Garlic Growth Model Manual

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HOW TO RUN THE MODEL:

[Files You Need]

1. Weather file (.wea):
   This file provides the weather information to drive the model simulations.

   - jday: Julian day (day of year)
   - time: time of day
   - Tair: mean air temperature (˚C)
   - Wind: wind speed (m/sec)
   - SolRad: incoming solar radiation (W/m^2)
   - Rain: precipitation (mm/hour)
   - Tsoil: mean soil temperature (˚C)
   - Example:

year	jday	time	Tair	RH	Wind	SolRad	Rain	Tsoil
2011	350	10:00	8.417	74.081	1.7	105.564	0	5.86
2011	350	11:00	8.527	73.192	1.851	129.243	0	5.913
2011	350	12:00	8.747	73.665	1.412	88.572	0	6.012
2011	350	13:00	8.946	73.582	1.12	54.969	0	6.122
2011	350	14:00	9.179	72.198	0.889	58.051	0	6.233
2011	350	15:00	9.278	71.733	0.72	32.475	0	6.332
2011	350	16:00	8.82	75.553	0.07	7.69	0	6.424
2011	350	17:00	7.486	81.708	0.018	0	0	6.494
2011	350	18:00	6.952	83.745	0.347	0	0	6.532
2011	350	19:00	5.959	86.921	0.711	0	0	6.526
2011	350	20:00	4.89	88.307	0.352	0	0	6.486
2011	350	21:00	3.94	89.148	0.636	0	0	6.405
2011	350	22:00	3.417	89.11	0.873	0	0	6.293
2011	350	23:00	2.575	89.16	0.602	0	0	6.169
2011	351	0:00	2.105	89.401	0.973	0	0	6.029
2011	351	1:00	1.802	89.195	0.958	0	0	5.884
2011	351	2:00	1.226	89.111	0.844	0	0	5.738

2. Crop initial file (.ini):
   This file provides information of user defined parameters, as well as environmental and management information.

   - Line 1: general description

- Line 2: define parameters
    - CV: cultivar name
    - PHYL: phyllochron
    - ILN: initial leaf number prior to planting
    - GLN: generic leaf number
    - LL: maximal leaf length
    - LER: leaf elongation rate
    - SG: stay-green duration (days)
    - SD: storage duration (days)
    - LTAR: leaf tip appearance rate (leaves/day)
    - $LTAR_a$: asymptote of leaf appearance rate
    - LIR: leaf initiation rate (leaves/day)
    - T_{opt}: optimal temperature for beta function
    - T_{ceil}: ceiling temperature for beta function
    - critPPD: critical photoperiod for vegetative to reproductive transition (hrs)
- Line 3: latitude longitude elevation
- Line 4: planting info
    - Y1: year of planting
    - bgn: start date for simulation (Julian days)
    - sow: sowing date (Julian days)
    - emg: emergence date (Julian days)
    - PD: planting density (number of plants / m^2)
    - Y2: year of harvest
    - SR: scape removal date (Julian days) – beyond 365 (i.e. 999) indicates no removal
    - end: end date of simulation (Julian days)
- Line 5: CO_2 time step
    - First value: CO_2 concentration (ppm)
    - Second value: CO_2 time step (mins)
- Line 6: respiration and maintenance info
    - Rm: maintenance respiration (%) – from 0 to 1
    - Yg: synthesis efficiency (%) – from 0 to 1
- Line 7: carbon partition coefficient to
  root – shoot – leaf – sheath – scape – bulb
    - 0: seed
    - 1: vegetative stage
    - 2: bulb growth with scape
    - 3: bulb growth with scape removal
    - 4: dead

- Note that the root and shoot ratios are currently not used and internally calculated instead.
- The amount of carbon assigned to the shoot will be further portioned into leaf, sheath, scape, and bulb. The sum of ratios for these four organs should be 1.

- Example:

```
Garlic Field Data  CUH  2014-2015  Experiment conducted by Jennifer Hsiao
# CV PHYL ILN GLN LL LER SG SD LTAR LTARa LIR Topt Tceil critPPD
SP1 134 6 10 65.0 4.70 1.47 93 0 0.4421 0.1003 22.28 34.23 12
# LAT LONG ALT
47.66 122.29 20.0
# Y1 bgn sow emg PD Y2 SR end
2014 274 274 5 55 2015 999 188
# CO2 timestep
390 60
# Rm Yg
0.012 0.8
# root shoot leaf sheath scape bulb
0  0.00  0.00  0.00  0.00  0.00  0.00 # seed
1  0.10  0.00  0.45  0.45  0.00  0.00 # vegetative
2  0.10  0.00  0.15  0.25  0.10  0.40 # bulb growth w/scape
3  0.10  0.00  0.15  0.30  0.00  0.45 # bulb growth wo/scape
4  0.00  0.00  0.00  0.00  0.00  0.00 # dead
```

3. Executable file (garlic.exe):
   This executable file is where all the actual model code is.

4. Data file (.dat):
   The data file tells the executable file which are the files it needs to run and where they are. It also tells the model what the output file should be named.

   - Line 1: file path for weather file
   - Line 2: file path for intial file
   - Line 3: file path for the output .crp file
   - Note that path separator can be platform dependent. For example, '/' should be used on macOS while '\' may be needed on Windows.
   - Example:

```
../input.jeju/2010.wea
./ND_2010.ini
./ND_2010.crp
```

[Files You Get]

1. Crop output file (.crp):
   The output file contains several plant related outputs

- Date: date in model simulations
- DOY: day of year
- DVS: developmental stage (0-4)
- Time: time in model simulations
- LeavesI: leaves initiated
- Leaves: leaves emerged
- LA/pl: leaf area per plant (cm^2)
- LAI: leaf area index
- matureL: number of matured leaves
- seneL: number of senesced leaves
- PFD: photon flux density
- SolRad: incoming solar radiation
- Tair: air temperature
- Tcan: canopy temperature
- Pn: net photosynthesis
- ET: evapotranspiration
- totalDM: total dry mass
- shootDM: shoot dry mass
- bulbDM: bulb dry mass
- leafDM: leaf dry mass
- stemDM: pseudostem dry mass
- scapeDM: scape dry mass
- rootDM: root dry mass
- sol_C: soil carbon
- reserve_C: reserved carbon

2. Leaf output file (.lef):
   The output file contains individual leaf-level outputs

   - Date: date in model simulations
   - DOY: day of year
   - DAP: days after planting
   - Time: time in model simulations
   - LeavesI: leaves initiated
   - Leaves: leaves emerged
   - Rank: leaf rank (1 = first leaf)
   - area: leaf area (cm^2)
   - mass: biomass (g)
   - areaS: senescent leaf area (cm^2)
   - areaP: potential leaf area (cm^2)
   - length: leaf length (cm)
   - lengthP: potential leaf length (cm)
   - SLA: specific leaf area (cm^2 / g)

- GDD2M: GDD to maturity
- Maturity: maturity in terms of length elongation (length / lengthP)

3. Log file (.log):
   The output file contains phenology development records.

[Running the Model with Windows]

1. Open terminal and navigate to where you have the executable file (garlic.exe)

   - Use the command “cd” followed by a file path to navigate to a specific directory
   - Use the command “dir” to show the contents within a specific directory

2. Within the repository, if you type the command “garlic.exe”, the model will run with a default data file.

3. If you wish to run the model with your customized data file (your_custum_data_file.dat), you should run the executable file followed by a space and then your data file:

   - `C:\Garlic> garlic sample.dat`

4. The model output (.crp) will be saved at the location with the name that was specified in the .dat file.

[Running the Model with macOS]

1. Open terminal and navigate to where you have the executable file (garlic)

   - Use the command “cd” followed by a file path to navigate to a specific directory
   - Use the command “ls” to show the contents within a specific directory

2. Within the repository, if you type the command “./garlic”, the model will run with a default data file.

3. If you wish to run the model with your customized data file (your_custum_data_file.dat), you should run the executable file followed by a space and then your data file:

   - `$ ./garlic sample.dat`

4. The model output (.crp) will be saved at the location with the name that was specified in the .dat file.