

User's Manual of GreenScilab Toolbox

Contents

1. Introduction.....	1
1.1 Features	1
1.2 Running.....	1
1.3 Note.....	2
1.4 Directories in ToolBox.....	2
2. Main Interface and Menu	2
2.1 File	2
2.2 Parameter	3
2.3 Simulate	3
2.4 Output	3
2.5 Fit	3
2.6 Demos	4
2.7 About.....	4
3. Parameter	4
3.1 Plant age.....	4
3.2 Topological Parameter.....	4
3.2.1 macrostate topological parameter.....	4
3.2.2 macrosate(time) topological parameter.....	5
3.2.3 microstate topological parameter	6
3.3 Functional Parameter	7
3.4 Allometry Parameter	8
3.5 Geometrical Parameter.....	9
3.5.1 shape.....	9
3.5.2 color	10
3.5.3 macrostate	11
3.5.4 microstate.....	12
3.6 Environmental Parameter.....	13
4. Output	15
4.1 number	15
4.1.1 organ.....	15
4.1.2 demand.....	15
4.2 Figure	16
4.3 3D.....	17
5. Equation	18
6. Example	19
Acknowledgement	25
References.....	25

1. Introduction

1.1 Features

This toolbox includes computation, visualization, calibration of a functional-structural plant growth model 'GreenLab' in Scilab environment. The name 'GreenScilab' is the combination of 'GreenLab' and 'Scilab'. The kernel of this toolbox was written in Scilab language, while the interface in TCL/TK. This toolbox runs both in Windows and Unix/Linux. As it is an open-source software, users can modify the plant parameters as well as the code freely. This tool aims at serving for teaching and research work in plant modeling, applied mathematics, simulation, botany, etc.

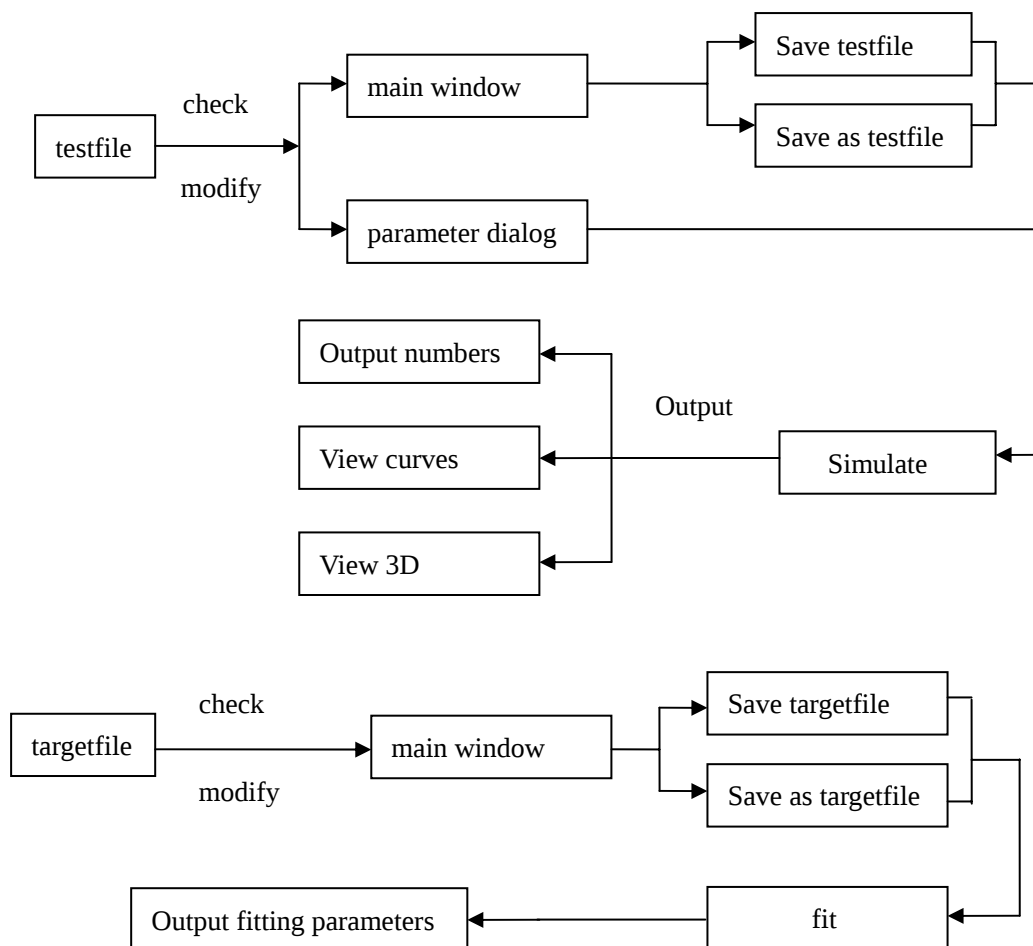


Figure 1.1 Flow Chart of GreenScilab

1.2 Running

1. start Scilab on Windows or Unix/Linux
 2. change the path to the directory in which the program named "inter_main.tcl" locates
 3. input command "TCL_EvalFile('inter_main.tcl')", If the version of Scilab used is 3.1
- Then the main window of this toolbox will appear, where users can operate through the menu and

dialogue. However, it is still possible to run directly the kernel without interface.

1.3 Note

1. If the main window of GreenScilab doesn't appear after typing the command above, user should open the editor of Scilab first.
2. If the version of Scilab used is 3.0, please type 'TK_EvalFile('inter_main.tcl')'.
If the version of Scilab used is 3.1, please type 'TCL_EvalFile('inter_main.tcl')'.

1.4 Directories in ToolBox

In main directory, there are 9 directories:

bin (*.sci) : kernel program of GreenScilab in Scilab language

demos (*.m) : parameter data files of plant model as demos

env (*.dat) : environment data files , including water, light and temperature condition at each cycle

inttcl (*.tcl) : shell program of GreenScilab in TCL/TK language

man: user's manual and help directory documents

smb (*.smb) : files describing geometrical shape of organs, like leaves, flowers, internodes, etc

str (*.str) : files describing substructures for setting up geometrical structure of plant

target (*.m) : data files of real plant

testfiles (*.m) : parameter files of virtual plant

2. Main Interface and Menu

The main interface of GreenScilab consists of a menu bar and a textbox as shown in Figure 2.1. There are seven main menus: File, Parameter, Simulate, Output, Fit, Demos and About. Except menu Simulate and Fit, each menu also has several submenus.

2.1 File

It manages test files, or parameter files. It has seven submenus:

- Load testfile: to open a dialog to open a test file, data can be shown and modified in dialogs.
- Save testfile: to save a test file with the same name.
- Save as testfile: to save a test file with a different name.
- Load targetfile: to open a dialog to open a target file, data can be shown and modified in the main window.
- Save targetfile: to save a target file with the same name.
- Save as targetfile: to save a target file with a different name.
- Exit: close the main window and quit GreenScilab.

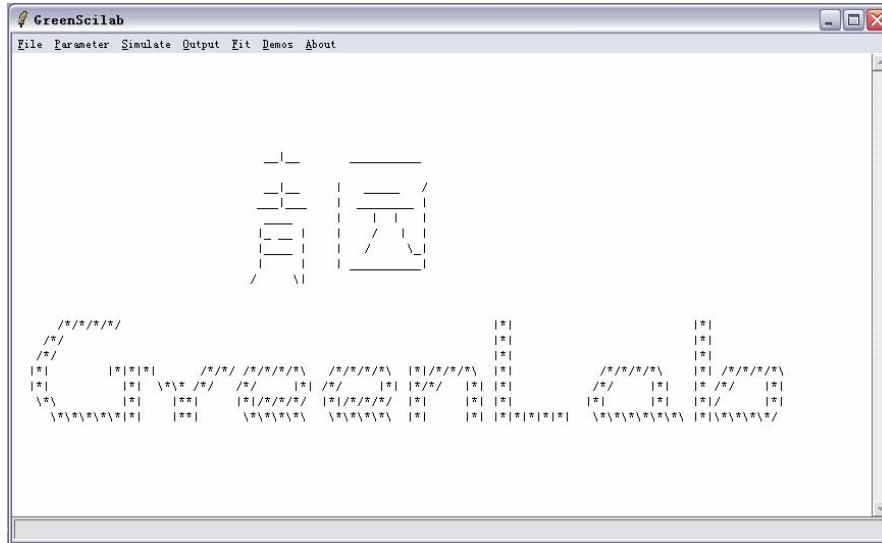


Figure 2.1 main window of GreenScilab

2.2 Parameter

It has seven submenus:

- Plant age:

set the chronological age(CA)and physiological age(PA) of the plant.

- Topological Parameter:

set the topological parameters of GreenLab model. It has three popmenus: macrostate topological parameter, macrostate(time) topological parameter, microstate topological parameter.

- Functional Parameter:

set the functional parameters of GreenLab model.

- Allometry Parameter:

set the allometry parameters of GreenLab model.

- Geometrical Parameter:

set the geometrical parameters of GreenLab model.

- Environmental Parameter:

Set the environmental parameters of GreenLab model.

The details on the parameters is explained in Section 3.

2.3 Simulate

Simulate the testfile which is already loaded. Computation is done without showing the results. If you want to see the result, please click the menu Output.

2.4 Output

Set the output options of GreenLab model. The details is explained in Section 3.

2.5 Fit

Fit parameters of GreenLab model from datum of real plants. Before clicking menu Fit, users

should load a target file first.

2.6 Demos

In this menu, there are three typical examples. Parameters of them cannot be modified, but they can be simulated without modifying parameters. These examples' files are in the directory of demos.

Demo 1: a simple example on Corner model

Demo 2: simulation of gingko

Demo 3: simulation a calibrated cotton

2.7 About

It has two submenus:

- help

User can click it to find some information which can help you to learn this toolbox.

- about...

It gives the current version number, copyright and developers of the toolbox.

3. Parameter

3.1 Plant age

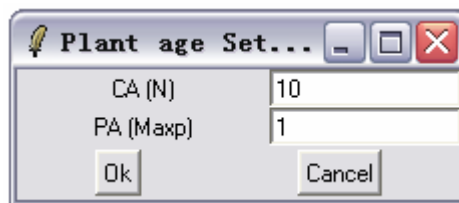


Figure 3.1 Plang age interface

Dialog

Setting chronological age and physiological age of GreenLab model

Parameters

- CA: chronological age of the plant which user selects from the "Load testfile" dialog. The data must be greater than 0.
- PA: physiological age of the plant which user selects from the "Load testfile" dialog. Here we suppose in the nature, plants' physiological age will not be more than 6, so the data must be greater or equal to 1 and smaller or equal to 6.

3.2 Topological Parameter

3.2.1 macrostate topological parameter

Popmenu

macrostate topological parameter

Dialog

Setting the macrostates topological parameters of the GreenLab model. In this dialog, there are 6 entries for each variable. The sequence of the entries for each variable is the sequence of the macrostates with different physiological ages. The data in the first entry for each variable stands for the parameter of the macrostate with physiological age 1.

Parameters

- Macro_Num(Nu_Ma): the maximum repetition times of macrostates with different physiological ages. The datum must be positive integers and greater or equal to 1.
- Struc_Jump(st_j): the data stands for physiological age of the substructure. It determines one substructure jumps to another substructure with which physiological age. The data must be greater or equal to the physiological age of the substructure itself and smaller or equal to 6.
- Reiter_Order(b_0): to set the parameter which determines reiteration branches' order at each physiological age. The data must be positive integer, greater or equal to 0 and smaller or equal to 6.
- Branch Control(br_a): to set the parameter to control phy_age/chr_age on branches. The data must be 1 or 0.
- Reiter Control(re_a): to set the parameter to control phy_age/chr_age on reiteration. The data must be 1 or 0.

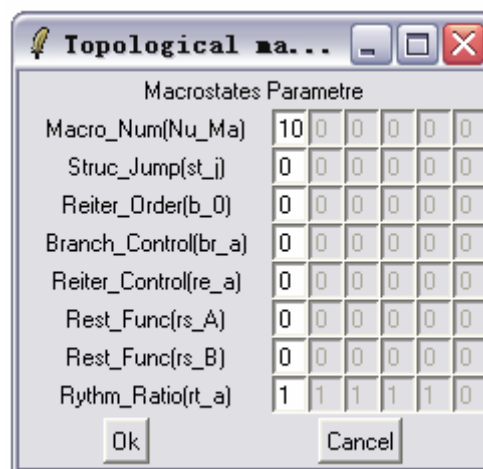


Figure 3.2 macrostate topological parameter interface

3.2.2 macrosate(time) topological parameter

Popmenu

macrostate(time) topological parameter

Dialog

Setting the macrostates topological parameters of GreenLab model which are relevant to time. In each section, each row stands for physiological age, and each column stands for organ type. The sequence of organ types is Blade, Petiel, Internode, FemaleFlower, MaleFlower. The data in each entry must be integer.

Parameters

- Time_Function: to set the parameters which determine the number of cycles the organ possessing *ith* physiological age can live. The data must be greater or equal to 1 and be integer.
- Time_appearance: to set the parameters which determine when the organ appearances. The data must be greater or equal to 1 and smaller or equal to chronological age which is set in the Plant age dialog and be integer.
- Time_disappearance: to set the parameters which determine when the organ disappearances. The data must be greater than the parameter of Time_appearance for the same organ with the same physiological age and be integer.
- Time_busy: to set the parameters which determine the number of cycles which the organ can actually exist. The data must be greater or equal to 1 and smaller or equal to the parameter of Time_Function for the same organ with the same physiological age and be integer.
- Time_idle: to set the parameters which determine the number of cycles the organ will be idle. The data must be greater or equal to 0 and be integer.

Topological Parameter Setting

Time_Function

phy1	1	1	1	1	1	1	1
phy2	1	1	1	1	1	1	1
phy3	1	1	1	1	1	1	1
phy4	1	1	1	1	1	1	1
phy5	1	1	1	1	1	1	1
phy6	1	1	1	1	1	1	1

Time_appearance

phy1	1	1	1	1	1	1	1
phy2	1	1	1	1	1	1	1
phy3	1	1	1	1	1	1	1
phy4	1	1	1	1	1	1	1
phy5	1	1	1	1	1	1	1
phy6	1	1	1	1	1	1	1

Time_disappearance

phy1	99	99	99	99	99	99	99
phy2	99	99	99	99	99	99	99
phy3	99	99	99	99	99	99	99
phy4	99	99	99	99	99	99	99
phy5	99	99	99	99	99	99	99
phy6	99	99	99	99	99	99	99

Time_busy

phy1	1	1	1	1	1	1	1
phy2	1	1	1	1	1	1	1
phy3	1	1	1	1	1	1	1
phy4	1	1	1	1	1	1	1
phy5	1	1	1	1	1	1	1
phy6	1	1	1	1	1	1	1

Time_idle

phy1	0	0	0	0	0	0	0
phy2	0	0	0	0	0	0	0
phy3	0	0	0	0	0	0	0
phy4	0	0	0	0	0	0	0
phy5	0	0	0	0	0	0	0
phy6	0	0	0	0	0	0	0

Ok Cancel

Figure 3.3 macrostate(time) topological parameter interface

3.2.3 microstate topological parameter

Popmenu

microstate topological parameter

Dialog

Setting the microstates topological parameters of GreenLab model. This dialog is divided to 5 sections according to different variables. In each entry, the data is a matrix. The data in each entry must be greater or equal to 0 and be positive integer. The datum can be modified directly.

Parameters

- Micro_Num(Nu_I): to set the self-cycling number of microstates. For example, the data in row 2, column 3 stands for the self-cycling number of the microstate with axillary bud of physiological age 3 in the macrostate of physiological age 2.
 - Axillary_Num(Nu_A): to set the number of axillary buds. For example, the data in row 1, column 2 stands for the number of axillary buds of physiological age 2 in the microstate of physiological age 1.
 - Leaf_Num(Nu_B): to set the number of leaves. For example, the data in row 1, column 2 stands for the number of leaves of physiological age 2 in the microstate of physiological age 1.
 - MaleF_Num(Nu_Ff): to set the number of male fruits.
 - FemaleF_Num(Nu_Fm): to set the number of female fruits.
- MaleF_Num(Nu_Ff), FemaleF_Num(Nu_Fm) are the same as Leaf_Num(Nu_B).

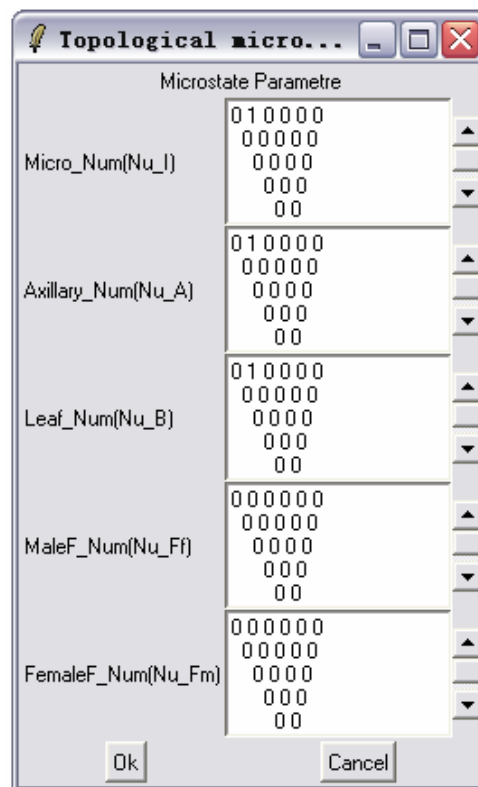


Figure 3.4 microstate topological parameter interface

3.3 Functional Parameter

Popmenu

functional parameter

Dialog

Setting the functional parameters of GreenLab model. This dialog is divided to 2 parts. The left part is divided to 2 sections. In the upper section, each column stands for physiological age. In the

lower section, each column stands for organ type. The sequence of organ types is Blade, Petiel, Internode, FemaleFlower, MaleFlower, Ring, Root. The data in each entry must be greater or equal to 0.

Parameters

- Sink_Blade(S_B): to set the number of sink of blades. The data in first column stands for the sink of the blade possessing the first physiological age. The data must be greater or equal to 0.
 - Time_Expansion(t_exp): to set the expansion span of organs.
 - Para_Expansion1(Bt_N): to set the parameter of expansion of organs.
 - Para_Expansion2(Bt_P): to set the parameter of expansion of organs.
 - Resist_Blade(r_B): to set the resistance of blades.
 - Resist_Petiol(r_P): to set the resistance of petioles.
 - Seed_Biomass(Q0): to set the total biomass of seed.
 - Flow_Biomass(dQ0): to set the parameter which determine the biomass the seed remains after the allocation of biomass from the seed at each cycle.
 - RingOption(0 or 1): If layer is proportional to number of leaves above, set the parameter 0. If section of layer is constant during a cycle, set the parameter 1.
- Sink_Petiol(S_P), Sink_Internode(S_I), Sink_Flowerm(S_Ff), Sink_Flowerm(S_Fm), Sink_ring(S_L) Sink_Root(S_R) are same as Sink_Blade(S_B).

	B	P	I	FF	MF	Ri	Ro
Sink_Blade(S_B)	0.5	0	0	0	0	0	0.0
Sink_Petiol(S_P)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sink_Internode(S_I)	0.5	0	0	0	0	0	0.0
Sink_Flowerf(S_Ff)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sink_Flowerm(S_Fm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sink_ring(S_L)	0	0	0	0	0	0	0.0
Sink_Root(S_R)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Time_Expansion(t_exp)	1	1	1	1	1	1	1
Para_Expansion1(Bt_N)	1	1	1	1	1	1	1
Para_Expansion2(Bt_P)	0	0	0	0	0	0	0

Resist_Blade(r_B)	12500	10000	10000
Resist_Petiol(r_P)	0	0	0
Seed_Biomass(Q0)	1		
Flow_Biomass(dQ0)	0.0		
RingOption(0 OR 1)	0		

Figure 3.5 functional parameter interface

3.4 Allometry Parameter

Popmenu

allometry parameter

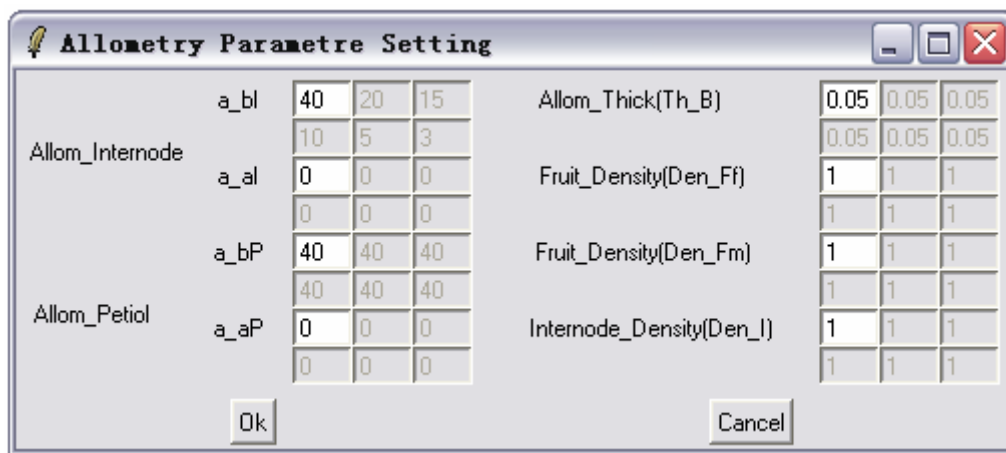
Dialog

Setting the allometry parameters of GreenLab model. The sequence of entries for each variable is the sequence of physiological ages which is from left to right and from up to down. The internode is treated as a cylinder whose volume, section area and length are noted as V_i , S_i , L_i ,

respectively. It is assumed that the relationship between S_i and L_i can be formulated as the equations below. The same case is with petiole. The data in each entry must be greater or equal to 0.

Parameters

- a_bI: to set the allometric parameters for the internodes
- a_aI: to set the allometric parameters for the internodes
- a_bP: to set the allometric parameters for the petiole of leaves
- a_aP: to set the allometric parameters for the petiole of leaves
- Allom_Thick(Th_B): to set the thick of blades with different physiological ages



The dialog box titled "Allometry Parameter Setting" contains two main sections for parameter input. The left section is organized into two groups: "Allom_Internode" and "Allom_Petiol". Each group has two rows of three input fields. The "Allom_Internode" group includes parameters a_bI (values: 40, 20, 15; 10, 5, 3) and a_aI (values: 0, 0, 0; 0, 0, 0). The "Allom_Petiol" group includes parameters a_bP (values: 40, 40, 40; 40, 40, 40) and a_aP (values: 0, 0, 0; 0, 0, 0). The right section contains four rows of three input fields for "Allom_Thick(Th_B)" (0.05, 0.05, 0.05; 0.05, 0.05, 0.05), "Fruit_Density(Den_Ff)" (1, 1, 1; 1, 1, 1), "Fruit_Density(Den_Fm)" (1, 1, 1; 1, 1, 1), and "Internode_Density(Den_I)" (1, 1, 1; 1, 1, 1). At the bottom are "Ok" and "Cancel" buttons.

Parameter Group	Parameter	Value 1	Value 2	Value 3
Allom_Internode	a_bI	40	20	15
		10	5	3
	a_aI	0	0	0
		0	0	0
Allom_Petiol	a_bP	40	40	40
		40	40	40
	a_aP	0	0	0
		0	0	0
Allom_Thick(Th_B)		0.05	0.05	0.05
		0.05	0.05	0.05
	Fruit_Density(Den_Ff)	1	1	1
		1	1	1
Fruit_Density(Den_Fm)		1	1	1
		1	1	1
	Internode_Density(Den_I)	1	1	1
		1	1	1

Figure 3.6 allometry parameter interface

3.5 Geometrical Parameter

3.5.1 shape

Popmenu

shape--geometrical parameter

Dialog

Setting the shape of the organs such as leaf, female flower and male flower in GreenLab model. User can click a radiobutton to select one kind of shapes and the figure can be displayed.

Parameters

- Leaf_shape(Smb_I): select one kind of shapes of leaves
- Flower_shape(Smb_Ff): select one kind of shapes of female fruits. If selecting 0, the plant has no female fruits and don't display the female fruits.
- Flower_shape(Smb_Fm): select one kind of shapes of male fruits. If selecting 0, the plant has no male fruits and don't display the male fruits.

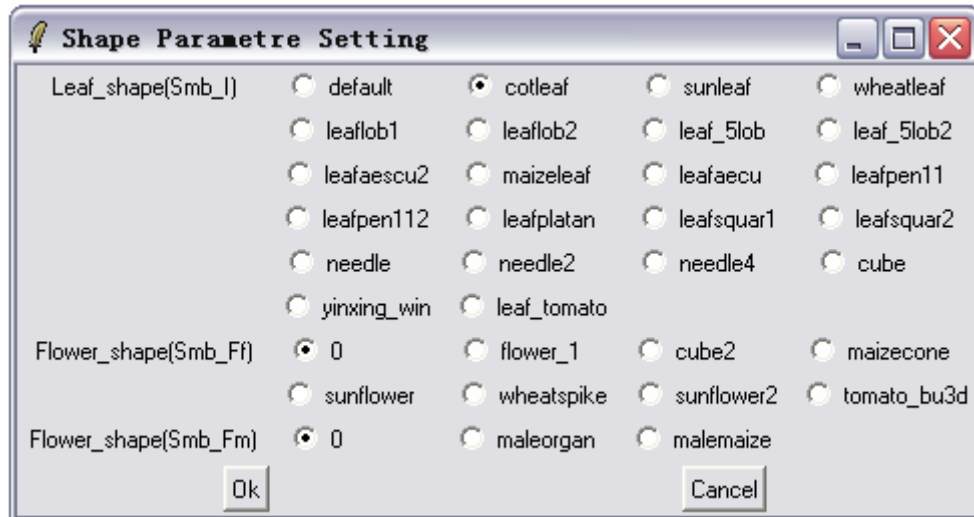


Figure 3.7 shape—geometrical parameter interface

3.5.2 color

Popmenu

color--geometrical parameter

Dialog

Setting the color of the organs such as leaf, female fruit, male fruit and internode with different physiological ages in GreenLab model which you want to see in the graph. According to RGB value, the data must be between 0 and 1.

Parameters

- leaf_color: to set the color of leaves
- Internode_Color: to set the color of internodes
- FemaleFruit_Color: to set the color of female fruits
- MaleFruit_Color: to set the color of male fruits
- Phy_Color: to set the color of organs at different physiological ages

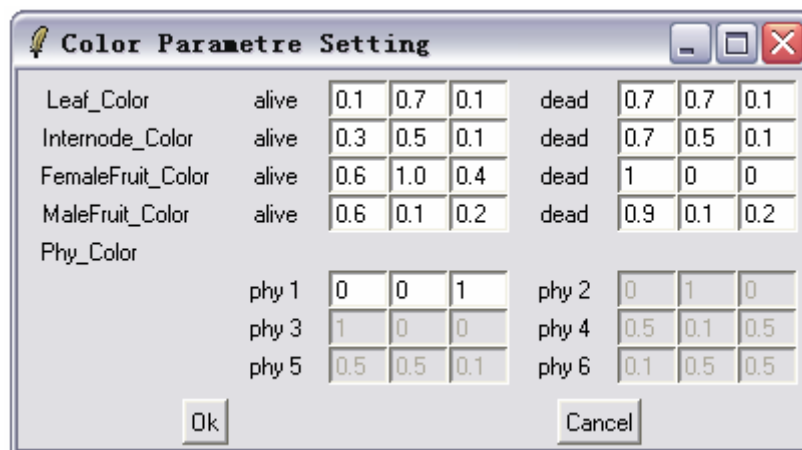


Figure 3.8 color—geometrical parameter interface

3.5.3 macrostate

Popmenu

macrostate--geometrical parameter

Dialog

Setting the angle on the level of macrostates with different physiological ages in GreenLab model. The sequence of entries of the first variables is the sequence of physiological ages which is from left to right and from up to down. the sequence of entries of the others is the sequence of physiological ages which is from left to right. The data must be greater or equal to 0.

Parameters

- Angle_Phyllotaxy(Ang_Ph): to set the rotation angles in horizontal plane between two successive leaves of different internodes which possess the same physiological age.
- Young_Modulus(Ey): to set the young elasticity modulus.
- Force_Point(fp): to set the points of the forces.
- Terminal_Angle(Eng_Ang): to set the angle between the terminal organ and its bearing axis.
- Righting_Point(Eng_N): to set the last point of forces.
- Initial_Angle(InitMin): to set the minimal initial angle.
- Initial_Angle(InitMax): to set the maximal initial angle.
- Initial_Angle(InitNum): to set parameters which determine the number of initial angles. The data must be greater or equal to 1 and be integer. If the data is 1, the initial angle is equal to InitMin.
- Max_Angle(wb): to set the opening angle.
- Opening_Cycle(wbn): to set the opening cycle. The data must be greater or equal to 0 and be integer. If the data is 0, don't consider the opening cycle, and the angle doesn't change.
- Flag_Plagiotropic: to set the parameter which determine whether the organs are plagiotropic or not. The data must be 1 or 0. If the data is 1, consider the organs to be plagiotropic. Or don't consider the organs to be plagiotropic.
- Leaf_direction: to set the primary direction of leaves. The data must be 1 or 0. If the data is 0, the primary direction is z-axis, and secondary direction is y-axis. If the data is 1, the primary direction is z-axis, and secondary direction is x-axis.

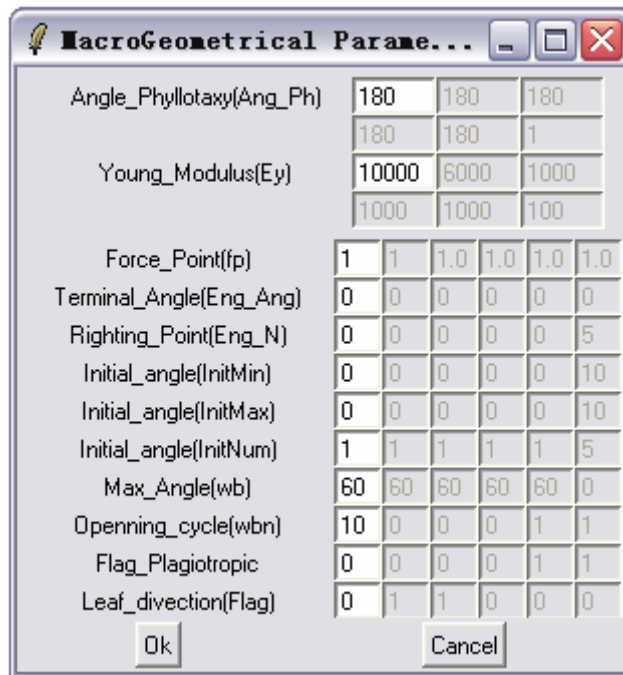


Figure 3.9 macrostate geometrical parameter interface

3.5.4 microstate

Popmenu

microstate--geometrical parameter

Dialog

Setting the angles between the organ(female flower, male flower, blade and axillary bud) and its bearing axis and bending degrees which determine branches, leaves and fruits distribution shape in vertical plane on the level of microstates with different physiological ages in GreenLab model. This dialog is divided to 2 sections. In the left section, each column stands for physiological age. In the right section, the data in each variable is a matrix. The data in both sections must be greater or equal to 0.

Parameters

·Angle_FlowerM(Ang_Fm): to set the parameters of angles between male fruits and their bearing axes . The data in row 1, column 2 stands for the angle of male fruit possessing the second physiological age in the microstate possessing the first physiological age.

Angle_FlowerF(Ang_Ff), Angle_Blade(Ang_B), Angle_Axillary(Ang_A) are same as Angle_FlowerM(Ang_Fm).

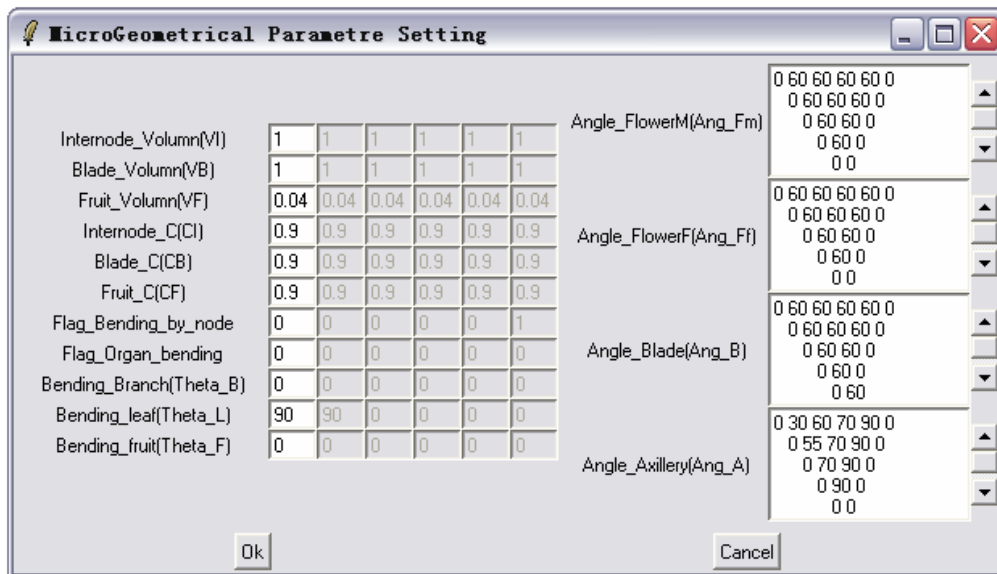


Figure 3.10 microstate geometrical parameter interface

3.6 Environmental Parameter

Popmenu

environmental parameter

Dialog

Setting the environmental parameters that can affect the process of plant growth, including water, temperature and light. According to these three aspects, this dialog is divided to 3 sections. The data must be greater or equal to 0.

Parameters

- water effect (Yes 1 or No 0): to set the parameter which determines whether the effect of water is considered. The data must be 0 or 1. If inputting 1, consider. Or don't consider.
- Soil budget para(C1): to set the parameter for calculating water value that plant can supply at some age.
- Soil budget para(C2): to set the parameter for calculating water value that plant can supply at some age.
- Initial Soil Water(QSW0): to set the number of initial water in the soil.
- Max Plant Soil Water(QSWMAX): to set the maximal water value that plant can supply.
- Min Plant Soil Water(QSWMIN): to set the minimal water value that plant can supply.
- Max Env Soil Water(QSW_MAX): to set the maximal environmental water value in soil. When the data in the file in env directory is bigger than it, consider it instead of the data.
- Max Env Soil Water(QSW_MIN): to set the minimal environmental water value in soil. When the data in the file in env directory is less than it, consider it instead of the data.
- temperature effect(Yes 1 or No 0): to set the parameter which determines whether the effect of temperature is considered. The data must be 0 or 1. If

- inputting 1, consider. Or don't consider.
- Temperature(E_ALPHA): to set the parameter for calculating temperature value which is used when Flag_temperature is 0 and temperature datum in files in env directory aren't enough.
 - Temperature(E_BETA): to set the parameter for calculating temperature value which is used when Flag_temperature is 0 and temperature datum in files in env directory aren't enough.
 - Max Env Temperature(THETA_MAX): to set the maximal environmental temperature. When the data in the file in env directory is bigger than it, consider it instead of the data.
 - Min Env Temperature(THETA_MIN): to set the minimal environmental temperature. When the data in the file in env directory is less than it, consider it instead of the data.
 - light effect(Yes 1 or No 0): to set the parameter which determines whether the effect of light is considered. The data must be 0 or 1. If inputting 1, consider. Or don't consider.
 - Max Env Light(LIGHT_MAX): to set the maximal environmental light intensity. When the data in the file in env directory is bigger than it, consider it instead of the data.
 - Min Env Light(LIGHT_MIN): to set the minimal environmental light intensity. When the data in the file in env directory is less than it, consider it instead of the data.
 - Potential Codition(E0): to set the water use efficiency.

Environmental Parameter Setting			
water effect (Yes 1 or No 0)		1	
Soil budget para (C1)	0.006	Soil budget para (C2)	0.006
Initial Soil Water (QSW0)	900		
Max Plant Soil Water (QSW_MAX)	1000	Min Plant Soil Water (QSW_MIN)	800
Max Env Soil Water (QSW_MAX)	1200	Min Env Soil Water (QSW_MIN)	800
temperature effect (Yes 1 or No 0)		1	
SumT effect (Flag_sumt)	0	Temperature (E_BETA)	3
Temperature (E_ALPHA)	3.5	SumT effect (THETA_BASE)	5
SumT effect (KSUMT)	0.05	Min Env Temperature (THETA_MIN)	5
Max Env Temperature (THETA_MAX)	40		
light effect (Yes 1 or No 0)		1	
Max Env Light (LIGHT_MAX)	1000	Min Env Light (LIGHT_MIN)	0
Potential Codition (E0)	1000		
Ok		Cancel	

Figure 3.11 environmental parameter interface

4. Output

4.1 number

4.1.1 organ

Popmenu

number of organ output parameter

Dialog

Setting parameters which determine whether the number of organs is displayed. The data must be 1 or 0. If inputting 1, display. Or don't display.

Parameters

- Number of organ(Flag_topo_disp): to set the parameters which determine whether the number of organs at each physiological age is displayed. The data must be 1 or 0.
- Total Number of Living organ(Flag_topo_disp_l): to set the parameters which determine whether the number of organs alive at each physiological age is displayed. The data must be 1 or 0.
- Number of living organ above each GU(Flag_topo_disp_a): to set parameters which determine whether the number of organs alive above each growth unit is displayed. The data must be 1 or 0.
- Total Number of organ(Flag_topo_disp_s): to set parameters which determine whether the total number of organs at all physiological ages is displayed. The data must be 1 or 0.

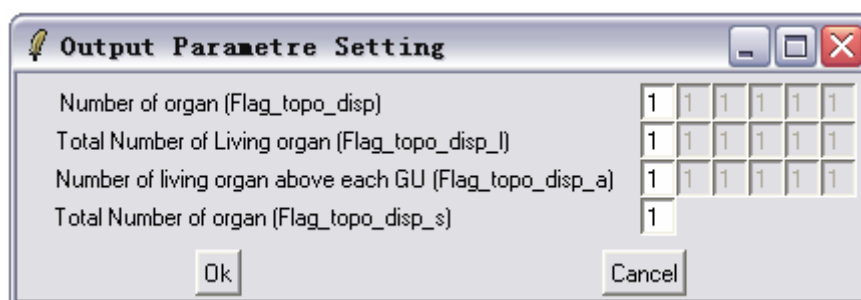


Figure 4.1 number of organs—output parameter interface

4.1.2 demand

Popmenu

number of demand -- output parameter

Dialog

Setting parameters which determine whether the number of demand is displayed. The data must be 1 or 0. If inputting 1, display. Or don't display.

Parameters

- Demand of layer \$ Biomass: to set the parameter which determines whether the demand of each layer and biomass of each layer at each physiological age is displayed. The data must be 1 or 0.
- Demand of plant \$ Biomass production: to set the parameter which determines whether the demand and biomass production of plant in each cycle are displayed. The data must be 1 or 0.
- Biomass repartition: to set the parameters which determined whether the biomass repartition of each organ in each cycle is displayed. The data must be 1 or 0.

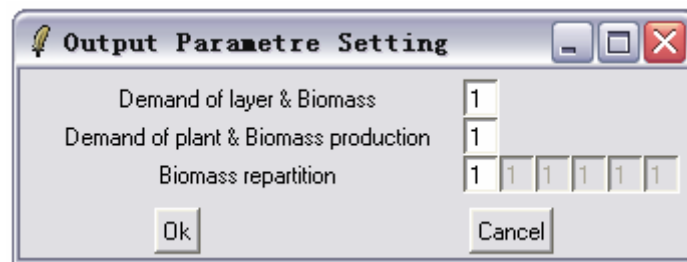


Figure 4.2 number of demand output parameter interface

4.2 Figure

Popmenu

Figure -- output parameter

Dialog

Setting parameters which determine whether curves are displayed. The data must be 1 or 0. If inputting 1, display. Or don't display.

Parameters

- Biomass repartition: to set the parameter which determines whether the curve of accumulated biomass production and repartition of each organ is displayed. The data must be 1 or 0.
- Biomass repartition_a: to set the parameter which determines whether the curve of accumulated biomass production and repartition of each organ is displayed. The data must be 1 or 0.
- Size of organ at the Phy_Age: if setting the parameter of the second entry 1, the curve of the size of each organ possessing the second physiological age at each chronological age is displayed. Each column stands for each physiological age. The data must be 1 or 0.
- Biomass of organ at the Phy_Age: if setting the parameter of the second entry 1, the curve of the biomass of each organ possessing the second physiological age at each chronological age is displayed. Each column stands for each physiological age. The data must be 1 or 0.

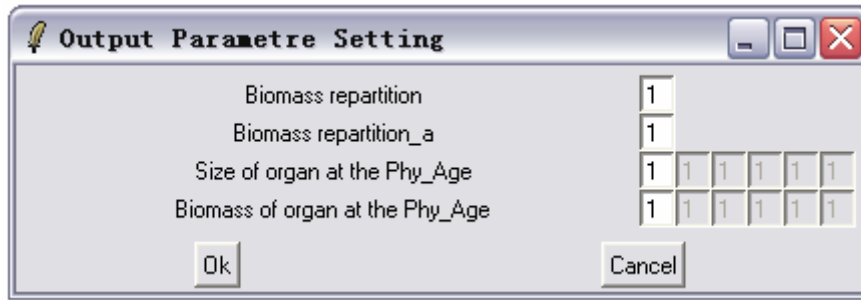


Figure 4.3 curve output parameter interface

4.3 3D

Popmenu

3D -- output parameter

Dialog

Setting parameters which determine whether 3D graph is displayed. The data must be 1 or 0. If inputting 1, display. Or don't display.

Parameters

- Flag_geo_full: to set the parameter which determines whether draw plant geometry only at the last chronological age or at any chronological age. The data must be 1 or 0. If inputting 1, draw plant geometry at any chronological age. Or draw plant geometry only at the last chronological age.
- Flag_light: to set the parameter which determines whether the effect of light to plant geometry is considered. The data must be 1 or 0. If inputting 1, consider. Or don't consider.
- Flag_windows: to set the parameter which determines whether the lig file is in windows(1) or unix(0) format. The data must be 1 or 0.
- Draw skeleton (Flag_geo_skeleton): to set the parameters which determine whether the skeleton of plant at each physiological age is displayed. The data must be 1 or 0.
- Draw 3D(Flag_geo_3D): to set the parameters which determine whether the 3D graph of plant is displayed. The data must be 1 or 0.
- Flag_geo_leaf: to set the parameters which determine whether the leaves are displayed or not. The data must be 1 or 0.
- Flag_geo_fruit: to set the parameters which determine whether the fruits are displayed or not. The data must be 1 or 0.

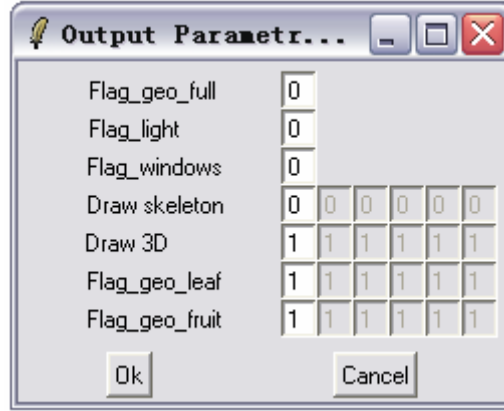


Figure 4.4 3D output parameter interface

5. Equation

Equations in section 3.3

$$Ex_o(i) = \frac{\left[\frac{i-0.5}{t_exp_o} \right]^{[(1+Bt_N_o)Bt_P_o-1]} \cdot \left[1 - \frac{i-0.5}{t_exp_o} \right]^{[(1+Bt_N_o)(1-Bt_P_o)-1]} \cdot \frac{1}{t_exp_o}}{\sum_{i=1}^{t_exp_o} \left[\frac{i-0.5}{t_exp_o} \right]^{[(1+Bt_N_o)Bt_P_o-1]} \cdot \left[1 - \frac{i-0.5}{t_exp_o} \right]^{[(1+Bt_N_o)(1-Bt_P_o)-1]} \cdot \frac{1}{t_exp_o}} \quad (1)$$

$$D_N^o = \sum_{i=1}^N N_o(N-i+1) \cdot Ex_o(i) \cdot S_o \quad (2)$$

$$r = \frac{r_B}{A_{i,N}} + r_P \quad (3)$$

$$q_{i,N}^o = \sum_{i=1}^N \frac{Ex_o(i) \cdot S_o}{D_N^o} \cdot Q_{N-1} \quad (4)$$

Where: $Ex_o(i)$ is the expansion rate of an organ in the i th cycle.

i is the index of the expansion cycle from one to the value of t_exp .

D_N^o is the demand of a kind of organs at the chronological age N .

$N_o(N-i+1)$ is the total number of a kind of organs at the chronological age $N-i+1$.

S_o is the sink value of a kind of organs.

N is the value of the chronological age of the plant model.

r is the resistance of a leaf with chronological age i in the plant with chronological age N .

$A_{i,N}$ is the surface area of a leaf with chronological age i in the plant with chronological age N .

n is the physiological age of a leaf

$q_{i,N}^o$ is the new biomass of an organ with chronological age i in the plant with chronological age N .

Q_{N-1} is the total biomass production of the plant at chronological age $N - 1$.

Equations in section 3.4

The internode is treated as a cylinder whose volume, section area and length are noted as V_i, S_i, L_i , respectively. It is assumed that the relationship between S_i and L_i can be formulated as the equations below. The same case is with petiole, and the variables are V_p, S_p, L_p and a_bP, a_aP .

$$\frac{L_i(n)}{S_i(n)} = a_bI(n) \cdot [V_i(n)]^{a_aI(n)} \quad (5)$$

Where: n is the physiological age of the considered internode.

Equations in section 3.5.3

$$\text{InitAngle} = \text{InitMin} + (g-1) \cdot (\text{InitMax} - \text{InitMin}) / (\text{InitNum} - 1) \quad (6)$$

Where: InitAngle is the initial angle.

g is from 1 to InitNum.

6. Example

This part will use the test file named plate01a.m to specify GreenScilab and the meanings of parameters. This model's physiological age is 1. The parameter of physiological age is very important.

First, run GreenScilab. Second, click menu File and click Load testfiles. Then the datum are shown in the main window. And you also can check parameters by clicking menu Parameter and its submenu.

From the datum, we know that the chronological age of this model is 10. because the physiological age is 1 and only one number in the variable Micro_Num(Nu_I) isn't 0, there is only one macrostate and only one microstate in each macrostate which is also called Growth Unit. In the microstate, the number of leaves is 1, the self-cycling number of microstate is 1 and the self-cycling number of macrostate is 10. Because the datum of variable MaleF_Num(Nu_Ff) and FemaleF_Num(Nu_Fm) are all 0, it has no fruit. The datum of Time_Function for all organs are 1—the living span of all organs is one cycle. The color for living organs is green, and that for dead

organs is yellow. So we can see that there are 10 leaves and only one leaf are alive as Figure 6.1 shows.

First, we don't modify any parameter. Click menu Simulate and then Click menu Output and submenu 3D. The graph of the model at chronological age 10 is shown in Figure 6.1.

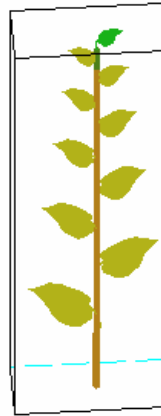


Figure 6.1 3D of plate01.m, don't modify any parameter

Now we modify the parameter Leaf_Num(Nu_B) and Axillary_Num(Nu_A) from 1 to 2 as Figure 6.2 shows(click menu Parameter, select Topological Parameter deterministic and click submenu microstate topological parameter). These two variables set the number of leaves and axillaries in microstates. For this example, If the data is 2, there are 2 leaves in each Growth Unit. 3D graph is shown in Figure 6.3.

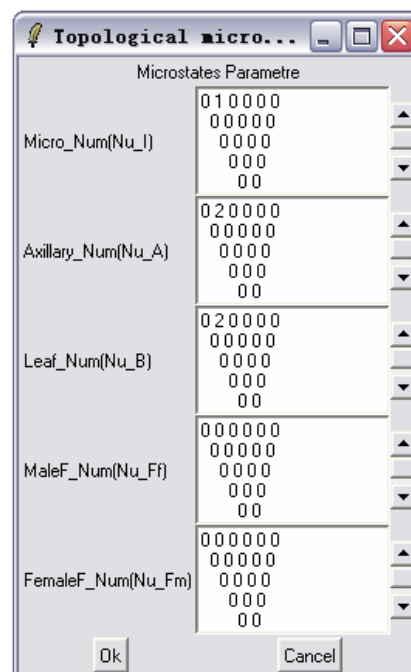


Figure 6.2 the dialog of microstate topological parameter

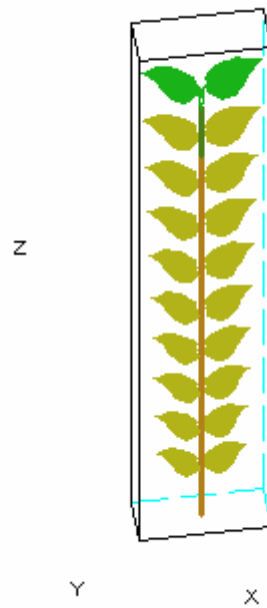


Figure 6.3 3D graph of plate01.m, modified Nu_B and Nu_A

We recover the datum of Leaf_Num(Nu_B) and Axillary_Num(Nu_A), and modify the parameter of Micro_Num(Nu_I) from 1 to 2 as Figure 6.4 shows (the method is the same as above). That means that the self-cycling number of microstate is 2 at each chronological age which is also called growth cycle and there are 2 microstates in each Growth Unit. So we can see that there are 20 leaves in the model as Figure 6.5 shows.

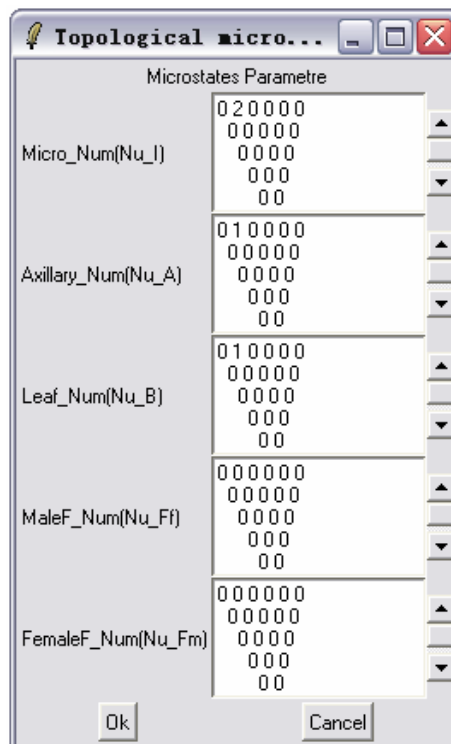


Figure 6.4 the dialog of microstates topological parameter

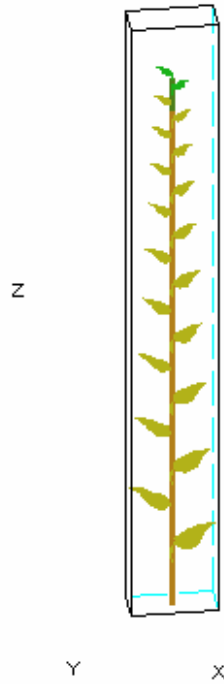


Figure 6.5 3D graph of plate01.m, modified Nu_I

Recover Micro_Num(Nu_I), and modify the parameter of Macro_Num(Nu_Ma) from 10 to 5 as Figure 6.6 shows. That means that the self-cycling number of macrostate is 5. Because the parameters of Time_Function for all organs are all 1—the span of living is one cycle, the plant model will not grow after 6 cycles even if the chronological age is 10 and all organs are dead. The graph is shown as Figure 6.7.

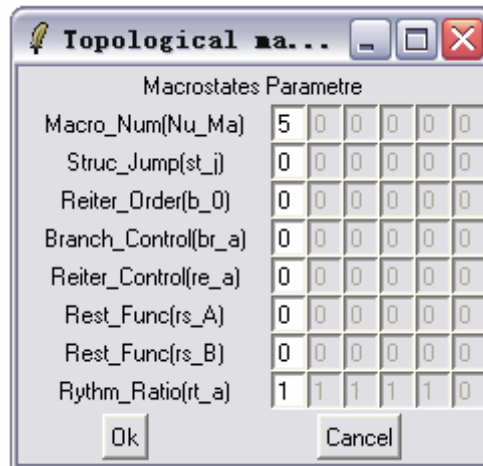


Figure 6.6 dialog of macrostates topological parameter

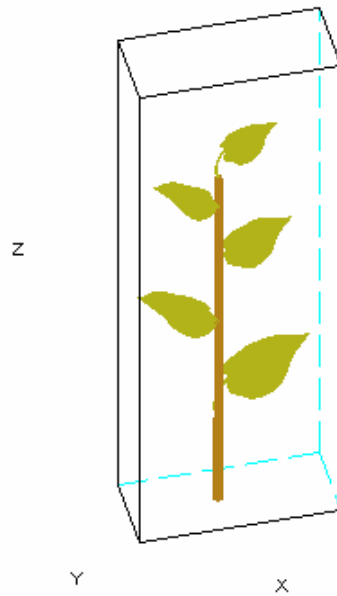


Figure 6.7 3D of plate01a.m, modified Nu_Ma

Recover Macro_Num(Nu_Ma), and modify the parameter of Time_Funtion for organs from 1 to 2—the living span is 2 cycles as Figure 6.8 shows. The 3D graph is shown as Figure 6.9. There are 2 leaves alive at chronological age 10.

Topological Param deterministic Setting

Time_Function	
phy1	2 2 2 1 1 1 1 1
phy2	1 1 1 1 1 1 1 1
phy3	1 1 1 1 1 1 1 1
phy4	1 1 1 1 1 1 1 1
phy5	1 1 1 1 1 1 1 1
phy6	1 1 1 1 1 1 1 1
Time_appearance	
phy1	1 1 1 1 1 1 1 1
phy2	1 1 1 1 1 1 1 1
phy3	1 1 1 1 1 1 1 1
phy4	1 1 1 1 1 1 1 1
phy5	1 1 1 1 1 1 1 1
phy6	1 1 1 1 1 1 1 1
Time_disappearance	
phy1	99 99 99 99 99 99 99 99
phy2	99 99 99 99 99 99 99 99
phy3	99 99 99 99 99 99 99 99
phy4	99 99 99 99 99 99 99 99
phy5	99 99 99 99 99 99 99 99
phy6	99 99 99 99 99 99 99 99
Time_busy	
phy1	1 1 1 1 1 1 1 1
phy2	1 1 1 1 1 1 1 1
phy3	1 1 1 1 1 1 1 1
phy4	1 1 1 1 1 1 1 1
phy5	1 1 1 1 1 1 1 1
phy6	1 1 1 1 1 1 1 1
Time_idle	
phy1	0 0 0 0 0 0 0 0
phy2	0 0 0 0 0 0 0 0
phy3	0 0 0 0 0 0 0 0
phy4	0 0 0 0 0 0 0 0
phy5	0 0 0 0 0 0 0 0
phy6	0 0 0 0 0 0 0 0

Ok Cancel

Figure 6.8 dialog of macrostates(time) topological parameter

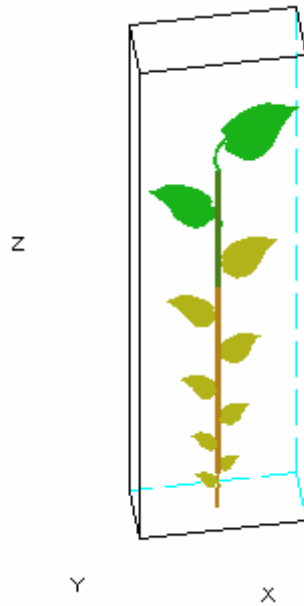


Figure 6.9 3D of plate01a.m, modified Time_Function

Recover Time_Funtion, and modify Time_idle for blade(leaf) from 0 to 1 as Figure 6.10 shows. That means that during one cycle the leaf doesn't grow and the leaf grows and doesn't grow by turns. The 3D graph is shown as Figure 6.11.

Topological Param deterministic Setting

Time_Function	Time_appearance	Time_disappearance	Time_busy	Time_idle
phy1	1 1 1 1 1 1 1 1	99 99 99 99 99 99 99 99	1 1 1 1 1 1 1 1	1 0 0 0 0 0 0 0
phy2	1 1 1 1 1 1 1 1	99 99 99 99 99 99 99 99	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0
phy3	1 1 1 1 1 1 1 1	99 99 99 99 99 99 99 99	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0
phy4	1 1 1 1 1 1 1 1	99 99 99 99 99 99 99 99	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0
phy5	1 1 1 1 1 1 1 1	99 99 99 99 99 99 99 99	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0
phy6	1 1 1 1 1 1 1 1	99 99 99 99 99 99 99 99	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0

Ok Cancel

Figure 6.10 dialog of macrostates(time) topological parameter

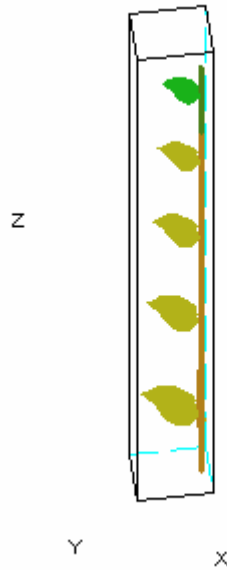


Figure 6.11 3D of plate01a.m, modified Time_idle

As figures above show, different datum of parameters will lead to different geometrical shape of plant model, and the size of organs will change, because the production and repartition of biomass will change.

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