=go back
JPSTAG(=n)      Run to ISTAGE "n" before bar display. -n=go back
JPEND           Run to end of weather file
BATCH           Run in batch mode
ISOW(=n)        Sow tomorrow or on JDATE "n"
IRR(=n) or +(=n) Irrigate tomorrow by "n" or AIRR(1) mm
FERT(=n)        Fertilize tomorrow by "n" or AFERT(1) kg/ha
KOUT            Write today's values to all output files
KOUTxx(=n)      Write today's values to "xx" output file
                where "xx"=GR or WA or NM or NB or NU
QUIT            Abandon run now
```

4.3.2 Terminate program

QUIT   I,S   closes files and terminates the run. This is effected only after initialization.

4.3.3 Iteration control

STORE(=n)   F,I,S   Writes to a temporary file (unit 99) variables and arrays stored in COMMON blocks. This enables the user to return to this point (using the commands BACK, JPSTAG or JPDATE) and resume the simulation with all variables and arrays reset to the values of that day.

STORE causes an immediate write to the file, and if a value "n" is specified, a write to file occurs every n^{th} day from the current day. When no value is specified, the current value is assumed. A value of 0 prevents subsequent stores. An automatic store takes place on the first day of the run. Each time a store to file takes place, a new record is written to file, and a sequential file of store records is built up for later searches and retrievals. The three commands used to retrieve a day's record provide the user with a convenient means of searching or moving back and forth through the file. When a record has been retrieved, the next store writes a record immediately after the retrieved record, thus previously stored records following the retrieved one are lost.

The temporary file is opened on the default disk drive, each write to file using approximately 7K bytes of space. Thus if "n" is 1 (a daily frequency), and the simulation run for 100 days, 700K bytes of disk space would be required during the run.

Examples:

STORE=10

This example causes a write to take place at the end of the current day and then at 10 day intervals, until the next store command.

STORE

This example causes a write to take place at the end of the current day and then at intervals defined by the last store command, if any.

BACK[=n] S The purpose of this command is to allow a user to move back through the temporary store file, one or more records at a time, restoring stored records as it goes. The user is able to select the required day by inspection and then proceed with the simulation from that day. The program reads from the temporary file (unit 99) the values of all variables and arrays for a day previously written to the file, thus causing the simulation to resume at that day. The command BACK with no value "n" causes the last stored data before the currently displayed day to be read. i.e. "n" defaults to the value 1. If a value "n" is specified, the n^{th} last stored record will be read. The standard PLOT screen is displayed for the restored day, after the data is read.

Examples:

BACK=3

This command causes the 3^{rd} last stored set of values to be reinstated. This is equivalent to the commands

BACK,BACK,BACK

4.3.4 JumP commands

These cause the simulation to run without halting or daily screen being displayed until a specified point is reached. During this period, if a new stage is started, the name of the stage is displayed on the screen for the first day. These commands can be used in the F or I stage of the program to allow simulation to proceed immediately to the specified point, before pausing and displaying the PLOT screen. They can also be used to cause the simulation to resume operation at a previous day for which variable and array values were stored. This facility allows the user to search the stored records for a particular day or stage.

JPDATE[=n] F,I,S The simulation runs until day number "n" is reached. The standard PLOT screen is displayed and the program pauses for the next command. If "n" is not specified, a default of seven days more than the current day number is used. To jump a number of years, the year may be specified in front of the three digit day number. e.g. 88009 will skip to the 9th day in '88. If "n" is negative, the temporary store file is searched for day number "n" and those values restored. If it is not found, the last stored values prior to day "n" are restored. When a backwards jump has taken place, forward jumps can be achieved using the temporary store file by specifying a negative day number greater than the current day. The simulation does not run, but searches the store file in the same manner as for backward jumps. This facility can be used for inspecting the stored records before a selection is made and the simulation resumed.

Examples:

JPDATE=107

This command causes the simulation to run until day number 107 is reached. If the current day number was 100 then the command JPDATE with no value would have the same effect.

JPDATE=-50

This command will cause the simulation to resume at day number 50 or the last stored day prior to day 50.

JPSTAG[=n] F,I,S The simulation runs until stage number "n" is reached, and then pauses and displays the standard PLOT screen. If "n" is not specified the default is the next stage. If "n" is negative, the temporary store file is searched for the first occurrence of stage "n", and the simulation resumes at that day. If stage "n" is not found the last stored values prior to stage "n" are used. Forward jumps using the temporary store file can be achieved in the same manner as described for JPDATE.

Examples:

JPSTAG=3

This causes the simulation to run to the beginning of stage three.

JPSTAG=-2

This causes the simulation to resume at the first occurence of stored data in stage two. If a stage two record is not found, then the last data stored prior to stage 2 is loaded.

JPEND	F,I,S	The simulation runs to the end of the weather file and is equivalent to JPDATE=999.
BATCH	F,I,S	The simulation runs in batch mode from the current point.

4.3.5 Graphic output commands

4.3.5.1 Plotting commands

PLOT S This command causes the current day's standard bar graph screen to be displayed. The screen is divided into two parts down the middle, with important variable names, their values, and proportional horizontal bars of selected characters displayed. The top line displays, on the first day of a new stage, the stage name, the next line the current day's date (mm/dd/yy), the day number (JDATE), and the stage number (STAGE), the fractional part indicating the current point within the stage. The next line displays solar radiation (SOLRAD), maximum temperature (TEMPMX) and minimum temperature (TEMPMN) for which no bars are displayed.

The upper limit of the bars are marked with the symbol "<", which is changed to a "/" when the variable's value exceeds the bar's upper limit. This can be seen for variables LAI and STMWT in the example screen. The plant extractable soil water (PESWn) bars for layers one to NLAYRS have the drained upper limit (DUL) marked with a "." symbol. Thresholds can be set, above which a bar changes to a preset symbol, usually the upper case of the letter being used. In the example below the bar for LN can be seen to change from "n" to "N" at the threshold value of five. In the case where the bar does not exceed the threshold, a ":" marks the point. This can be seen for PRECIP which has a threshold of 25 in the example.

The left side of the screen contains variables relating to water balance and the right side relates to plant growth and nitrogen.

Example PLOT screen of standard bar graph display

```
      75% SILKING
  6/ 9/81    JDATE=160    STAGE=4.00
SOLRAD  513.      TEMPMX  34.0           TEMPMN  22.3
PRECIP 11.20 pppppp    :              <  LN      21.00 nnnNNNNNNNNNNNNNNNN   <
CRAIN   156. cccc                     <  LAI     3.750 aaaaaaaaaaaaaaaaaaaaaaa/
RUNOFF  0.00                          <  BIOMAS   797. bbbbbbbbb             <
DRAIN   0.00                          <  LFWT    44.69 1111111111111111111   <
CDRAIN  7.18 tttt                     <  STMWT   53.17 sssssssssssssssssssssss/
ET      5.36 sssppppppppp             <  RTWT    32.82 rrrrrrrrrrrrrrrr      <
EO      5.36 ooooooooooooo            <  GRNWT     0.0                       <
PESW 1 2.037 1111111111111111.        <  1-SWDF 0.000                        <
PESW 2 1.559 2222222222      .        <  CSD2     0.00 122                   <
PESW 3 3.683 333333333      .         <  TIMOB    0.05 b                     <
PESW 4  9.12 4444444444444444.        <  TOTN    128.4 nnnnnnnnnnnnnnn       <
PESW 5  9.42 5555555555555555.        <
PESW 6 7.067 6666666666666666.        <
PESW 7 7.049 7777777777777777.        <
PESW   39.93 ppppppppppppppp .        <
Next Command->
```

The format of a displayed variable's value is selected automatically by the program by examining the maximum value of the bar (see scaling commands).

Table 8 lists the variables and arrays capable of being shown on the PLOT screen, with their scaling and threshold commands and default settings, and a description of the variable. Many of the variables and arrays are described in the Glossary (pp 175-189) of Jones and Kiniry (1986).

TABLE 8 - List of variables for PLOT screen.

Name	Scaling Command	Scaling Default	Threshold Command	Threshold Default	Description
(a) Water balance					
CDRAIN	HCDRAIN	50.0	TCDRAIN	999999	Cumulative drainage from profile (cm)
CRAIN	HCRAIN	1000.0	TCRAIN	999999	Cumulative precipitation after germination (mm)
DRAIN	HDRAIN	10.0	TDRAIN	999999	Drainage from the profile (cm)
EO	HEO	20.0	TEO	999999	Potential evapotranspiration (mm)
EP	HEP	20.0	TEP	999999	Actual plant evaporation (transpiration) (mm). Part of ET bar.
ES	HES	20.0	TES	999999	Actual soil evaporation (mm). Part of ET bar.
ET	HET	20.0	TET	999999	Actual evapotranspiration (mm). The bar consists of ES (s) and EP (p).
PESW i		SAT(i)	TPESW i	999999	Plant extractable soil water content for layer "i" (1-10) (cm). Layers not defined are not displayed. These are called ESW(L) in CERES-Maize. The bars range from LL to SAT. PESW(L) is defined as SW(L)*DLAYR(L).
PESW		SAT	TOPESW	999999	Total plant extractable soil water in the profile (cm)
PRECIP	HPRECIP	50.0	TPRECIP	999999	Sum of irrigation and rain (mm)
RUNOFF	HRUNOFF	50.0	TRUNOFF	999999	Runoff (mm)

(b) Plant growth

BIOMAS	HBIOMAS	2000.0	TBIOMAS	999999	Dry weight biomass of plant (g/m^2)
CSD2	HCSD2	10.0	TCSD2	999999	Average soil water deficit factor during a growth stage. The bar is cumulative and shows the stage numbers.
GRNWT	HGRNWT	150.0	TGRNWT	999999	Grain weight (g/plant)
LAI	HLAI	5.0	TLAI	999999	Leaf area index (m^2 leaf/m^2 land)
LFWT	HLFWT	50.0	TLFWT	999999	Leaf weight (g/plant)
LN	HLN	25.0	TLN	999999	Number of leaf tips that have emerged
RLV i	HRLV i	100.0	TRLV i	0	Root length density for soil layer "i" (1-10) (cm root/cm^3 soil). Layers not defined are not displayed.
RTDEP	HRTDEP	200.0	TRTDEP	0	depth of rooting (cm)
RTWT	HRTWT	50.0	TRTWT	999999	Root weight (g/m^2)
STMWT	HSTMWT	50.0	TSTMWT	999999	Stem weight (g/plant)
1-SWDF	HSWDF1	1.0	TSWDF1	999999	Water stress factor (1-0). Defined as 1-SWDF1.

(c) Nitrogen

CNSD1	HCNSD1	5.0	TCNSD1	0	Average nitrogen deficit factor during a growth stage. The bar is cumulative and shows the stage number.
CTNUP	HCTNUP	300.0	TCTNUP	0	Cumulative plant N uptake (kg/ha)
FON i	HFON i	100.0	TFON i	0	N in fresh organic matter in layer "i"
IMOB	HIMOB	2.0	TIMOB	0	Total immobilization of mineral N (kg/ha)
MINF	HMINF	2.0	TMINF	0	mineralization of N from fresh organic N pool
MINH	HMINH	2.0	TMINH	0	mineralization of N from humus N pool
NDEM2	HNDEM2	10.0	TNDEM2	0	N demand of the crop (kg/ha)
NH4 i	HNH4 i	100.0	TNH4 i	0	Soil ammonium in layer "i" (mg elemental N/kg soil)
NO3 i	HNO3 i	100.0	TNO3 i	0	Soil nitrate in layer "i" (mg elemental N/kg soil)
PNUP i	HPNUP i	100.0	TPNUP i	0	Potential N uptake from layer "i" (kg/ha)
PTNUP	HPTNUP	200.0	TPTNUP	0	N content of nongrain portion of shoot
RNTRF i	HRNTRF i	100.0	TRNTRF i	0	Rate of nitrification for layer "i" (kg/ha)
SNH4 i	HSNH4 i	100.0	TSNH4 i	0	Ammonium N in layer "i" (kg/ha)
SNO3 i	HSNO3 i	100.0	TSNO3 i	0	Nitrate N in layer "i" (kg/ha)
TANC	HTANC	0.05	TTANC	0	Tops actual N conc. (g N/g dry weight)
TCNP	HTCNP	0.05	TTCNP	0	Tops critical N conc. (g N/g dry wt)
TIMOB	HTIMOB	10.0	TTIMOB	999999	Total N immobilization in profile (kg/ha)
TLCH i	HLCH i	100.0	TLCH i	0	Leaching of NO_3 (kg/ha) in layer "i"
TMINF	HTMINF	30.0	TTMINF	0	Total N released by mineralization of fresh organic matter in profile (kg/ha)
TMINH	HTMINH	30.0	TTMINH	0	Total N released by mineralization of stable humic fraction in profile (kg/ha)
TNH4	HTNH4	100.0	TTNH4	0	Total ammonium N in profile (kg/ha)
TNO3	HTNO3	100.0	TTNO3	0	Total nitrate N in profile (kg/ha)
TOTN	HTOTN	200.0	TTOTN	999999	Total mineral N in profile (kg/ha)
UPFLX i	HUPFLX i	100.0	TUPFLX i	0	Upward movement of NO_3 (kg/ha)
XGNP	HXGNP	5.0	TXGNP	0	Grain N content (%)

PLOTSW

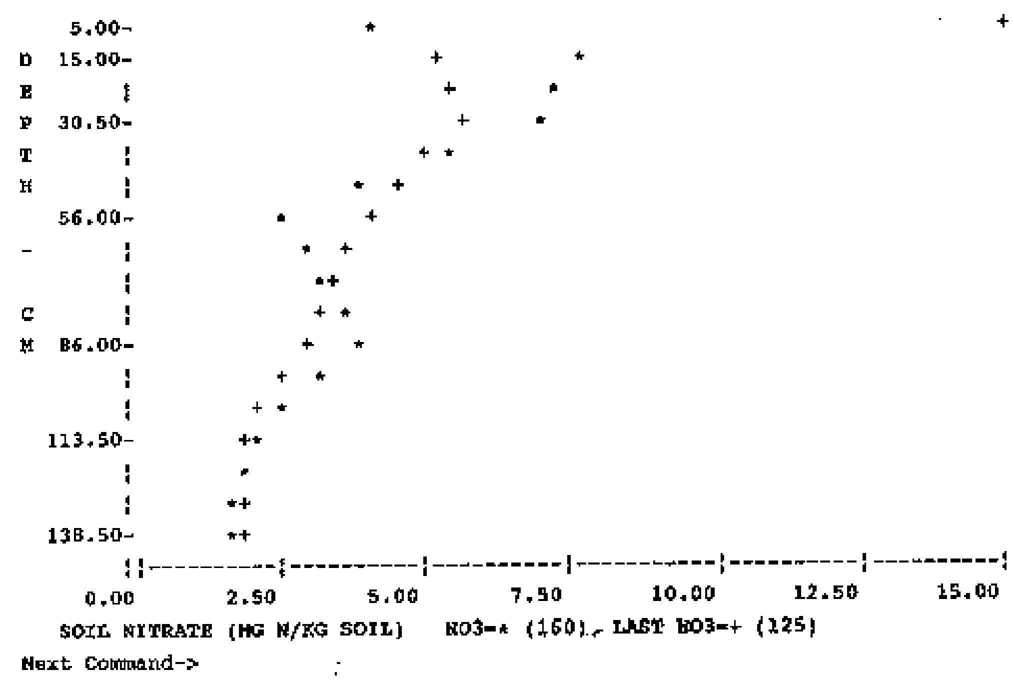
6 A plot of current (*) and last graphed (+) soil water (SW) versus soil depth (DLAYR) is displayed. The day number of each is shown in brackets after the symbols below the graph. The Y axis range is between the midpoints of the top layer and the bottom layer. The Y axis ticks and labels are at the midpoints of each layer. The X axis range lies between the lowest lower limit and the highest saturated water content. The area between the lower limits (LL) and the lower X bound is filled (L) and similarly the area between the saturated water contents (SAT) and the upper X bound is filled (S). The area between drained upper limit (DUL) and saturated water content (SAT) is filled with another symbol (_).

Example PLOTSW screen.

```
     5.00-L            +            *  _________SSSSSSSSSSSSSSSSSSSSSSSSSS
D   15.00-L                  +       *__________SSSSSSSSSSSSSSSSSSSSSSSSSS
E        |LLLL                   +      *  ___________SSSSSSSSSSSSSSSSSSSSSS
P   30.50-LLLLLL                     +     *   ____________SSSSSSSSSSSSSSSSS
T        |LLLLLLLLLLLLLL                     +   *  ___________SSSSSSSSSSSS
H        |LLLLLLLLLLLLLLLLLLLLLLL                   +*  __________SSSSSSS
    56.00-LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                     *+________SSS
-        |LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                      *+________SS
         |LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                      *+________SS
C        |LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                      *  +________S
M   86.00-LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                      *  +________S
         |LLLLLLLLLLLLLLLLLLLLLLLLLLLLL                       *_+________SSSS
         |LLLLLLLLLLLLLLLLLLLLLLLLLLL                       *+________SSSSSSS
   113.50-LLLLLLLLLLLLLLLLLLLLLLLLLL                     _*________SSSSSSSSSS
         |LLLLLLLLLLLLLLLLLLLLLLLLLL                     _*_________SSSSSSSSSS
         |LLLLLLLLLLLLLLLLLLLLLLLLLL                     _*_________SSSSSSSSSS
   138.50-LLLLLLLLLLLLLLLLLLLLLLLLLL                     _*_________SSSSSSSSSS
         ||----------|----------|----------|-----------|----------|----------|
     0.08          0.12       0.17       0.22        0.27        0.31      0.36
    SOIL WATER (CM/CM)    DUL=_   LL=L   SAT=S   SW=* (160)   LAST SW=+ (125)
 Next Command->
```

PLOTSN   S   A plot of current (*) and last graphed (+) soil nitrate (NO3) versus soil depth is displayed. The day number for each is shown in brackets following the symbols below the graph. The Y axis is as for PLOTSW. The X axis uses default upper and lower bounds which may be altered with the commands HNO3 and RMNO3 respectively.

Example PLOTSN screen.



4.3.5.2 Commands for control of bar graph display and highlighting.

These commands are used to set the threshold value for highlighting display of a bar or to add and delete variables for bar graphing. When this value is exceeded by the bar, the bar character changes to a preset character, usually the upper case of the currently used character. When the bar is below this value, the threshold point is marked with ":". The thresholds are preset to 999999.0 and consequently have no effect until lowered. If the threshold is set to 0, then the variable, value and bar are omitted from the screen.

The commands are generally constructed from the variable name (which is displayed on the bar graph) preceded by a "T".

Program stage F,I,S.

(commands for water balance bars)

TCDRAIN=n	TCRAIN=n	TDPESW=n	TDRAIN=n
TEO=n	TEP=n	TES=n	TET=n
TPESW i=n	TPRECIP=n	TRUNOFF=n	

(commands for plant growth bars)

TBIOMAS=n	TCSD2=n	TGRNWT=n	TLAI=n
TLFWT=n	TLN=n	TRLV i=n	TRTDEP=n
TRTWT=n	TSTMWT=n	TSWDF1=n	

(commands for nitrogen bars)

TCNSD1=n	TCTNUP=n	TFON i=n	TIMOB=n
TLCH i=n	TMINF=n	TMINH=n	TNDEM2=n
TNH4 i=n	TNO3 i=n	TPNUP i=n	TPTNUP=n
TRNTRF i=n	TSNH4 i=n	TSNO3 i=n	TTANC=n
TTCNP=n	TTIMOB=n	TTMINF=n	TTMINH=n
TTNH4=n	TTNO3=n	TTOTN=n	TUPFLX i=n
TXGNP=n			

4.3.5.3 Commands for altering the scale of graphs.

i. Plot screen bar displays.

These commands are used to set the maximum value of a nominated bar. When this maximum is exceeded, the bar terminator (<) is changed to a "/" symbol. When this occurs, the maximum can be increased, to allow the bar to keep moving between the daily displays. These maxima are initialized to possibly suitable values.

The commands are generally constructed from the variable names, with an "H" preceding the name.

Program stage F,I,S.

(commands for water balance bars)

HCDRAIN=n	HCRAIN=n	HDRAIN=n	HEO=n
HEP=n	HES=n	HET=n	HPRECIP=n
HRUNOFF=n			

(commands for plant growth bars)

HBIOMAS=n	HCSD2=n	HGRNWT=n	HLAI=n
HLFWT=n	HLN=n	HRLV i=n	HRTDEP=n
HRTWT=n	HSTMWT=n	HSWDF1=n	

(commands for nitrogen bars)

HCNSD1=n	HCTNUP=n	HFON i=n	HIMOB=n
HMINF=n	HMINH=n	HNDEM2=n	HNH4 i=n
HNO3 i=n	HPNUP i=n	HPTNUP=n	HRNTRF i=n
HSNH4 i=n	HSNO3 i=n	HTANC=n	HTCNP=n
HTIMOB=n	HLCH i=n	HTMINF=n	HTMINH=n
HTNH4=n	HTNO3=n	HTOTN=n	HUPFLX i=n
HXGNP=n			

ii. PLOTSN screen

HMNO3=n	F,I,S	Set the lower bound of the x axis
HNO3=n	F,I,S	Set the upper bound of the x axis

4.3.6 Output file commands

Any of the six output files can be displayed by typing its name as a command. The output file is then scrolled on the screen, one page at a time. At the end of each page, the options N/P/E/S may be selected for the following actions.

N or carriage return - display next page
P - display previous page
E - display last page of file
S - stop display and return to command mode.

Program stage S.

OYLD OWAT OBIO OMIN ONIS ONIP

4.3.7 SHOW commands - display current parameter settings

SHOW I,S Displays current settings of all CERES-Maize input parameters, including the new additional controls. These are management, genetic, measured and soil parameters.

Example SHOW screen.

```
FLO,SC 81   SW-SPEC, IRR, FERT
  ISOW=       97   PLANTS=     7.10   SDEPTH=      4.00      LAT=    34.00
  DNOD=     0.01   KOUTGR=        7   KOUTNN=        14   KOUTNS=        5
KOUTNU=        7   KOUTWA=        7    IIRR=      1.00   INSOIL=     1.10
ISWNIT=        1     KGEN=        0    KIRR=         0    KSOIL=        0
 KFERT=        0     KMAN=        0   KLAYR=         0    STORE=   -99999
 KMEAS=        0    KWETH=        0
PIO 3382
   P1=    200.00       P2=     0.70      P5=    800.00
   G2=    650.00       G3=     8.50

ISLKJD=      156   MATJD=       210  XYIELD= 11550.00    XGRWT=     0.28
XGPSM=    418.50    XGPE=      0.00    XLAI=      4.20   XBIOM= 23800.00
STRAW= 10954.00  GRPCTN=       1.62  XTOTNP=    248.00   XGNUP=   158.00

  SALB=     0.14        U=     5.00   SWCON=      0.60      CN2=    60.00
   TAV=    16.80      AMP=    20.00   JDATE=     60.00    STRAW=   500.00
  SDEP=    10.00      SCN=    80.00    ROOT=    200.00      RCN=    45.00
Next Command->
```

SHOWF I,S Displays fertilizer parameters.

Example SHOWF screen.

```
JFDAY( 1)= 90   AFERT( 1)=  66.7 DFERT( 1)=  10.0   IFTYPE( 1)= 1
JFDAY( 2)=139   AFERT( 2)=  66.7 DFERT( 2)=  10.0   IFTYPE( 2)= 1
JFDAY( 3)=153   AFERT( 3)=  66.7 DFERT( 3)=  10.0   IFTYPE( 3)= 1
Next Command->
```

SHOWI I,S Displays irrigation parameters.

Example SHOWI screen.

```
JDAY( 1)=121   AIRR( 1)=13.70 JDAY( 2)=133   AIRR( 2)= 4.30
JDAY( 3)=139   AIRR( 3)=14.00 JDAY( 4)=146   AIRR( 4)=14.20
JDAY( 5)=153   AIRR( 5)= 5.60 JDAY( 6)=160   AIRR( 6)=11.20
JDAY( 7)=162   AIRR( 7)=27.20 JDAY( 8)=168   AIRR( 8)=27.20
JDAY( 9)=170   AIRR( 9)=27.40 JDAY(10)=174   AIRR(10)=26.40
JDAY(11)=177   AIRR(11)=25.90 JDAY(12)=201   AIRR(12)=27.70
JDAY(13)=205   AIRR(13)=27.40 JDAY(14)=   0  AIRR(14)= 0.00
Next Command->
```

SHOWS I,S Displays soil layer parameters.

Example SHOWS screen.

```
 SOIL LAYERS
LAYER DLAYR    LL   DUL   SAT     WR    SW     OC     BD    PH    NH4    NO3
( 1)  10.0 0.075 0.210 0.250  1.00 0.203  0.30  1.55  6.00   0.6   3.9
( 2)  10.0 0.075 0.210 0.250  1.00 0.207  0.30  1.55  6.00   1.9   5.4
( 3)  21.0 0.180 0.240 0.290  0.80 0.230  0.17  1.67  6.20   2.0   5.2
( 4)  30.0 0.210 0.310 0.350  0.40 0.314  0.01  1.54  6.50   2.0   4.9
( 5)  30.0 0.210 0.320 0.360  0.10 0.321  0.01  1.54  6.70   1.0   2.1
( 6)  25.0 0.180 0.280 0.320  0.10 0.282  0.01  1.68  6.80   1.0   2.0
( 7)  25.0 0.180 0.280 0.320  0.10 0.280  0.01  1.74  6.80   1.0   2.0
Next Command->
```

SHOWB I,S Displays standard PLOT screen parameters - Highest value of bar and threshold value of bar.

Example SHOWB screen.

```
 BAR & PLOT THRESHOLDS (T) AND HIGHEST (H)
HCDRAIN=    50.00  TCDRAIN=999999.00   HCRAIN=  1000.00   TCRAIN=999999.00
 HDRAIN=    50.00   TDRAIN=999999.00      HEO=    10.00      TEO=999999.00
    HEP=    10.00      TEP=999999.00      HES=    10.00      TES=999999.00
    HET=    10.00      TET=999999.00  HPRECIP=    50.00  TPRECIP=999999.00
HRUNOFF=    50.00  TRUNOFF=999999.00
 TDPESW=999999.00  TPESW 1=999999.00  TPESW 2=999999.00  TPESW 3=999999.00
TPESW 4=999999.00  TPESW 5=999999.00  TPESW 6=999999.00  TPESW 7=999999.00
TPESW 8=999999.00  TPESW 9=999999.00  TPESW10=999999.00

 HBIOMA=  2000.00   TBIOMA=999999.00    HCSD2=    10.00    TCSD2=999999.00
 HGRNWT=   150.00   TGRNWT=999999.00     HLAI=     1.00     TLAI=999999.00
  HLFWT=    50.00    TLFWT=999999.00      HLN=    25.00      TLN=999999.00
 HRTDEP=   100.00   TRTDEP=     0.00    HRTWT=    50.00    TRTWT=999999.00
 HSTMWT=    50.00   TSTMWT=999999.00   HSWDF1=     1.00   TSWDF1=999999.00
 HRLV 1=   100.00   TRLV 1=     0.00   HRLV 2=   100.00   TRLV 2=     0.00
 HRLV 3=   100.00   TRLV 3=     0.00   HRLV 4=   100.00   TRLV 4=     0.00
 HRLV 5=   100.00   TRLV 5=     0.00   HRLV 6=   100.00   TRLV 6=     0.00
 HRLV 7=   100.00   TRLV 7=     0.00   HRLV 8=   100.00   TRLV 8=     0.00
 HRLV 9=   100.00   TRLV 9=     0.00   HRLV10=   100.00   TRLV10=     0.00
 HCNSD1=     5.00   TCNSD1=999999.00    RMNO3=     0.00     HNO3=    40.00
Next Command->
```

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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APPENDIX I.

I.1 Additional logical unit numbers used by V/I CERES-Maize.

Logical Unit No.	Use
95	Input from keyboard
97	Output to screen
99	Scratch file used by STORE command

I.2 Hardware requirements and host specific parameters

The executable program (CERESVI.EXE) requires an IBM-PC or compatible, a 8087 maths co-processor and an ANSI.SYS or equivalent file declared in a CONFIG.SYS file. The source code, being written in ANSI 77 Fortran, can be compiled, linked and run on any computer that has a Fortran 77 compiler.

Memory (RAM) requirements to run CERESVI.EXE

The program as compiled with Lahey's Fortran Version 2.2 uses 253 Kb of RAM. The MS/PC-DOS operating system and other memory resident programs will require additional RAM. When the source code is compiled by other compilers or on other systems, the memory requirements will differ.

Disk space for CERESVI.EXE and F77L.EER files

The program (CERESVI.EXE) and error message (F77L.EER) files require 258000 bytes of disk space. When the source code is compiled and linked on other systems or by other compilers and linkers, the disk space required will differ.

Disk space for output and scratch files

When the program runs, disk space may be required for up to 6 output files and one temporary scratch file.

The space required is as follows -

Output File	Space used at start up	Space used per run or season	space used per output to file.
store	approx 7000		
OYLD	1493	1563	
OWAT		265	70
OBIO		266	70
OMIN		2164	780
ONIP		266	70
ONIS		269	72

Thus a run that produces output at weekly intervals to all files for one year would require -

store	7000	
OYLD	3056	(1493+1563)
OWAT	3905	(265+ 70*52)
OBIO	3906	(266+ 70*52)
OMIN	42724	(2164+ 780*52)
ONIP	3906	(266+ 70*52)
ONIS	4013	(269+ 72*52)
Total	68508	

Take off the initial overhead (7000+1493) and we have 60017 bytes used per annual crop. Thus it would take 17 runs to exceed 1 megabyte.

Host specific parameters

There are some parameters specified in Subroutine SETHST that may be host specific. These are suitable for IBM-PC compatibles which have DEVICE=ANSI.SYS or equivalent specified in the CONFIG.SYS file and the ANSI.SYS or equivalent file present in the root directory at boot time. Three screen escape sequences used are VT100/220 compatible and IBM-PC compatible when using the ANSI.SYS screen driver or equivalent. These are -

```
Clear Screen - Escape [2J
Home         - Escape [H
Erase Line   - Escape [K
```

The console name for units 95 and 97 used is 'CON' which is suitable for IBM PC compatibles. However other hosts such as PDP11 and VAX require the name 'TT' to be used.

I.3 List of files and routine names

The Fortran source files are listed below

File CERESVI1.FOR

Main program

PROGRI	program initialization
SOILRI	subroutine to read and initialize soil information
WATBAL	water balance subroutine

File CERESVI2.FOR

PHENOL	subroutine to calculate phenological stage
PHASEI	phase initialization subroutine
GROSUB	growth subroutine
WRITE	write subroutine
OUTWA	output subroutine for water balance
OUTGR	output subroutine for growth
CALDAT	subroutine to convert day number of year to calendar date

File CERESVI3.FOR

SOILNI	soil nitrogen initialization subroutine
MINIMO	mineralization and immobilization routine
NUPTAK	nitrogen uptake routine
NFLUX	drainage and leaching routine
NFACTO	nitrogen deficiency factor routine
DNIT	denitrification subroutine
NITRIF	nitrification subroutine
SOLT	soil temperature routine
NWRITE	nitrogen output controlling routine
NBAL	detailed nitrogen balance output routine
OUTMN	soil nitrogen output routine
OUTNU	uptake and plant N output routine

File CERESVI4.FOR

BPLOT	produce bar plot page
PVAL	print name & value subroutine
CLRPAG	clear page array subroutine
PRNPAG	print page array subroutine
NEWPAG	clear screen subroutine
BSCALE	set bar scale subroutine
PBAR	print bar to page subroutine
PLINE	print name, value and bar subroutine
PLOT	plot subroutine
PLOTWA	plot subroutine for water balance
PLOTGR	plot subroutine for growth
NPLOT	nitrogen plot controlling routine
NBALP	detailed nitrogen balance plot routine
PLOTMN	soil nitrogen plot routine
PLOTNU	uptake and plant N plot routine
CHNAM	add specified character to name
PLOTSW	plot soil water graph to screen
PTITLE	plot x and y axis lines and titles
YAXIS	scale y axis and draw tic marks and labels
XAXIS	scale x axis and draw tic marks and labels
PLOT2	plots points on graph
PLOTSN	graph soil nitrate NO_3

File CERESVI5.FOR

PDFALT	sets plot defaults
FREAD	input subroutine for parameters
XTRACT	get keyword and value from line
CRACK	get keyword and value
NONBL	find first and last non blank
SHOW	display parameters
SHOWF	display fertilizer values
SHOWI	display irrigation values
SHOWS	display soil layer values
SHOWB	display bar thresholds and limits
SETVAL	takes action on keyword
ABOUND	check array bounds of word
LASTNB	find last non blank character

File CERESVI6.FOR

SETHST	set host parameters
ALTER	to alter input parameters just read
MESSAG	write message to console
NXTPAR	find next parameter set
LOCATE	find where data set is
HELP	command reference screen
COPFIL	copy all records of file
STORE	store variables
BACDAT	find saved date
BACSTG	find saved stage
BACREC	read a previously saved record
STOREC	store subroutine
RESTOR	restore subroutine
INDEX	find position of character in string

File LNK.BAT

This is a batch file to be used to link all the object modules to produce the EXE module. It can be run by typing

LNK CERESVI<cr>

File CERESVI.EXE

This is the executable code, compiled and linked to run on an IBM-PC or compatible equipped with an 8087 or 80287 maths coprocessor and requirements specified in section I.2.

File F77L.EER

This file contains the error messages for the supplied EXE file. This is only needed when executable errors occur to explain the error. EXE files compiled by other compilers will not require this file.

File NITSP.DAT

File of parameter data for test and tutorial purposes.

File NITWTH.DAT

File of weather data for test and tutorial purposes.

Files TABLE1.DAT to TABLE7.DAT

These are parameter files as shown in the documentation tables with the same name. They are provided for the user to try as desired.

File TABLE6I.DAT

Parameter file shown in Table 6, but set to run interactively.

APPENDIX II

II.1 Tutorial

This tutorial uses the parameter file "NITSP.DAT" modified to enable interactive mode and the climate file "NITWTH.DAT" as supplied on the Nitrogen version disk with the CERES-Maize book. Throughout this tutorial the commands are printed in **bold face** and the "enter" or "return" or "carriage return" key is represented by "<cr>". To use this tutorial, the reader is required to have the V/I CERES-Maize program (CERESVI) and the two data files available on disk. With these in the default drive, the reader then types the commands in bold face, pressing the <cr> key as required, and observes the responses on the screen. These responses should match those shown in this tutorial. The words "(new screen)" have been inserted whenever the screen is cleared before the next display. The text in *italic face* is descriptive text inserted for explanation only.

The objective of the tutorial is to familiarise the reader with the use of some of the commands and the responses and is not meant to be the recommended or standard method used for other runs. A full description of the commands used is documented in Section 4.

To run the tutorial to completion, 190,000 bytes of free disk space will be needed, and the requirements specified in section I.2 satisfied.

II.2 Example Tutorial

CERESVI<cr>

Interactive version program name. This loads the complete program into memory and starts it running.

TYPE IN PARAMETER FILE NAME
NITSP.DAT<cr>

The parameter file with "+" as the first character in the title line to indicate that the parameters are in fixed format and the program is to run in interactive mode.

TYPE IN WEATHER FILE NAME
NITWTH.DAT<cr>

Climate file containing weather data

(new screen)

```
FLO,SC 81  SW=SPEC, IRR, FERT
  ISOW=       97    PLANTS=      7.10    SDEPTH=      4.00      LAT=     34.00
  DMOD=     0.01    KOUTGR=        -7    KOUTMN=       -14    KOUTNB=        -5
KOUTNU=       -7    KOUTWA=        -7      IIRR=      1.00   INSOIL=      1.10
ISWNIT=        1      KGEN=         0      KIRR=         0    KSOIL=         0
 KFERT=        0      KMAN=         0     KLAYR=         0    STORE=    -99999
 KMEAS=        0     KWETH=         0
PIO 3382
     P1=  200.00        P2=      0.70         P5=   800.00
     G2=  650.00        G3=      8.50

ISLKJD=      156    MATJD=        210    XYIELD= 11550.00     XGRWT=      0.28
 XGPSN=   418.50     XGPE=       0.00      XLAI=      4.20     XBIOM=  23800.00
STRAW=  10954.00   GRPCTN=       1.62   XTOTNP=     248.00    XGNUP=    158.00

   SALB=    0.14         U=      5.00     SWCON=      0.60       CN2=     60.00
    TAV=   16.80       AMP=     20.00    JDATE=      60.00     STRAW=    500.00
   SDEP=   10.00       SCN=     80.00     ROOT=     200.00       RCN=     45.00

Parameter and genetic data read.
  You are in keyword input mode and may alter parameters now.
Next Command-> KOUTNB=7<cr>
```

The screen displays parameter settings which can be altered at this point. Here we change the output frequency of detailed N balance to ONIS.DAT from 5 days to 7 days.

```
Next Command-> SHOW<cr>
```

Now lets look at the parameters again to make sure they are correct.

(new screen)

```
FLO,SC 81  SW=SPEC, IRR, FERT
  ISOW=       97    PLANTS=      7.10    SDEPTH=      4.00      LAT=     34.00
  DMOD=     0.01    KOUTGR=        -7    KOUTMN=       -14    KOUTNB=        -7
KOUTNU=        7    KOUTWA=        -7      IIRR=      1.00   INSOIL=      1.10
ISWNIT=        1      KGEN=         0      KIRR=         0    KSOIL=         0
 KFERT=        0      KMAN=         0     KLAYR=         0    STORE=    -99999
 KMEAS=        0     KWETH=         0
PIO 3382
     P1=  200.00        P2=      0.70         P5=   800.00
     G2=  650.00        G3=      8.50

ISLKJD=      156    MATJD=        210    XYIELD= 11550.00     XGRWT=      0.28
 XGPSN=   418.50     XGPE=       0.00      XLAI=      4.20     XBIOM=  23800.00
STRAW=  10954.00   GRPCTN=       1.62   XTOTNP=     248.00    XGNUP=    158.00

   SALB=    0.14         U=      5.00     SWCON=      0.60       CN2=     60.00
    TAV=   16.80       AMP=     20.00    JDATE=      60.00     STRAW=    500.00
   SDEP=   10.00       SCN=     80.00     ROOT=     200.00       RCN=     45.00

Next Command-> <cr>
```

Continue on to next step.

```
V/I CERES MAIZE RUN FOR
   FLO,SC 81  SW-SPEC, IRR, FERT          PROGRAM BEGINS DAY  60

CULTIVAR PIO 3382                   POPULATION (PLANTS/M2)    7.10

                              GENETIC CONSTANTS
   P1 200.00     P2 0.70       P5 800.00     G2 650.00     G3  8.500

Next Command-> <cr>
```

Continue on to next step.

(new screen)

```
 SOIL LAYERS
LAYER DLAYR    LL    DUL    SAT     WR    SW     OC     BD     PH     NH4    NO3
 ( 1)  10.0 0.075 0.210 0.250  1.00 0.189  0.30  1.55  6.00   2.0    5.0
 ( 2)  10.0 0.075 0.210 0.250  1.00 0.189  0.30  1.55  6.00   2.0    5.0
 ( 3)  21.0 0.100 0.240 0.290  0.80 0.228  0.17  1.67  6.20   2.0    5.0
 ( 4)  30.0 0.210 0.310 0.350  0.40 0.310  0.01  1.54  6.50   2.0    5.0
 ( 5)  30.0 0.210 0.320 0.360  0.10 0.320  0.01  1.54  6.70   1.0    2.0
 ( 6)  25.0 0.180 0.280 0.320  0.10 0.280  0.01  1.68  6.80   1.0    2.0
 ( 7)  25.0 0.180 0.280 0.320  0.10 0.280  0.01  1.74  6.80   1.0    2.0

Soil Layer data read.
  You are in keyword input mode and may alter parameters now.
Next Command-> <cr>
```

Continue on to next step.

(new screen)

```
JDAY( 1)=121   AIRR( 1)=13.70 JDAY( 2)=133   AIRR( 2)= 4.30
JDAY( 3)=139   AIRR( 3)=14.00 JDAY( 4)=146   AIRR( 4)=14.20
JDAY( 5)=153   AIRR( 5)= 5.60 JDAY( 6)=160   AIRR( 6)=11.20
JDAY( 7)=162   AIRR( 7)=27.20 JDAY( 8)=168   AIRR( 8)=27.20
JDAY( 9)=170   AIRR( 9)=27.40 JDAY(10)=174   AIRR(10)=26.40
JDAY(11)=177   AIRR(11)=25.90 JDAY(12)=201   AIRR(12)=27.70
JDAY(13)=205   AIRR(13)=27.40 JDAY(14)=   0   AIRR(14)= 0.00

Irrigation data read.
  You are in keyword input mode and may alter parameters now.
Next Command-> <cr>
```

Continue on to next step

DEPTH-CM	LL	DUL	SAT	ESW	SW	WR	NH4	NO3
0.- 10.	0.075	0.210	0.250	0.135	0.189	1.000	2.00	5.00
10.- 20.	0.075	0.210	0.250	0.135	0.189	1.000	2.00	5.00
20.- 41.	0.100	0.240	0.290	0.140	0.228	0.800	2.00	5.00
41.- 71.	0.210	0.310	0.350	0.100	0.310	0.400	2.00	5.00
71.- 101.	0.210	0.320	0.360	0.110	0.320	0.100	1.00	2.00
101.- 126.	0.180	0.280	0.320	0.100	0.280	0.100	1.00	2.00
126.- 151.	0.180	0.280	0.320	0.100	0.280	0.100	1.00	2.00
TOT PROF	25.2	42.1	48.4	16.9	41.5		43.	82.

IRRIGATION (MM)

	1	2	3	4	5	6	7	8	9	10	11	12
DAY	121	133	139	146	153	160	162	168	170	174	177	201
AMOUNT	14.	4.	14.	14.	6.	11.	27.	27.	27.	26.	26.	28.

	13
DAY	205
AMOUNT	27.

Next Command-> <cr>

Continue on to next step.

(new screen)

FERTILIZER NITROGEN (KG/HA)
(new screen)

```
JFDAY( 1)= 90   AFERT( 1)=  66.7 DFERT( 1)=  10.0   IFTYPE( 1)= 1
JFDAY( 2)=139   AFERT( 2)=  66.7 DFERT( 2)=  10.0   IFTYPE( 2)= 1
JFDAY( 3)=153   AFERT( 3)=  66.7 DFERT( 3)=  10.0   IFTYPE( 3)= 1
```

Fertilizer and nitrogen data read.
You are in keyword input mode and may alter parameters now.
Next Command-> <cr>

Continue on to next step

	1	2	3
DAY	90	139	153
AMOUNT	66.7	66.7	66.7
SOURCE			

Next Command-> <cr>

Continue on to next step.

```
(new screen)

 3/ 1/81     JDATE= 60     STAGE=7.00
SOLRAD  149.       TEMPMX  21.8              TEMPMN  15.6
PRECIP  0.00                            <  TIMOB    3.52 bbbbbbbbb               <
CRAIN     0.                            <
RUNOFF  0.00                            <
DRAIN   0.00                            <
CDRAIN  0.00                            <
ET      1.41 ss                         <
EO      1.41 oo                         <
PESW 1 1.784 11111111111111    .        <
PESW 2 1.912 2222222222222222 .         <
PESW 3 4.676 333333333333333 .          <
PESW 4  9.37 4444444444444444.          <
PESW 5  9.57 5555555555555555.          <
PESW 6 7.013 6666666666666666.          <
PESW 7 7.000 7777777777777777.          <
PESW   41.33 pppppppppppppppp.          <


Next Command-> <cr>
```

Continue on to next step. The input of parameters is now complete and the first day of model execution will be displayed. Note that no biological output is displayed as germination date has not yet been reached.

```
 3/ 2/81     JDATE= 61     STAGE=7.00
SOLRAD  380.       TEMPMX  20.6              TEMPMN  10.7
PRECIP  0.00                            <  TIMOB    0.16 b                       <
CRAIN     0.                            <  TOTN   115.6 nnnnnnnnnnnnnn           <
RUNOFF  0.00                            <
DRAIN   0.00                            <
CDRAIN  0.00                            <
ET      1.63 ss                         <
EO      3.40 oooo                       <
PESW 1 1.669 1111111111111     .        <
PESW 2 1.890 222222222222222  .         <
PESW 3 4.613 333333333333333 .          <
PESW 4  9.41 4444444444444444.4         <
PESW 5  9.55 5555555555555555.          <
PESW 6 7.024 6666666666666666.          <
PESW 7 7.001 7777777777777777.          <
PESW   41.16 pppppppppppppppp.          <


Next Command-> <cr>
```

Continue on to next day. Note the visual effect of the bars as the water balance changes.

```
 3/ 3/81    JDATE= 62    STAGE=7.00
SOLRAD  438.       TEMPMX  15.7          TEMPMN   0.8
PRECIP  0.00                         <   TIMOB    0.11 b                   <
CRAIN     0.                         <   TOTN    115.4 nnnnnnnnnnnnnn      <
RUNOFF  0.00                         <
DRAIN   0.00                         <
CDRAIN  0.00                         <
ET       1.19 ss                     <
EO       3.33 oooo                   <
PESW 1 1.605 111111111111     .      <
PESW 2 1.855 222222222222222  .      <
PESW 3 4.561 333333333333333 .       <
PESW 4  9.39 4444444444444444.       <
PESW 5  9.60 5555555555555555.       <
PESW 6 7.036 6666666666666666.       <
PESW 7 7.002 7777777777777777.       <
PESW   41.04 pppppppppppppppp.       <
```

Next Command-> JPEND<cr>

Jump to the end of the climate file, modelling each day with only the stage names and the final output at physiological maturity being displayed.

(new screen)

SOWING

(new screen)

GERMINATION

(new screen)

SEEDLING EMERGENCE

(new screen)

END OF JUVENILE STAGE

(new screen)

TASSEL INITIATION

(new screen)

75% SILKING

(new screen)

BEGIN GRAIN FILLING

(new screen)

END GRAIN FILLING

(new screen)

PHYSIOLOGICAL MATURITY

(new screen)

	PREDICTED	MEASURED		PREDICTED	MEASURED
SILKING DAY	160	156	STOVER KG/HA	10578.1	10954.0
MATURITY DAY	203	210	GRAIN N%	1.72	1.62
GRAIN KG/HA 15%	11051.	11550.	TOTAL N KG/HA	221.0	248.0
KERN WT G DRY	0.2618	0.2760	GRAIN N KG/HA	161.0	158.0
FINAL GPSM	3567.	419.			
GRAINS/EAR	502.	0.			
LAI AT SILKING	3.94	4.20			
BIOMASS KG/HA	19916.	23800.			

GROWTH STAGE	CSD1	CSD2	CNSD1	CNSD2
1	0.00	0.00	0.01	0.08
2	0.00	0.00	0.05	0.19
3	0.00	0.00	0.00	0.01
4	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.03

(new screen)

END OF WEATHER DATA REACHED
Next Command-> OYLD<cr>

We will inspect the output summary in the OYLD.DAT file now.

V/I CERES-MAIZE OUTPUT SUMMARY
FLO,SC 81 SW=SPEC, IRR, FERT PROGRAM BEGINS DAY 60

CULTIVAR PIO 3382 POPULATION (PLANTS/M2) 7.10

GENETIC CONSTANTS
P1 200.00 P2 0.70 P5 800.00 G2 650.00 G3 8.500

SALB 0.14 U 5.0 SWCON 0.60 CN2 60.0

DEPTH-CM	LL	DUL	SAT	ESW	SW	WR	NH4	NO3
0.- 10.	0.075	0.210	0.250	0.135	0.189	1.000	2.00	5.00
10.- 20.	0.075	0.210	0.250	0.135	0.189	1.000	2.00	5.00
20.- 41.	0.100	0.240	0.290	0.140	0.228	0.800	2.00	5.00
41.- 71.	0.210	0.310	0.350	0.100	0.310	0.400	2.00	5.00
71.- 101.	0.210	0.320	0.360	0.110	0.320	0.100	1.00	2.00
101.- 126.	0.180	0.280	0.320	0.100	0.280	0.100	1.00	2.00
126.- 151.	0.180	0.280	0.320	0.100	0.280	0.100	1.00	2.00
TOT PROF	25.2	42.1	48.4	16.9	41.5		43.	82.

Next, Previous, End or Stop (N/P/E/S)? <cr>

An "N" (Next) or <cr> will display the next screen.

```
IRRIGATION (MM)
          1    2    3    4    5    6    7    8    9    10   11   12
DAY      121  133  139  146  153  160  162  168  170  174  177  201
AMOUNT   14.   4.  14.  14.   6.  11.  27.  27.  27.  26.  26.  28.

          13
DAY      205
AMOUNT   27.

FERTILIZER NITROGEN (KG/HA)
             1           2           3
DAY          90          139         153
AMOUNT       66.7        66.7        66.7
SOURCE

      WATER BALANCE COMPONENTS CUMULATIVE AFTER GERMINATION
   DATE    DAY               BIOMASS   LAI  N %   ET    EP   PREC IRRIG PESW
 4/ 7/81   97    SOWING
 4/ 8/81   98    GERMIN.                           61.    0.   63.    0.   16.
 4/12/81  102    EMERG.                             3.    0.    0.    0.   15.
 4/29/81  119    END JUV.        16. 0.33 2.55     35.    8.   26.    0.   14.
 5/ 5/81  125    TAS.INIT.       37. 0.67 3.40     59.   22.   26.   14.   13.
 6/ 9/81  160    75% SILK       757. 3.94 2.16    211.  125.  156.   63.   15.
Next, Previous, End or Stop (N/P/E/S)?  <cr>
```

Display the next screen.

```
 6/17/81  168    BEG.GR.F      1077. 3.59 2.23 260. 164.  172.  117.   16.
 7/20/81  201    END GR.F      1992. 0.88 1.31 442. 296.  328.  225.   14.
 7/22/81  203    PHYS.MAT.     1992. 0.88 1.31 447. 296.  328.  225.   13.

                    PREDICTED  MEASURED                  PREDICTED   MEASURED
SILKING DAY            160        156     STOVER KG/HA    10578.1     10954.0
MATURITY DAY           203        210     GRAIN N%           1.72        1.62
GRAIN KG/HA 15%     11051.      11550.    TOTAL N KG/HA    221.0       248.0
KERN WT G DRY        0.2618     0.2760    GRAIN N KG/HA    161.0       158.0
FINAL GPSM           3567.       419.
GRAINS/EAR            502.        0.
LAI AT SILKING        3.94       4.20
BIOMASS KG/HA       19916.     23800.

GROWTH STAGE        CSD1       CSD2       CNSD1      CNSD2
          1         0.00       0.00       0.01       0.08
          2         0.00       0.00       0.05       0.19
          3         0.00       0.00       0.00       0.01
          4         0.00       0.00       0.00       0.00
          5         0.00       0.00       0.00       0.03
Previous or Stop (P/S)?  S<cr>
```

Stop displaying the OYLD.DAT file

```
Next Command-> BACK<cr>
```

It is possible to return the simulation to a previously stored date with the BACK or JPDATE/JPSTAG="-ve no." commands. As no date has been stored as yet, a BACK command returns the program to the last stored day which is the default first day.

(new screen)

```
 3/ 1/81     JDATE= 60     STAGE=7.00
SOLRAD  149.        TEMPMX   21.8            TEMPMN  15.6
PRECIP  0.00                              <  TIMOB    3.52 bbbbbbbbb              <
CRAIN      0.                             <  TOTN   115.6 nnnnnnnnnnnnnn          <
RUNOFF  0.00                              <
DRAIN   0.00                              <
CDRAIN  0.00                              <
ET       1.41 ee                          <
EO       1.41 oo                          <
PESW 1 1.784 11111111111111    .          <
PESW 2 1.912 2222222222222222 .           <
PESW 3 4.676 333333333333333 .            <
PESW 4   9.37 4444444444444444.           <
PESW 5   9.57 5555555555555555.           <
PESW 6 7.013 6666666666666666.            <
PESW 7 7.000 7777777777777777.            <
PESW    41.33 pppppppppppppppp.           <
```

Next Command-> STORE=7<cr>

Now, set the store flag to store all variables on a weekly interval. This will enable the program to return to any date which is a multiple of 7 starting at day 60 (the current day). A STORE=1 would enable a return to any previously simulated date, however the time and disk space required are considerably increased.

Next Command-> JPSTAG=8<cr>

Proceed to the first day of stage 8.

(new screen)

```
 SOWING
  4/ 7/81     JDATE= 97     STAGE=8.00
SOLRAD  542.        TEMPMX   20.1            TEMPMN    2.2
PRECIP  0.00                              <  TIMOB    0.09 b                      <
CRAIN     63. cc                          <  TOTN      0.0                        <
RUNOFF  0.00                              <
DRAIN    0.66 dd                          <
CDRAIN   9.14 ttttt                       <
ET       1.07 ee                          <
EO       4.46 oooooo                      <
PESW 1 1.479 1111111111        .          <
PESW 2 1.774 22222222222222    .          <
PESW 3 4.482 33333333333333  .            <
PESW 4   9.39 4444444444444444.           <
PESW 5   9.61 5555555555555555.           <
PESW 6 7.057 6666666666666666.            <
PESW 7 7.044 7777777777777777.            <
PESW    40.84 pppppppppppppppp.           <
```

Next Command-> <cr>

Step through the days until one day past seedling emergence. For convenience, the screens are not shown here. Note that at stage 9, the biological display is shown. Pressing <cr> repeatedly allows the user to watch the bars changing as the model progresses.

(new screen)

Next Command-> <cr>

Proceed to next day.

Next Command-> <cr>

Proceed to next day.

Next Command-> <cr>

Proceed to next day.

Next Command-> <cr>

Proceed to next day.

(new screen)

Next Command-> <cr>

Proceed to next day.

```
  4/13/81     JDATE=103     STAGE=1.09
SOLRAD  510.        TEMPMX   29.3            TEMPMN   14.8
PRECIP  0.00                           <  LN        2.00 nn          <
CRAIN      0.                          <  LAI      0.006 a           <
RUNOFF  0.00                           <  BIOMAS      2. b           <
DRAIN   0.00                           <  LFWT      0.01 l           <
CDRAIN  0.56 t                         <  STMWT     0.20 s           <
ET      0.61 e                         <  RTWT      0.30 r           <
EO      5.25 ooooooo                   <  GRNWT      0.0             <
PESW 1 1.343 11111111            .     <  1-SWDF 0.000               <
PESW 2 1.637 222222222222        .     <  CSD2      0.00             <
PESW 3 4.262 3333333333333      .      <  TIMOB     0.13 b           <
PESW 4   9.39 4444444444444444.        <  TOTN      70.4 nnnnnnnnn   <
PESW 5   9.59 5555555555555555.        <
PESW 6 7.080 6666666666666666.         <
PESW 7 7.041 7777777777777777.         <
PESW    40.34 PPPPPPPPPPPPPPPP.        <
```

Next Command-> JPDATE=159<cr>

Proceed to day number 159.

(new screen)

END OF JUVENILE STAGE

(new screen)

TASSEL INITIATION

(new screen)

```
  6/ 8/81     JDATE=159     STAGE=3.98
SOLRAD  457.       TEMPMX  30.9            TEMPMN  20.9
PRECIP  0.00                           <  LN      21.00 nnnnnnnnnnnnnnnnnnnn  <
CRAIN   156. cccc                      <  LAI     3.944 aaaaaaaaaaaaaaaaaaa   <
RUNOFF  0.00                           <  BIOMAS   757. bbbbbbbbb             <
DRAIN   0.00                           <  LFWT    44.69 11111111111111111111  <
CDRAIN  7.18 tttt                      <  STMWT   61.86 ssssssssssssssssssssss/
ET      4.57 spppp                     <  RTWT    32.74 rrrrrrrrrrrrrrrr      <
EO      4.57 oooooo                    <  GRNWT    0.0                        <
PESW 1 1.318 11111111          .       <  1-SWDF 0.000                        <
PESW 2 1.465 2222222222        .       <  CSD2     0.00 122                   <
PESW 3 3.831 3333333333        .       <  TIMOB    0.05 b                     <
PESW 4  9.18 444444444444444.          <  TOTN    132.7 nnnnnnnnnnnnnnn       <
PESW 5  9.44 555555555555555.          <
PESW 6 7.069 666666666666666.          <
PESW 7 7.049 777777777777777.          <
PESW   39.35 ppppppppppppppp .         <
```

Next Command-> **HSTMWT=90,TLAI=3,PLOT<cr>**

Change the bar high value of STMWT from 50 to 90 because the bar has exceeded the current high value. Set the threshold value of LAI to 3. Redisplay today's screen to view the changes. Note LAI bar now showing the threshold and STMWT bar now scaled correctly.

(new screen)

```
  6/ 8/81     JDATE=159     STAGE=3.98
SOLRAD  457.       TEMPMX  30.9            TEMPMN  20.9
PRECIP  0.00                           <  LN      21.00 nnnnnnnnnnnnnnnnnnnn  <
CRAIN   156. cccc                      <  LAI     3.944 aaaaaaaaaaaaaAAAAAA   <
RUNOFF  0.00                           <  BIOMAS   757. bbbbbbbbb             <
DRAIN   0.00                           <  LFWT    44.69 11111111111111111111  <
CDRAIN  7.18 tttt                      <  STMWT   61.86 ssssssssssssssss      <
ET      4.57 spppp                     <  RTWT    32.74 rrrrrrrrrrrrrrrr      <
EO      4.57 oooooo                    <  GRNWT    0.0                        <
PESW 1 1.318 11111111          .       <  1-SWDF 0.000                        <
PESW 2 1.465 2222222222        .       <  CSD2     0.00 122                   <
PESW 3 3.831 3333333333        .       <  TIMOB    0.05 b                     <
PESW 4  9.18 444444444444444.          <  TOTN    132.7 nnnnnnnnnnnnnnn       <
PESW 5  9.44 555555555555555.          <
PESW 6 7.069 666666666666666.          <
PESW 7 7.049 777777777777777.          <
PESW   39.35 ppppppppppppppp .         <
```

Next Command-> **BACK<cr>**

*Go back to the last stored day. The last multiple of 7 from day 60 is 158 (60 + 14*7 = 158).*

(new screen)

```
 6/ 7/81     JDATE=158     STAGE=3.95
SOLRAD  356.        TEMPMX  31.7          TEMPMN  22.2
PRECIP  0.00                            < LN      21.00 nnnnnnnnnnnnnnnnnnnn  <
CRAIN   156. cccc                       < LAI     3.883 aaaaaaaaaaaaaAAAAA    <
RUNOFF  0.00                            < BIOMAS  719. bbbbbbbbb              <
DRAIN   0.00                            < LFWT    43.83 111111111111111111111 <
CDRAIN  7.18 tttt                       < STMWT   57.47 ssssssssssssssss      <
ET      3.63 spppp                      < RTWT    32.61 rrrrrrrrrrrrrrr       <
EO      3.63 ooooo                      < GRNWT    0.0                        <
PESW 1 1.457 1111111111     .           < 1-SWDF 0.000                        <
PESW 2 1.561 22222222222    .           < CSD2    0.00 122                    <
PESW 3 3.985 33333333333    .           < TIMOB   0.07 b                      <
PESW 4  9.23 4444444444444444.          < TOTN   140.1 nnnnnnnnnnnnnnnnnn     <
PESW 5  9.45 5555555555555555.          <
PESW 6 7.069 6666666666666666.          <
PESW 7 7.048 7777777777777777.          <
PESW   39.81 pppppppppppppppp .         <
```

Next Command-> BACK=3<cr>

Now go back 3 more weeks to view variable values. An alternative command would be JPDATE=-137.

(new screen)

```
 5/17/81     JDATE=137     STAGE=3.27
SOLRAD  462.        TEMPMX  25.4          TEMPMN  13.3
PRECIP  0.00                            < LN      13.00 nnnnnnnnnnnnn          <
CRAIN    66. cc                         < LAI     1.848 aaaaaaaaa     :        <
RUNOFF  0.00                            < BIOMAS  135. bb                      <
DRAIN   0.00                            < LFWT    17.44 111111111              <
CDRAIN  3.24 tt                         < STMWT    1.60 s                      <
ET      4.19 ssppp                      < RTWT    19.72 rrrrrrrrrr             <
EO      4.19 ooooo                      < GRNWT    0.0                         <
PESW 1 0.807 1              .           < 1-SWDF 0.000                         <
PESW 2 1.159 222222         .           < CSD2    0.00 122                     <
PESW 3 3.601 333333333      .           < TIMOB   0.04 b                       <
PESW 4  9.12 4444444444444444.          < TOTN    84.3 nnnnnnnnnn              <
PESW 5  9.37 5555555555555555.          <
PESW 6 7.056 6666666666666666.          <
PESW 7 7.043 7777777777777777.          <
PESW   38.15 ppppppppppppp  .           <
```

Next Command-> JPDATE=-158<cr>

This command allows a return to the last stored day in the store file without running the model, thus saving unnecessary outputs being repeated to the output files.

(new screen)

```
  6/ 7/81     JDATE=158     STAGE=3.95
SOLRAD  356.      TEMPMX  31.7          TEMPMN  22.2
PRECIP  0.00                        <  LN       21.00 nnnnnnnnnnnnnnnnnnnn   <
CRAIN   156. cccc                   <  LAI      3.883 aaaaaaaaaaaaaAAAAA    <
RUNOFF  0.00                        <  BIOMAS   719. bbbbbbbbb              <
DRAIN   0.00                        <  LFWT     43.83 111111111111111111111  <
CDRAIN  7.18 tttt                   <  STMWT    57.47 sssssssssssssss       <
ET      3.63 spppp                  <  RTWT     32.61 rrrrrrrrrrrrrrr       <
EO      3.63 ooooo                  <  GRNWT     0.0                        <
PESW 1 1.457 1111111111        .    <  1-SWDF  0.000                        <
PESW 2 1.561 22222222222       .    <  CSD2     0.00 122                    <
PESW 3 3.985 33333333333       .    <  TIMOB    0.07 b                      <
PESW 4   9.23 444444444444444.      <  TOTN    140.1 nnnnnnnnnnnnnnnnn      <
PESW 5   9.45 555555555555555.      <
PESW 6 7.069 666666666666666.       <
PESW 7 7.048 777777777777777.       <
PESW    39.81 ppppppppppppppp .     <
```

Next Command-> JPSTAG=4<cr>

Proceed to the start of stage 4.

(new screen)

```
 75% SILKING
  6/ 9/81     JDATE=160     STAGE=4.00
SOLRAD  513.      TEMPMX  34.0          TEMPMN  22.3
PRECIP 11.20 pppppp                 <  LN       21.00 nnnnnnnnnnnnnnnnnnnn   <
CRAIN   156. cccc                   <  LAI      3.750 aaaaaaaaaaaaaAAAAA    <
RUNOFF  0.00                        <  BIOMAS   797. bbbbbbbbbb             <
DRAIN   0.00                        <  LFWT     44.69 111111111111111111111  <
CDRAIN  7.18 tttt                   <  STMWT    53.17 ssssssssssssss        <
ET      5.36 ssppppp                <  RTWT     32.82 rrrrrrrrrrrrrrr       <
EO      5.36 ooooooo                <  GRNWT     0.0                        <
PESW 1 2.037 111111111111111111.    <  1-SWDF  0.000                        <
PESW 2 1.559 22222222222       .    <  CSD2     0.00 122                    <
PESW 3 3.683 3333333333        .    <  TIMOB    0.05 b                      <
PESW 4   9.12 444444444444444.      <  TOTN    128.4 nnnnnnnnnnnnnnn        <
PESW 5   9.42 555555555555555.      <
PESW 6 7.067 666666666666666.       <
PESW 7 7.049 777777777777777.       <
PESW    39.93 ppppppppppppppp .     <
```

Next Command-> PLOTSW<cr>

Display plot of the soil water profile.

(new screen)

```
      5.00-+                                        * ---------SSSSSSSSSSSSSSSSSSSSSSSSSSSS
  D   15.00-+                          *             ---------SSSSSSSSSSSSSSSSSSSSSSSSSSSS
  E         |+LLL                        *                ----------SSSSSSSSSSSSSSSSSSSSSS
  P   30.50-+LLLLL                         *                 ------------SSSSSSSSSSSSSSSS
  T         |+LLLLLLLLLLLLLL                           *           -----------SSSSSSSSSSSS
  H         |+LLLLLLLLLLLLLLLLLLLLLLLLLL                         *       ----------SSSSSSS
      56.00-+LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                       * ---------SSS
  -         |+LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                        * ---------SS
            |+LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                        * ---------SS
  C         |+LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                         * ---------S
  M   86.00-+LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                         * ---------S
            |+LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                         *----------SSSS
            |+LLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                          *---------SSSSSSS
     113.50-+LLLLLLLLLLLLLLLLLLLLLLLLLLLLL                         -*--------SSSSSSSSSS
            |+LLLLLLLLLLLLLLLLLLLLLLLLLLLL                         -*--------SSSSSSSSSS
            |+LLLLLLLLLLLLLLLLLLLLLLLLLLLL                         -*--------SSSSSSSSSS
     138.50-+LLLLLLLLLLLLLLLLLLLLLLLLLLLLL                         -*--------SSSSSSSSSS
            ||----------|----------|----------|-----------|----------|----------|
          0.08        0.12       0.17       0.22        0.27       0.31       0.36
        SOIL WATER (CM/CM)   DUL=_  LL=L  SAT=S  SW=* ( 160)  LAST SW=+ (    0)
Next Command-> PLOTSN<cr>
```

Display plot of the soil N profile.

(new screen)

```
      5.00-+                                 *
  D   15.00-+      *
  E         |+     *
  P   30.50-+     *
  T         |+   *
  H         |+   *
      56.00-+   *
  -         |+    *
            |+     *
  C         |+      *
  M   86.00-+       *
            |+     *
            |+    *
     113.50-+  *
            |+ *
            |+ *
     138.50-+ *
            ||----------|----------|----------|-----------|----------|----------|
          0.00        6.67       13.33      20.00       26.67      33.33      40.00
        SOIL NITRATE (KG N/KG SOIL)   NO3=* ( 160)   LAST NO3=+ (    0)
Next Command-> HNO3=5,PLOTSN<cr>
```

Change the high value of the X axis from 40 to 5 and redisplay the plot.

(new screen)

```
     5.00-+                                                          *
D   15.00-+                                             *
E         |+                                    *
P   30.50-+                                 *
T         |+                               *
H         |+                              *
    56.00-+                              *
-         |+                                 *
          |+                                       *
C         |+                                            *
N   86.00-+                                                 *
          |+                                       *
          |+                                *
   113.50-+                        *
          |+                      *
          |+                     *
   138.50-+                     *
          ||-----------|-----------|-----------|------------|-----------|-----------|
        0.00        0.83        1.67        2.50         3.33        4.17        5.00
     SOIL NITRATE (MG N/KG SOIL)   NO3=* ( 160)   LAST NO3=+ (    0)
Next Command-> JPSTAG=-7<cr>
```

Go back to the first day.

(new screen)

```
  3/ 1/81    JDATE= 60    STAGE=7.00
SOLRAD  149.       TEMPMX  21.8         TEMPMN  15.6
PRECIP  0.00                         <  TINOB    3.52 bbbbbbbbb          <
CRAIN     0.                         <  TOTN   115.6 nnnnnnnnnnnnnn      <
RUNOFF  0.00                         <
DRAIN   0.00                         <
CDRAIN  0.00                         <
ET      1.41 ss                      <
EO      1.41 oo                      <
PESW 1 1.784 11111111111111   .      <
PESW 2 1.912 2222222222222222 .      <
PESW 3 4.676 333333333333333 .       <
PESW 4  9.37 4444444444444444.       <
PESW 5  9.57 5555555555555555.       <
PESW 6 7.013 6666666666666666.       <
PESW 7 7.000 7777777777777777.       <
PESW   41.33 PPPPPPPPPPPPPPPP.       <


Next Command-> NFERT=0,JPSTAG=3<cr>
```

To demonstrate some of the capabilities of the interactive model we will now undertake a simple example of examining the effect of applied N fertilizer on Maize growth. Firstly, turn fertilizing off and proceed to stage 3.

(new screen)

SOWING

(new screen)

GERMINATION

(new screen)

SEEDLING EMERGENCE

(new screen)

END OF JUVENILE STAGE

(new screen)

```
TASSEL INITIATION
 5/ 5/81     JDATE=125     STAGE=3.00
SOLRAD  573.       TEMPMX  32.2          TEMPMN  10.1
PRECIP  0.00                          <  LN        9.00 nnnnnnnnn             <
CRAIN    26. c                        <  LAI      0.746 aaaa          :       <
RUNOFF  0.00                          <  BIOMAS     42. b                     <
DRAIN   0.00                          <  LFWT      5.71 lll                   <
CDRAIN  2.70 tt                       <  STMWT     0.20 s                     <
PT      3.70 ssppp                    <  RTWT      3.88 rr                    <
EO      5.67 ooooooo                  <  GRNWT      0.0                       <
PESW 1 1.075 11111             .      <  1-SWDF 0.000                         <
PESW 2 1.204 222222            .      <  CSD2      0.00 1111111222222222222233<
PESW 3 3.426 33333333          .      <  TIMOB     0.08 b                     <
PESW 4  9.21 4444444444444444.        <  TOTN      60.8 nnnnnnn       .       <
PESW 5  9.48 5555555555555555.        <
PESW 6 7.077 6666666666666666.        <
PESW 7 7.042 7777777777777777.        <
PESW   38.51 pppppppppppppp  .        <
```

Next Command-> STORE=0<cr>

This command stores the model at this point and turns off automatic storing which we previously set to every 7 days.

Next Command-> PLOTSW<cr>

Display the soil water profile plot.

(new screen)

```
     5.00-L        *                          + ---------SSSSSSSSSSSSSSSSSSSSSSSSSSSS
D   15.00-L           *        +                ---------SSSSSSSSSSSSSSSSSSSSSSSSSSSS
E         |LLLL            *    +                   ----------SSSSSSSSSSSSSSSSSSSSSS
P   30.50-LLLLLL                * +                    ------------SSSSSSSSSSSSSSSSS
T         |LLLLLLLLLLLLLLL              *+                   ----------SSSSSSSSSSSS
H         |LLLLLLLLLLLLLLLLLLLLLLLLL               *              ----------SSSSSSS
    56.00-LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                           +*---------SSS
-         |LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                            +*---------SS
          |LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                            +*---------SS
C         |LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                             +*---------S
H   86.00-LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                             +*---------S
          |LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                           +*---------SSSS
          |LLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                           *---------SSSSSSS
   113.50-LLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                         -*--------SSSSSSSSSS
          |LLLLLLLLLLLLLLLLLLLLLLLLLLLLL                         -*--------SSSSSSSSSS
          |LLLLLLLLLLLLLLLLLLLLLLLLLLLLL                         -*--------SSSSSSSSSS
   138.50-LLLLLLLLLLLLLLLLLLLLLLLLLLLLLL                         -*--------SSSSSSSSSS
          ||----------|----------|----------|-----------|----------|----------|
    0.08       0.12       0.17       0.22        0.27       0.31       0.36
   SOIL WATER (CM/CM)   DUL=_  LL=L  SAT=S  SW=* ( 125)  LAST SW=+ ( 160)
Next Command-> PLOTSN<cr>
```

The "+" symbol on the graph represents soil water on the day when PLOTSW was last used. In this case, day 160 from the previous run prior to the BACK command. Now display the soil N profile plot with the same effect.

(new screen)

```
     5.00-                *                                         +
D   15.00-                                    *        +
E         |                                    +           *
P   30.50-                              +                                 *
T         |                            +                            *
H         |                           +                        *
    56.00-                           +                    *
-         |                                +           *
          |                                     +    *
C         |                                        * +
H   86.00-                                      *       +
          |                                *    +
          |                           *       +
   113.50-                      *   +
          |                      *+
          |                      *
   138.50-                      +*
          ||----------|----------|----------|-----------|----------|----------|
    0.00       0.83       1.67       2.50        3.33       4.17       5.00
   SOIL NITRATE (MG N/KG SOIL)   NO3=* ( 125)   LAST NO3=+ ( 160)
Next Command-> IRR=25,JPSTAG=4<cr>
```

Irrigate with 25 mm tomorrow and proceed to stage 4.

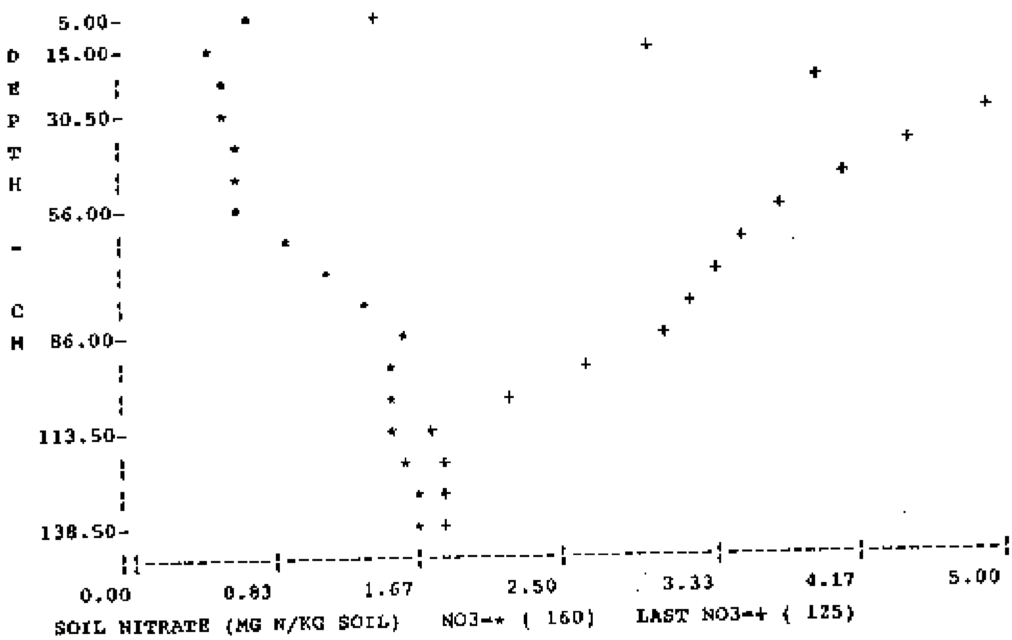
(new screen)

```
 75% SILKING
  6/ 9/81     JDATE=160     STAGE=4.00
SOLRAD  513.        TEMPMX  34.0               TEMPMN  22.3
PRECIP 11.20 pppppp                      <  LN      21.00 nnnnnnnnnnnnnnnnnnnnn  <
CRAIN   156. cccc                        <  LAI     3.098 aaaaaaaaaaaaaAA        <
RUNOFF  0.00                             <  BIOMAS  464.  bbbbbb                 <
DRAIN   0.00                             <  LFWT    35.20 11111111111111111      <
CDRAIN 17.11 tttttttt                    <  STHWT   23.98 ssssss                 <
ET      5.38 ssppppp                     <  RTWT    18.18 rrrrrrrrr              <
EO      5.38 ooooooo                     <  GRNWT    0.0                         <
PESW 1 2.046 11111111111111111.          <  1-SWDF 0.000                         <
PESW 2 1.588 222222222222      .         <  CSD2     0.00 1111111222222222222233<
PESW 3 3.830 3333333333       .          <  TIMOB    0.05 b                      <
PESW 4  9.06 4444444444444444.           <  TOTN     62.2 nnnnnnnn               <
PESW 5  9.38 5555555555555555.           <
PESW 6 7.045 6666666666666666.           <
PESW 7 7.038 7777777777777777.           <
PESW   39.99 pppppppppppppppp .          <
```

Next Command-> **PLOTSN<cr>**

Notice plant growth components at 75% silking with no applied nitrogen. Also the amount of cumulative drainage CDRAIN. Lets look at soil N profile with no fertilizer applied.

(new screen)



Next Command-> **BACK<cr>**

The plot shows nitrogen depletion from the top 100 cm of the profile since day 125. Differences in the plots below 100 cm are probably due to leaching with water drainage. If interested in this you could check the QMIN file to examine the leaching variable. Now, go back to start of stage 3. (Last stored day).

(new screen)

```
  5/ 5/81     JDATE=125     STAGE=3.00
SOLRAD  573.        TEMPMX   32.2          TEMPMN   10.1
PRECIP  0.00                          <  LN        9.00 nnnnnnnnn              <
CRAIN     26. c                       <  LAI      0.746 aaaa          '        <
RUNOFF  0.00                          <  BIOMAS     42. b                      <
DRAIN   0.00                          <  LFWT      5.71 lll                    <
CDRAIN  2.70 tt                       <  STMWT     0.20 s                      <
ET        3.70 ssppp                  <  RTWT      3.88 rr                     <
EO        5.67 ooooooo                <  GRNWT      0.0                        <
PESW 1 1.075 11111              .     <  1-SWDF 0.000                          <
PESW 2 1.204 222222             .     <  CSD2      0.00 1111111222222222222233<
PESW 3 3.426 33333333           .     <  TIMOB     0.08 b                      <
PESW 4   9.21 4444444444444444.       <  TOTN      60.8 nnnnnnn                <
PESW 5   9.48 5555555555555555.       <
PESW 6 7.077 6666666666666666.        <
PESW 7 7.042 7777777777777777.        <
PESW    38.51 pppppppppppppp  .       <
```

Next Command-> **FERT=25,IRR=25,JPSTAG=4<cr>**

Now apply 25 Kg/ha fertilizer and irrigate with 25 mm tomorrow, then proceed to stage 4 again.

(new screen)

```
 75% SILKING
  6/ 9/81     JDATE=160     STAGE=4.00
SOLRAD  513.        TEMPMX   34.0          TEMPMN   22.3
PRECIP 11.20 pppppp                   <  LN       21.00 nnnnnnnnnnnnnnnnnnnnn  <
CRAIN    156. cccc                    <  LAI      3.377 aaaaaaaaaaaaaAAA       <
RUNOFF  0.00                          <  BIOMAS    583. bbbbbbb                <
DRAIN   0.00                          <  LFWT     39.21 lllllllllllllllllll    <
CDRAIN 18.40 ttttttttt                <  STMWT    34.24 sssssssss              <
ET        5.37 sappppp                <  RTWT     26.01 rrrrrrrrrrr            <
EO        5.37 ooooooo                <  GRNWT      0.0                        <
PESW 1 2.019 1111111111111111.        <  1-SWDF 0.000                          <
PESW 2 1.592 222222222222       .     <  CSD2      0.00 1111111222222222222233<
PESW 3 3.050 33333333333      .       <  TIMOB     0.05 b                      <
PESW 4   9.06 4444444444444444.       <  TOTN      61.1 nnnnnnnn               <
PESW 5   9.36 5555555555555555.       <
PESW 6 7.047 6666666666666666.        <
PESW 7 7.045 7777777777777777.        <
PESW    39.98 pppppppppppppppp .      <
```

Next Command-> **PLOTSN<cr>**

Note that 25 kg N/ha increased biomas, LAI etc at silking. Look at soil N profile and compare with last stage 4 profile (+).

(new screen)

```
      5.00-     *    +
D    15.00-        +*
E         |         *
P    30.50-         *
T         |          *
H         |          +*
     56.00-          +*
-         |             *
          |                *
C         |                   *
M    86.00-                     +*
          |                    *+
          |                   * +
   113.50-                    * +
          |                    * +
          |                     * +
   138.50-                       *+
         ||----------|----------|----------|----------|----------|----------|
      0.00       0.83       1.67       2.50       3.33       4.17       5.00
  SOIL NITRATE (HG N/KG SOIL)   NO3=* ( 160)   LAST NO3=+ ( 160)
Next Command-> BACK<cr>
```

The two profiles don't differ greatly - the plant utilized most of the 25 kg N. Go back to stage 3.

(new screen)

```
 5/ 5/81     JDATE=125     STAGE=3.00
SOLRAD  573.       TEMPMX   32.2           TEMPMN   10.1
PRECIP  0.00                           <  LN        9.00 nnnnnnnnn          <
CRAIN    26. c                         <  LAI      0.746 aaaa       :        <
RUNOFF  0.00                           <  BIOMAS     42. b                   <
DRAIN   0.00                           <  LFWT      5.71 lll                 <
CDRAIN  2.70 tt                        <  STMWT     0.20 s                   <
ET      3.70 ssppp                     <  RTWT      3.88 rr                  <
EO      5.67 ooooooo                   <  GRNWT      0.0                     <
PESW 1 1.075 11111              .      <  1-SWDF 0.000                       <
PESW 2 1.204 222222             .      <  CSD2      0.00 111111122222222222222233<
PESW 3 3.426 33333333           .      <  TIMOB     0.08 b                   <
PESW 4  9.21 4444444444444444.         <  TOTN      60.6 nnnnnnn             <
PESW 5  9.48 5555555555555555.         <
PESW 6 7.077 6666666666666666.         <
PESW 7 7.042 7777777777777777.         <
PESW   38.51 pppppppppppppp     .      <


Next Command-> FERT=50,IRR=25,JPSTAG=4<cr>
```

Now apply 50 Kg/ha fertilizer and irrigate with 25 mm tomorrow, then proceed to stage 4.

(new screen)

```
 75% SILKING
  6/ 9/81     JDATE=160     STAGE=4.00
SOLRAD  513.      TEMPMX  34.0          TEMPMN  22.3
PRECIP 11.20 pppppp               <  LN      21.00 nnnnnnnnnnnnnnnnnnnn   <
CRAIN   156. cccc                 <  LAI     3.567 aaaaaaaaaaaaaAAAA      <
RUNOFF  0.00                      <  BIOMAS   682. bbbbbbbb               <
DRAIN   0.00                      <  LFWT    41.99 11111111111111111111   <
CDRAIN 10.94 tttttttt             <  STMWT   43.11 ssssssssssss           <
ET      5.36 sepppppp             <  RTWT    27.64 rrrrrrrrrrrrr          <
EO      5.36 ooooooo              <  GRNWT    0.0                         <
PESW 1 2.034 1111111111111111.    <  1-SWDF 0.000                         <
PESW 2 1.587 22222222222      .   <  CSD2     0.00 1111111222222222222222233<
PESW 3 3.799 3333333333       .   <  TIKOB    0.05 b                      <
PESW 4  9.08 444444444444444.     <  TOTN     63.3 nnnnnnnn               <
PESW 5  9.38 5555555555555555.    <
PESW 6 7.054 6666666666666666.    <
PESW 7 7.047 7777777777777777.    <
PESW   39.98 pppppppppppppppp .   <
```

Next Command-> **PLOTSN<cr>**

The extra N has produced greater plant growth up till silking. Lets look at change in soil N profile.

(new screen)

```
       5.00-    +  *
 D    15.00-   *    +
 E         |       *+
 P    30.50-        +*
 T         |         *
 H         |         *+
      56.00-         *+
 -         |              ++
           |                 + *
 C         |                    +  *
 H    86.00-                      +    *
           |                     +   *
           |                    +  *
     113.50-                    +*
           |                     +*
           |                      +*
     138.50-                       *
           ||----------|----------|----------|----------|----------|----------|----------|
       0.00       0.83       1.67       2.50       3.33       4.17       5.00
    SOIL NITRATE (MG N/KG SOIL)   NO3=* ( 160)   LAST NO3=+ ( 160)
```

Next Command-> **BACK<cr>**

Go back to stage 3.

(new screen)

```
 5/ 5/81    JDATE=125    STAGE=3.00
SOLRAD  573.       TEMPMX  32.2        TEMPMN  10.1
PRECIP  0.00                        <  LN      9.00 nnnnnnnnn             <
CRAIN    26. c                      <  LAI     0.746 aaaa                 <
RUNOFF  0.00                        <  BIOMAS   42. b                     <
DRAIN   0.00                        <  LFWT    5.71 lll                   <
CDRAIN  2.70 tt                     <  STMWT   0.20 s                     <
ET      3.70 ssppp                  <  RTWT    3.88 rr                    <
EO      5.67 ooooooo                <  GRNWT    0.0                       <
PESW 1 1.075 11111           .      <  1-SWDF 0.000                       <
PESW 2 1.204 222222          .      <  CSD2    0.00 1111111222222222222233<
PESW 3 3.426 33333333        .      <  TIMOB   0.08 b                     <
PESW 4  9.21 4444444444444444.      <  TOTN    60.8 nnnnnnn               <
PESW 5  9.48 5555555555555555.      <
PESW 6 7.077 6666666666666666.      <
PESW 7 7.042 7777777777777777.      <
PESW   38.51 ppppppppppppppp  .     <
```

Next Command-> **FERT=100,IRR=25,JPSTAG=4<cr>**

This time fertilize at 100 kg/ha and irrigate with 25 mm tomorrow and proceed to stage 4.

(new screen)

```
 75% SILKING
 6/ 9/81    JDATE=160    STAGE=4.00
SOLRAD  513.       TEMPMX  34.0        TEMPMN  22.3
PRECIP 11.20 pppppp                 <  LN     21.00 nnnnnnnnnnnnnnnnnnnnn <
CRAIN   156. cccc                   <  LAI    3.738 aaaaaaaaaaaaaAAAAA    <
RUNOFF  0.00                        <  BIOMAS  795. bbbbbbbbbb            <
DRAIN   0.00                        <  LFWT   44.52 llllllllllllllllllll  <
CDRAIN 19.49 ttttttttt              <  STMWT  53.07 ssssssssssssss        <
ET      5.36 ssppppp                <  RTWT   28.98 rrrrrrrrrrrrrr        <
EO      5.36 ooooooo                <  GRNWT    0.0                       <
PESW 1 2.031 1111111111111111.      <  1-SWDF 0.000                       <
PESW 2 1.555 22222222222     .      <  CSD2    0.00 1111111222222222222233<
PESW 3 3.754 3333333333      .      <  TIMOB   0.05 b                     <
PESW 4  9.10 4444444444444444.      <  TOTN    68.2 nnnnnnnn              <
PESW 5  9.40 5555555555555555.      <
PESW 6 7.068 6666666666666666.      <
PESW 7 7.054 7777777777777777.      <
PESW   39.97 ppppppppppppppp .      <
```

Next Command-> **PLOTSN<cr>**

Look at additional soil N effect in profile.

(new screen)

```
     5.00-   *   +
D   15.00-  +  *
E        |      + *
P   30.50-        +*
T        |        *
H        |        *
    56.00-        *
-        |             +  *
         |                 +    *
C        |                     +        *
H   86.00-                        +          *
         |                      +       *
         |                     +    *
   113.50-                   + *
         |                     +*
         |                     *
   138.50-                     *
         ||----------|----------|----------|----------|----------|----------|
     0.00       0.83       1.67       2.50       3.33       4.17       5.00
   SOIL NITRATE (MG N/KG SOIL)   NO3=* ( 160)   LAST NO3=+ ( 160)
Next Command-> JPEND<cr>
```

Lets now look at the final yield with 100 kg N applied. Proceed to the end of the climate file.

(new screen)

BEGIN GRAIN FILLING

(new screen)

END GRAIN FILLING

(new screen)

PHYSIOLOGICAL MATURITY

(new screen)

	PREDICTED	MEASURED		PREDICTED	MEASURED
SILKING DAY	160	156	STOVER KG/HA	9024.3	10954.0
MATURITY DAY	203	210	GRAIN N%	1.33	1.62
GRAIN KG/HA 15%	9953.	11550.	TOTAL N KG/HA	144.0	248.0
KERN WT G DRY	0.2358	0.2760	GRAIN N KG/HA	111.5	158.0
FINAL GPSM	3566.	419.			
GRAINS/EAR	502.	0.			
LAI AT SILKING	3.93	4.20			
BIOMASS KG/HA	17434.	23000.			

GROWTH STAGE	CSD1	CSD2	CNSD1	CNSD2
1	0.00	0.00	0.09	0.15
2	0.00	0.00	0.50	0.60
3	0.00	0.00	0.03	0.07
4	0.00	0.00	0.02	0.15
5	0.00	0.00	0.33	0.45

(new screen)

```
END OF WEATHER DATA REACHED
Next Command-> OYLD<cr>
```

Look at the OYLD.DAT file.

```
          V/I CERES-MAIZE OUTPUT SUMMARY
   FLO,SC 81   SW-SPEC, IRR, FERT          PROGRAM BEGINS DAY  60

CULTIVAR PIO 3382                   POPULATION (PLANTS/M2)    7.10

                              GENETIC CONSTANTS
   P1 200.00    P2 0.70      P5 800.00    G2 650.00    G3  8.500

SALB   0.14          U    5.0        SWCON  0.60        CN2   60.0

 DEPTH-CM     LL     DUL    SAT    ESW    SW     WR     NH4    NO3

   0.-  10. 0.075  0.210  0.250  0.135  0.189  1.000  2.00   5.00
  10.-  20. 0.075  0.210  0.250  0.135  0.189  1.000  2.00   5.00
  20.-  41. 0.100  0.240  0.290  0.140  0.228  0.800  2.00   5.00
  41.-  71. 0.210  0.310  0.350  0.100  0.310  0.400  2.00   5.00
  71.- 101. 0.210  0.320  0.360  0.110  0.320  0.100  1.00   2.00
 101.- 126. 0.180  0.280  0.320  0.100  0.280  0.100  1.00   2.00
 126.- 151. 0.180  0.280  0.320  0.100  0.280  0.100  1.00   2.00
TOT PROF     25.2   42.1   48.4   16.9   41.5          43.    82.


Next, Previous, End or Stop (N/P/E/S)?  E<cr>
```

Display the last screen, to view the final report summary.

```
 6/ 9/81 160   75% SILK     657. 3.75 1.23 212. 124.  156.   88.   15.
 6/ 9/81 160   75% SILK     754. 3.93 1.69 211. 124.  156.   88.   15.
 6/17/81 168   BEG.GR.F    1075. 3.58 1.71 260. 163.  172.  142.   16.
 7/20/81 201   END GR.F    1743. 0.88 1.00 442. 295.  328.  250.   14.
 7/22/81 203   PHYS.MAT.   1743. 0.88 1.00 447. 295.  328.  250.   13.

                  PREDICTED  MEASURED                  PREDICTED  MEASURED
SILKING DAY           160        156     STOVER KG/HA     9024.3   10954.0
MATURITY DAY          203        210     GRAIN N%           1.33      1.62
GRAIN KG/HA 15%    9953.      11550.     TOTAL N KG/HA     144.0     248.0
KERN WT G DRY     0.2358      0.2760     GRAIN N KG/HA     111.5     158.0
FINAL GPSM         3566.        419.
GRAINS/EAR          502.          0.
LAI AT SILKING      3.93        4.20
BIOMASS KG/HA     17434.      23800.

GROWTH STAGE       CSD1       CSD2      CNSD1      CNSD2
          1        0.00       0.00       0.09       0.15
          2        0.00       0.00       0.50       0.60
          3        0.00       0.00       0.03       0.07
          4        0.00       0.00       0.02       0.15
          5        0.00       0.00       0.33       0.45
Previous or Stop (P/S)?  S<cr>
```

Stop viewing this file.

Next Command-> **OBIO<cr>**

View the OBIO.DAT file.

FLO,SC 81 SW=SPEC, IRR, FERT

DAY	LEAF NO.	LAI M2/M2	----- ORGAN WEIGHT ------ ROOT	STEM	EAR	LEAF	ROOT DPTH CM	--- ROOT LENGTH --- L1	L2	L3	L4	L5
			-------- G/PLANT --------					----- CM/CM3 ------				
108	4	0.04	0.4	0.2	0.0	0.1	25.	0.3	0.1	0.0	0.0	0.0
115	6	0.20	1.3	0.2	0.0	1.1	44.	0.5	0.3	0.1	0.0	0.0
122	8	0.58	4.7	0.2	0.0	4.2	66.	1.8	1.5	0.4	0.0	0.0
129	10	0.97	9.2	0.2	0.0	7.8	80.	3.6	3.7	1.1	0.2	0.0
136	12	1.73	18.6	1.3	0.0	16.0	98.	5.0	5.0	2.1	0.5	0.0
143	14	2.59	27.7	5.4	0.0	26.6	115.	5.0	5.0	3.3	0.8	0.1
150	17	3.38	31.8	27.0	0.0	36.8	138.	5.0	5.0	4.0	0.9	0.1
157	20	3.83	32.5	54.1	0.0	43.2	151.	5.0	5.0	4.2	1.0	0.2
164	21	3.66	34.0	59.3	29.7	44.7	151.	5.0	5.0	4.2	1.0	0.2
171	21	3.49	35.2	64.4	58.4	44.7	151.	5.0	5.0	4.4	1.0	0.2
178	21	3.27	38.7	64.4	86.0	44.7	151.	5.0	5.0	5.0	1.2	0.2
185	21	2.94	39.9	60.1	113.6	44.7	151.	5.0	5.0	5.0	1.3	0.3
192	21	2.21	40.9	64.4	141.6	44.7	151.	5.0	5.0	5.0	1.4	0.3
199	21	1.07	40.9	62.3	170.0	44.7	151.	5.0	5.0	5.0	1.5	0.3
108	4	0.04	0.4	0.2	0.0	0.1	25.	0.3	0.1	0.0	0.0	0.0

Next, Previous, End or Stop (N/P/E/S)? **E<cr>**

Go to the final screen.

157	20	3.22	18.2	25.5	0.0	34.7	151.	3.3	5.0	3.3	1.2	0.2
129	10	0.96	4.9	0.2	0.0	7.7	80.	1.2	1.8	0.8	0.2	0.0
136	12	1.71	14.3	1.3	0.0	15.9	98.	5.0	2.9	1.8	0.5	0.1
143	14	2.58	23.5	5.4	0.0	26.4	115.	5.0	5.0	3.0	1.1	0.2
150	17	3.26	26.0	22.2	0.0	35.2	138.	5.0	5.0	3.5	1.3	0.3
157	20	3.50	26.0	36.5	0.0	38.5	151.	5.0	5.0	3.5	1.3	0.3
129	10	0.96	4.9	0.2	0.0	7.7	80.	1.2	1.8	0.8	0.2	0.0
136	12	1.71	14.3	1.3	0.0	15.9	98.	5.0	3.0	1.7	0.5	0.0
143	14	2.58	23.5	5.4	0.0	26.4	115.	5.0	5.0	2.9	0.9	0.1
150	17	3.36	27.2	26.8	0.0	36.6	138.	5.0	5.0	3.6	1.2	0.2
157	20	3.60	27.6	45.8	0.0	41.1	151.	5.0	5.0	3.6	1.2	0.2
129	10	0.96	4.9	0.2	0.0	7.7	80.	1.2	1.8	0.8	0.2	0.0
136	12	1.71	14.3	1.3	0.0	15.9	98.	5.0	3.5	1.7	0.5	0.0
143	14	2.58	23.5	5.4	0.0	26.4	115.	5.0	5.0	2.8	0.8	0.1
150	17	3.36	27.8	27.0	0.0	36.7	138.	5.0	5.0	3.4	1.0	0.2
157	20	3.82	28.6	54.1	0.0	43.0	151.	5.0	5.0	3.6	1.0	0.2
164	21	3.65	30.2	59.2	29.7	44.5	151.	5.0	5.0	3.7	1.1	0.2
171	21	3.48	31.6	64.3	58.4	44.5	151.	5.0	5.0	4.0	1.2	0.3
178	21	3.26	34.9	64.3	86.0	44.5	151.	5.0	5.0	4.4	1.4	0.3
185	21	2.93	35.2	56.8	113.5	44.5	151.	5.0	5.0	4.7	1.4	0.3
192	21	2.21	34.1	51.0	141.6	44.5	151.	5.0	5.0	4.7	1.4	0.3
199	21	1.07	32.9	41.1	160.1	43.6	151.	5.0	5.0	4.7	1.4	0.3

Previous or Stop (P/S)? **S<cr>**

Stop viewing this file.

Next Command-> OMIN<cr>

View the OMIN.DAT file.

+++ 1

DAY = 60

GROSS N IMMOBILIZATION IN PROFILE = 0.00 KG N/HA DAY
GROSS N RELEASE FROM FRESH OM MINERALIZATION = 0.00 KG N/HA DAY
N RELEASED FROM HUMUS = 0.00 KG N/HA DAY

LAYER FON SNO3 SNH4 NITRIF LEACH UPFLX UPTK

FLO,SC 81 SW=SPEC, IRR, FERT

INITIAL MINERAL N IN LAYERS

LAYER DEPTH --- AMMONIUM -- --- NITRATE -- BULK PH
CM G/MG KG/HA G/MG KG/HA DEN.
Next, Previous, End or Stop (N/P/E/S)? E<cr>

Go to the last screen.

5	0.0	3.4	4.7	0.000	0.000	-0.034	0.000
6	0.0	3.0	4.2	0.000	0.000	0.000	0.000
7	0.0	3.3	4.4	0.000	0.000	0.000	0.929

DAY = 242

GROSS N IMMOBILIZATION IN PROFILE = 0.00 KG N/HA DAY
GROSS N RELEASE FROM FRESH OM MINERALIZATION = 0.01 KG N/HA DAY
N RELEASED FROM HUMUS = 0.00 KG N/HA DAY

LAYER	FON	SNO3	SNH4	NITRIF	LEACH	UPFLX	UPTK
1	2.2	1.0	3.1	0.059	0.000	0.193	0.052
2	0.2	0.6	3.1	0.015	0.000	0.016	0.010
3	0.1	1.7	7.0	0.000	0.000	-0.141	0.008
4	0.1	3.0	9.3	0.000	0.000	0.028	0.005
5	0.0	3.6	4.7	0.000	0.000	-0.035	0.000
6	0.0	3.0	4.2	0.000	0.000	0.000	0.000
7	0.0	3.3	4.4	0.000	0.000	0.000	0.929

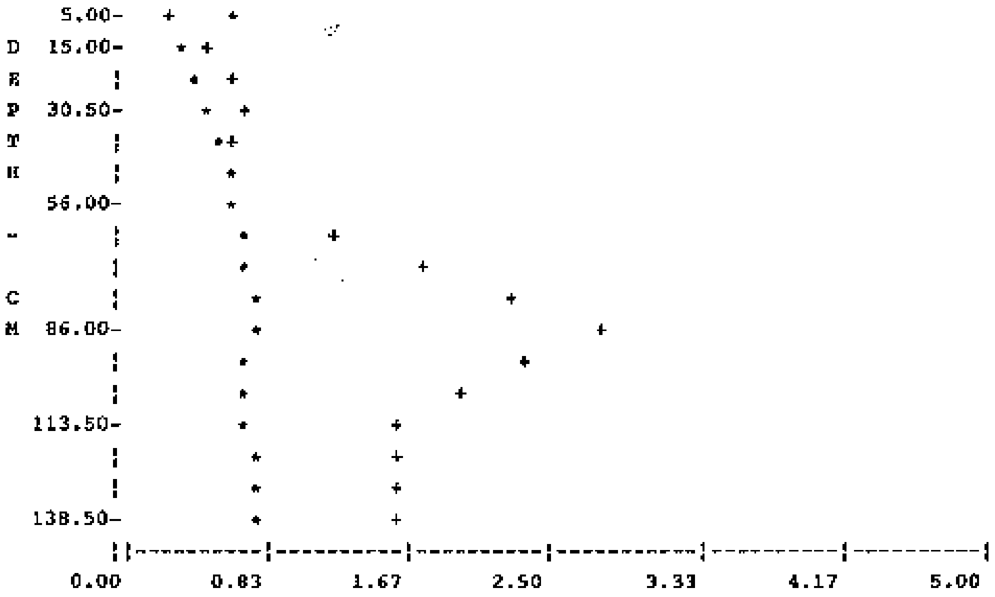
Previous or Stop (P/S)? S<cr>

Stop viewing this file

Next Command-> **PLOTSN<cr>**

Look at the final soil N profile.

(new screen)



SOIL NITRATE (MG N/KG SOIL)   NO3=* (242)   LAST NO3=+ (160)

Next Command-> **JPSTAG=-7<cr>**

We have the analysis of applied N and will now go back to the first day.

(new screen)

```
  3/ 1/81    JDATE= 60    STAGE=7.00
SOLRAD  149.       TEMPMX  21.8           TEMPMN  15.6
PRECIP  0.00                         <  TIMOB    3.52 bbbbbbbbb          <
CRAIN     0.                         <  TOTN   115.6 nnnnnnnnnnnnn       <
RUNOFF  0.00                         <
DRAIN   0.00                         <
CDRAIN  0.00                         <
ET      1.41 ss                      <
EO      1.41 oo                      <
PESW 1 1.784 11111111111111   .      <
PESW 2 1.912 2222222222222222 .      <
PESW 3 4.676 333333333333333 .       <
PESW 4  9.37 4444444444444444.       <
PESW 5  9.57 5555555555555555.       <
PESW 6 7.013 6666666666666666.       <
PESW 7 7.000 7777777777777777.       <
PESW   41.33 pppppppppppppppp.       <
```

Next Command-> **SHOW<cr>**

Look at the current parameters.

(new screen)

```
FLO,SC 81   SW=SPEC, IRR, FERT
  ISOW=        97   PLANTS=      7.10   SDEPTH=       4.00      LAT=     34.00
  DMOD=      0.01   KOUTGR=         7   KOUTHN=        -14   KOUTND=         7
KOUTNU=         7   KOUTWA=         7     IIRR=       1.00   INSOIL=      1.10
ISWNIT=         1     KGEN=         0     KIRR=          0    KSOIL=         0
 KFERT=         0     KMAN=         0    KLAYR=          0    STORE=     99999
 KMEAS=         0    KWETH=         0
PIO 3382
    P1=    200.00       P2=      0.70       P5=     800.00
    G2=    650.00       G3=      8.50

ISLKJD=       156   MATJD=        210   XYIELD= 11550.00    XGRWT=      0.28
 XGPSM=    418.50    XGPE=       0.00     XLAI=       4.20    XBIOM= 23800.00
STRAW= 10954.00   GRPCTN=       1.62   XTOTNP=     248.00    XGNUP=    158.00

  SALB=      0.14        U=      5.00    SWCON=       0.60      CN2=     60.00
   TAV=     16.80      AMP=     20.00    JDATE=      60.00    STRAW=    500.00
  SDEP=     10.00      SCN=     80.00     ROOT=     200.00      RCN=     45.00

Next Command-> SHOWF<cr>
```

Look at the current fertilizer data.

(new screen)

```
JFDAY( 1)= 90    AFERT( 1)=  66.7 DFERT( 1)=  10.0    IFTYPE( 1)= 1
JFDAY( 2)=139    AFERT( 2)=  66.7 DFERT( 2)=  10.0    IFTYPE( 2)= 1
JFDAY( 3)=153    AFERT( 3)=  66.7 DFERT( 3)=  10.0    IFTYPE( 3)= 1
Next Command-> ISOW=120,JFDAY=110,=160,=174,SHOWF<cr>
```

Lets change the sowing to day 120 for a late planting, and alter the fertilizer dates appropriately. Display fertilizer data again.

(new screen)

```
JFDAY( 1)=110    AFERT( 1)=  66.7 DFERT( 1)=  10.0    IFTYPE( 1)= 1
JFDAY( 2)=160    AFERT( 2)=  66.7 DFERT( 2)=  10.0    IFTYPE( 2)= 1
JFDAY( 3)=174    AFERT( 3)=  66.7 DFERT( 3)=  10.0    IFTYPE( 3)= 1
Next Command-> SHOWI<cr>
```

Show current irrigation schedule.

(new screen)

```
JDAY( 1)=121    AIRR( 1)=13.70 JDAY( 2)=133    AIRR( 2)= 4.30
JDAY( 3)=139    AIRR( 3)=14.00 JDAY( 4)=146    AIRR( 4)=14.20
JDAY( 5)=153    AIRR( 5)= 5.60 JDAY( 6)=160    AIRR( 6)=11.20
JDAY( 7)=162    AIRR( 7)=27.20 JDAY( 8)=168    AIRR( 8)=27.20
JDAY( 9)=170    AIRR( 9)=27.40 JDAY(10)=174    AIRR(10)=26.40
JDAY(11)=177    AIRR(11)=25.90 JDAY(12)=201    AIRR(12)=27.70
JDAY(13)=205    AIRR(13)=27.40 JDAY(14)=   0   AIRR(14)= 0.00
Next Command-> SHOW<cr>
```

Check parameters again.

(new screen)

```
FLO,SC 81  SW=SPEC, IRR, FERT
  ISOW=       120  PLANTS=      7.10  SDEPTH=      4.00     LAT=    34.00
  DMOD=      0.01  KOUTGR=         7  KOUTHN=       -14  KOUTNB=        7
KOUTNU=         7  KOUTWA=         7    IIRR=      1.00  INSOIL=     1.10
ISWNIT=         1    KGEN=         0    KIRR=         0   KSOIL=        0
 KFERT=         0    KHAN=         0   KLAYR=         0   STORE=    99999
 KMEAS=         0   KWETH=         0
PIO 3382
    P1=    200.00      P2=      0.70      P5=    800.00
    G2=    650.00      G3=      8.50

ISLKJD=       156   MATJD=       210  XYIELD= 11550.00   XGRWT=     0.28
 XGPSM=    418.50    XGPE=      0.00    XLAI=      4.20   XBIOM= 23800.00
STRAW= 10954.00   GRPCTN=      1.62  XTOTNP=    248.00  XGNUP=   158.00

  SALB=      0.14       U=      5.00   SWCON=      0.60     CN2=    60.00
   TAV=     16.80     AMP=     20.00   JDATE=     60.00   STRAW=   500.00
  SDEP=     10.00     SCN=     80.00    ROOT=    200.00     RCN=    45.00

Next Command-> JPEND<cr>
```

Proceed to the end of the climate file and see what effect a late sowing has on maize growth.

(new screen)

SOWING

(new screen)

GERMINATION

(new screen)

SEEDLING EMERGENCE

(new screen)

END OF JUVENILE STAGE

(new screen)

TASSEL INITIATION

(new screen)

75% SILKING

(new screen)

BEGIN GRAIN FILLING

(new screen)

END GRAIN FILLING

(new screen)

PHYSIOLOGICAL MATURITY

(new screen)

	PREDICTED	MEASURED
SILKING DAY	176	156
MATURITY DAY	221	210
GRAIN KG/HA 15%	10497.	11550.
KERN WT G DRY	0.2557	0.2760
FINAL GPSM	3469.	419.
GRAINS/EAR	489.	0.
LAI AT SILKING	4.31	4.20
BIOMASS KG/HA	19601.	23800.

	PREDICTED	MEASURED
STOVER KG/HA	10730.8	10954.0
GRAIN N%	1.74	1.62
TOTAL N KG/HA	219.1	248.0
GRAIN N KG/HA	154.5	158.0

GROWTH STAGE	CSD1	CSD2	CNSD1	CNSD2
1	0.00	0.00	0.01	0.07
2	0.00	0.00	0.00	0.15
3	0.00	0.00	0.00	0.01
4	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.01

(new screen)

END OF WEATHER DATA REACHED
Next Command-> **OYLD<cr>**

View the OYLD.DAT file.

V/I CERES-MAIZE OUTPUT SUMMARY
FLO,SC 81 SH-SPEC, IRR, FERT PROGRAM BEGINS DAY 60

CULTIVAR PIO 3382 POPULATION (PLANTS/M2) 7.10

GENETIC CONSTANTS

P1 200.00 P2 0.70 P5 800.00 G2 650.00 G3 8.500

SALB 0.14 U 5.0 SWCON 0.60 CN2 60.0

DEPTH-CM	LL	DUL	SAT	BSW	SW	WR	NH4	NO3
0.- 10.	0.075	0.210	0.250	0.135	0.189	1.000	2.00	5.00
10.- 20.	0.075	0.210	0.250	0.135	0.189	1.000	2.00	5.00
20.- 41.	0.100	0.240	0.290	0.140	0.228	0.800	2.00	5.00
41.- 71.	0.210	0.310	0.350	0.100	0.310	0.400	2.00	5.00
71.- 101.	0.210	0.320	0.360	0.110	0.320	0.100	1.00	2.00
101.- 126.	0.180	0.280	0.320	0.100	0.280	0.100	1.00	2.00
126.- 151.	0.180	0.280	0.320	0.100	0.280	0.100	1.00	2.00
TOT PROF	25.2	42.1	48.4	16.9	41.5		43.	82.

Next, Previous, End or Stop (N/P/E/S)? **E<cr>**

Show the final screen of the file.

```
5/30/81 150   TAS.INIT.    42. 0.74 3.19  81.  18.  117.   46.   16.
6/25/81 176   75% SILK    802. 4.31 2.14 221. 119.  154.  171.   16.
7/ 6/81 187   BEG.GR.F   1125. 3.93 2.22 267. 157.  274.  197.   16.
8/ 7/81 219   END GR.F   1960. 0.98 1.32 434. 277.  388.  252.   15.
8/ 9/81 221   PHYS.MAT.  1960. 0.98 1.32 437. 277.  399.  252.   15.

                 PREDICTED  MEASURED                 PREDICTED  MEASURED
SILKING DAY           176       156   STOVER KG/HA    10730.8   10954.0
MATURITY DAY          221       210   GRAIN N%           1.74      1.62
GRAIN KG/HA 15% 10497.       11550.   TOTAL N KG/HA     219.1     248.0
KERN WT G DRY    0.2557      0.2760   GRAIN N KG/HA     154.5     158.0
FINAL GPSM        3469.        419.
GRAINS/EAR         489.          0.
LAI AT SILKING     4.31        4.20
BIOMASS KG/HA    19601.      23800.

GROWTH STAGE       CSD1       CSD2      CNSD1      CNSD2
           1       0.00       0.00       0.01       0.07
           2       0.00       0.00       0.00       0.15
           3       0.00       0.00       0.00       0.01
           4       0.00       0.00       0.00       0.00
           5       0.00       0.00       0.00       0.01
Previous or Stop (P/S)?  S<cr>
```

Stop viewing the file.

Next Command-> QUIT<cr>

Exit the model.