



# WatchDog<sup>®</sup>

## 2000 Series Mini Stations

### PRODUCT MANUAL

Model #'s  
2400, 2425, 2450, 2475



# **Spectrum<sup>®</sup>**

## **Technologies, Inc.**

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# GENERAL OVERVIEW

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Thank you for purchasing a WatchDog 2000 Series Mini Station. The loggers are completely waterproof and feature 12-bit resolution for higher accuracy. The loggers can be accessed at different times by multiple users because the data is not cleared from memory following a download. The 2000-Series Mini Stations can communicate via direct-wire, radio or telephone connections.

Current weather conditions, historical data, and computed parameters are easily viewed on the station's LCD screen. The internal electronics calculate Growing Degree Days (GDD) for up to three degree day counters. For example, one counter can be activated at planting while another can track the development of insects. The station calculates Chill Hours, which is the total amount of hours during which temperatures have been below a specified low temperature. The station LCD can also be programmed to display a variety of plant disease infection potentials. The arrow keys allow you to scroll through the sensor readings, Degree Day/Chill Hour calculations as well as set your temperature ranges.

## LOGGER CAPACITY

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WatchDog 2000 Series Mini Stations not connected to SMEC300 sensors can log up to 9544 data intervals. This also applies to 2400 and 2425 stations that have just one SMEC300 sensor connected to channel A and no sensors attached to channels B and C. This represents 198+ days at 30-minute intervals, 99 days at 15 minute intervals, or other proportionate capacities. Mini Stations with SMEC300 sensors connected (other than the 2 exceptions mentioned above), can log up to 4278 data intervals. This corresponds to 89 days at 30-minute intervals. When the station reaches capacity, it wraps and begins recording over the oldest data. It is important to download data within the appropriate number of days to ensure no data is lost.

# SPECIFICATIONS

## INTERNAL SENSORS

| Model # | Internal Sensors   | Measurement Range   | Accuracy   |
|---------|--|---|--|
| 2400    | None   | N/A   | N/A  |
| 2425    | Temperature  | -25° to 212°F<br>-32° to 100°C  | ±1°F<br>±0.6°C                                     |
| 2450    | Temperature<br>-----<br>Humidity                           | -25° to 212°F<br>-32° to 100°C<br>-----<br>10% to 100%<br>@ 5 to 50C  | ±1°F<br>±0.6°C<br>-----<br>±3%                     |
| 2475    | Temperature<br>-----<br>Humidity<br><br>-----<br>PAR Light | -25° to 212°F<br>-32° to 100°C<br>-----<br>10% to 100%<br>@ 5 to 50C<br>-----<br>0 to 2500 μmol/m <sup>2</sup> /s | ±1°F<br>±0.7°C<br>-----<br>±4%<br><br>-----<br>±5% |

Operating Temperature Range: -22° to 130°F (-30° to 55°C)

# EXTERNAL SENSORS

All WatchDog 2000 Mini Station models have external channels (ports) for additional sensor input. The following table lists some of the available optional sensors. See [www.specmeters.com](http://www.specmeters.com) for a complete list. Most sensors include a 6-foot cable with pin-type connector. Items 3667-20, 6460-20, 6470-20 and 6450WD20 have 20 foot cables.

| Item #                      | Description  | Measurement Range  | Accuracy  |
|-----------------------------|--|--|---|
| 3665R                       | Tipping Bucket Rain collector                            | N/A  | ±2%   |
| 3666                        | Leaf Wetness Sensor                                      | 0(Dry) - 15(Wet)   | N/A   |
| 3667,<br>3667-20            | External (Soil) Temperature Sensor                       | -40 to 185°F<br>-40 to 85°C  | ±1.1°F<br>±0.6°C  |
| 3670i                       | Silicon Pyranometer                                      | 1-1250 W/m <sup>2</sup>  | ±5%   |
| 3668i,<br>3668i3,<br>3668i6 | Quantum Light Sensor and Sensor Bars                     | 0-2500 μmol m <sup>-2</sup> s <sup>-1</sup>  | ±5%   |
| 3676i                       | UV Light Sensor  | 0-200 μmol m <sup>-2</sup> s <sup>-1</sup>   | ±5%   |
| 6460,<br>6460-20            | WaterScout SM 100 Soil Moisture Sensor                   | 0% to saturation (typically 50%)   | ±3%   |
| 6470,<br>6470-20            | WaterScout SMEC 300 Soil Moisture/ EC/Temperature Sensor | <b>VWC:</b> 0% to sat.<br><b>EC:</b> 0 to 10 mS/cm,<br><b>Temp:</b> 0 to 122 °F (-18 to 50 °C) | <b>VWC</b> ±3%<br><b>EC:</b> ±2%<br><b>Temp:</b> ±1.4 °F (0.8 °C) |
| 3669                        | Soil Moisture Transducer                                 | 0-100 kPa  | ±2%   |
| 6450WD<br>6450WD20          | Watermark Soil Moisture Sensor                           | 0 - 200 cbars  | N/A   |
| 6451                        | Irrigation Sensor  | Switches at 5 psi  | ±1 psi  |
| 3673<br>3674                | Input Cables for user-supplied sensor                    | 0-2.5V<br>4-20mA   | ±0.005V<br>±1%  |

To connect the external sensor to the station, plug the sensor cable into the station port that has been programmed for that particular sensor.

**Port A is the only channel that will record rainfall data.**

Program each channel (port) to a specific sensor through the SpecWare launch screen. Refer to the **SpecWare Software User's Guide** for more detailed instructions on launching and sensor configuration.

For a Weather Station to be compatible with the SMEC300 sensor, SpecWare software version 9.04 or later is required. See the following table for the earliest compatible firmware and number of sensors that can be used per station type.

**Connecting a SMEC 300 sensor to channel D will reduce the logging capacity.** When using 30-minute intervals, the logger will hold 89 days of data rather than 198. Be sure to download data more often.

| <b>Weather Station</b> | <b>Firmware Version</b> | <b>Number of Sensors</b> | <b>Available Channels</b> |
|------------------------|-------------------------|--------------------------|---------------------------|
| 2475                   | 3.9                     | 1                        | A                         |
| 2450                   | 3.9                     | 2                        | A, B                      |
| 2425                   | 3.9                     | 3                        | A, B, C                   |
| 2400                   | 3.9                     | 4                        | A, B, C, D                |

# STATION INSTALLATION

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The data logger has the versatility to be located in any micro-climate for recording weather data. Hardware is included for attaching it to a 1" to 1¼" outside diameter mast (pipe). Use a 5' - 10' length of conduit or pipe as the mast mount. When purchasing and/or cutting the mast to size, plan on placing 1½' - 2' of the mast into the ground. It can also be mounted to a wooden post with the screws that are provided.

For all models (except model 2400), the radiation shield protects the temperature sensor from solar radiation and other sources of reflected heat. If other sensors are connected, secure the sensor wires to the mast just below the display module with a plastic tie. This will make the wires less vulnerable to being accidentally severed during the season.

**Note: If the station is connected to an external power source such as a solar panel or AC adapter, the batteries must be removed. Failure to do so will result in damage to the station.**

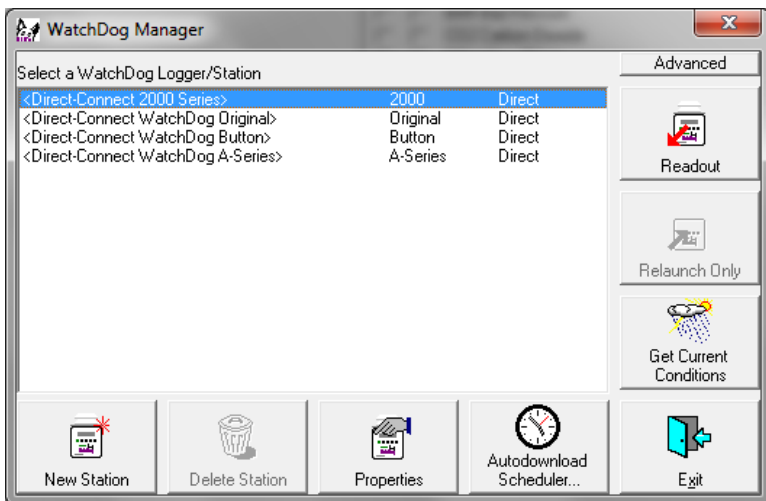


# CONFIGURING THE DATA LOGGER

The 2000-Series data logger does not have a button or switch for powering up and down. Instead, the device is operational whenever the batteries are installed. The loggers are shipped with default logging settings that can be modified with SpecWare software (see SpecWare User's Guide for details). Once the logger is configured, it will retain those settings even after the battery is removed or replaced.

The WatchDog 2000-Series loggers do not need to be re-launched after being downloaded. This allows greater flexibility for loggers that are accessed by multiple users. Although, the logger stores data on an interval set in SpecWare, the sensor readings displayed on the LCD are refreshed every 20 seconds.

The 2000-Series data loggers are configured in the **WatchDog Manager** screen of SpecWare software. Remember to identify the WatchDog type as 2000-series.



# CONNECTING TO A PC/ BATTERY REPLACEMENT

The computer port of the data logger is accessed by removing the plastic screw on the underside of the logger (see fig. 1). The PC interface cable that accompanied SpecWare software plugs into the serial jack inside the logger casing.

The only time the logger needs to be connected to a computer is during a download and/or when a change is being made to the logger configuration. The data is not erased following a download, and the logger does not need to be restarted. Please consult the SpecWare User's Guide or Spectrum Technologies' online troubleshooting resource if you experience difficulty connecting to the logger.

Whenever the batteries are replaced, the time and date must be reset immediately so the data is time-stamped correctly. However, all settings related to Degree Days, Chill Hours and IPM parameters (disease models, DIF, etc.) remain stored in the meter's memory even when the batteries are removed.

The 2000 Series data loggers are powered by 4 AA batteries. This will provide enough power for 1 year of continuous use. The battery compartment is accessed by removing the 4 Philips head screws on the face plate (see fig 1).

Upon installation of the batteries, the LCD should illuminate and the logger resume functioning. The LCD will prompt you to set the date and time (see p. 11).

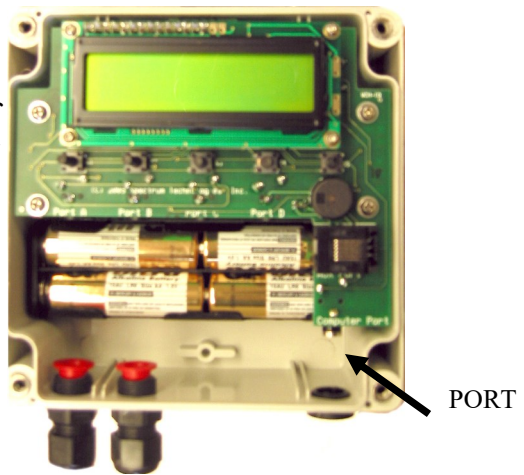


Figure 1

# CLEARING THE LOGGER'S MEMORY

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The memory of the 2000-Series data logger is not automatically cleared when the logger is downloaded or the batteries are replaced. The logger can be cleared manually through SpecWare software. This may be desired if, for example, the logger is being shut down for the season or is being moved to a new location.

Once the command is sent from SpecWare to clear the memory, the data erasure is carried out automatically by the logger itself. The PC interface cable can then be disconnected without affecting the process. **A data erasure will take several minutes to complete and the logger cannot be contacted in the interim. Once the memory is cleared, it is impossible to recover.** SpecWare provides warning messages to prevent an accidental clearing of the memory.

## KEYPAD/DISPLAY

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The keypad of the 2000-Series data logger allows you to scroll through all measured and calculated parameters available on the LCD. It is necessary to use the keypad to set the date and time for the data being stored in the long-term memory. This is the only keypad function that is also reflected in the data stored in the data logger. Otherwise, the data logger only records the measurements from the sensors. Parameters calculated and displayed on the LCD by the firmware (such as Growing Degree Days) are only retained in the Daily and Monthly Archives (see Archives, p. 16). The functions of each of the keypad buttons are described in the following pages.

Pressing the **Display** key once brings the LCD display to life. The screen will initially display descriptive information about the station. The screen then displays current conditions. Current conditions are refreshed every 20 seconds. Pressing the **Display** key a second time will deactivate the display. The station continues to record data when the display is not active. To conserve battery power, the display goes off after 2 minutes of inactivity.

# SETTING THE DATE AND TIME

---

1. Press **Display**.
2. Press **Set**.

Select Parameter  
To Be Set (↑↓)

3. Press the down arrow key once to reach the Time & Date screen.

TIME & DATE  
Press SET

4. Press **Set**.

09-22-13 11:45AM  
Press SET

5. Press **Set**.
6. Enter the month using the arrow keys.

\*\* -22-13 11:45AM  
Press SET

7. Press **Set**.
8. Enter the year
9. Press **Set**.
10. Enter the day.
11. Press **Set**.
12. Enter the hour.
13. Press **Set**.
14. Enter the minutes.
15. Press **Set**.
16. Enter AM or PM.
17. Press **Set**.

# SETTING THE DISPLAY UNITS

---

If the display is off, press **Display** to turn it on.

1. Press **Set**.

Select Parameter  
To Be Set (↑↓)

2. Use arrows to scroll to display units.

DISPLAY UNITS  
Press SET

3. Press **Set**.
4. Use the arrow keys to choose data in English or metric units.
5. Press **Set**.

Note: The unit system used by the 2000-Series Data Logger can be modified by both the keypad and by SpecWare. Although it is advisable to have both the software and firmware using the same unit system, it is not required. SpecWare is equipped to handle situations where it receives data in a different unit system. However, if you use SpecWare to change any of the data logger's configuration parameters (i.e. logging interval), the data logger will also be reconfigured to use the unit system used by SpecWare.

# SETTING THE DEGREE-DAY COUNTER

---

**Caution:** Be careful when entering a parameter update screen for a degree day counter when that counter is enabled. If the **Set** key is pressed, the counter status will become modifiable and the archives **WILL BE ERASED**. If this is not desirable, press one of the arrow keys instead of the **Set** key to exit the screen.

If the display is off, press **Display** to turn it on.

1. Press **Set**.

Select Parameter  
To Be Set (↑↓)

2. Scroll to Degree Day Counter #1 screen.

DEG DAY COUNT #1  
Press SET

3. Press **Set**.
4. The counter will say **DISABLED**.

Counter: **DISABLED**  
BASE=55 UPPER=55

5. Press **Set**.
6. Use arrow keys to scroll to “Start Now” option. This will start the degree day counter. The other option is **DISABLED**.
7. Use arrow keys to scroll to **BASE**.
8. Press **Set**.
9. Choose the base temperature using the arrow keys.
10. Press **Set**.
11. Choose the upper temperature limit using the arrow keys.
12. Press **Set**.

# SETTING THE CHILL HOUR COUNTER

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**Caution:** Be careful when entering a parameter update screen for a chill hour counter when that counter is enabled. If the **Set** key is pressed, the counter status will become modifiable and the archives WILL BE ERASED. If this is not desirable, press one of the arrow keys instead of the **Set** key to exit the screen.

If the display is off, press **Display** to turn it on.

1. Press **Set**.
2. Scroll to the Chill Hour screen.

Select Parameter  
To Be Set (↑↓)

3. Press **Set**.

CHILL HOURS  
Press SET

4. The counter will say DISABLED.
5. Press **Set**.

Counter: DISABLED  
BASE=40

6. Use arrow keys to scroll to “Start Now” option. This will start the degree day counter. The other option is DISABLED.
7. Use arrow keys to scroll to BASE.
8. Press **Set**.
9. Choose base temperature using the arrow keys.
10. Press **Set**.



# RESETTING DISEASE MODELS

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This option restarts the disease model calculations and should be done at the beginning of the season.

If the display is off, press **Display** to turn it on.

1. Press **Set**.

Select Parameter  
To Be Set (↑↓)

2. Scroll to the Reset Disease screen.

RESET DISEASE  
Press SET

3. Press **Set** to reset the disease model.
4. The screen will go back to Current Values and the disease model will be reset.

# ARCHIVES

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The data logger features two archives that allow you to look at historical data for that location. The archives are regularly updated whenever the data logger is actively collecting data. The archives are accessed by pressing the **Current/Archive** key.

## Daily Archive

The Daily Archive retains the last 30 days of data. If the battery power runs low, the logger's firmware will stop measuring and archiving data until the battery is replaced.

After using the arrow key to select a certain day from the Daily Archive, the data logger will then cycle through all the information stored for that day. This will include a screen with the high and low temperatures for that day, any active degree day counters and the average readings for any sensors connected to the device. If a currently active Degree Day Counter was not active on that day, the screen will say "No Data".

## Monthly Archive

The Monthly Archive retains 12 months of data. When a month is selected, the data logger's LCD will then cycle through all the information stored for that month. This will include a screen with high and low temperatures for the month, degree day data and the cumulative rainfall (if applicable) for that month. If a currently active Degree Day Counter was not active at the end of a month, the screen will say "No Data" for that month.

# ARCHIVES (CONT)

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**Note:** If an active Degree Day counter is disabled or reset, the entire archive for that counter will be erased. Disabling a Degree Day counter does not affect the storing of data in memory and, thus will not affect any of the SpecWare report functions.

## Displaying Archives

If the display is off, press **Display** to turn it on.

1. Press Current/Archive once to bring up the daily archive.
2. Use the arrow keys to scroll to the date of interest.

DAILY ARCHIVE  
Select Day (↑↓)

3. The unit will automatically scroll through all the screens for that date.
4. Press Current/Archive again to bring up monthly summaries.

2/14/13  
READING VALUES...

5. Use the arrow keys to scroll through the past 12 months of data.

# SCREENS

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The following figures give examples of what each of the various weather monitor screens look like.

## *-Initial information screen*

Model 2450 v 1.1  
Apple IPM Alert

This is the first screen that comes up when you turn on the logger. It gives the model number, version number and model description. This screen is from a Model 2450 version 1.1 with the apple disease model enabled.

## *-Current Values*

Air Temp 74°F  
Leaf Wet Hours 05

This screen shows the current air temperature and status of the leaf wetness sensor (Dry or Wet) and the cumulative number of hours for the day. The current temperature on this screen is 74°F. The leaf wetness sensor is wet, and there is a total number of 5 leaf wetness hours for the day.

## *-Daily High and Low Values*

HI 74°F 01:58 PM  
LO 66°F 03:05 AM

This screen shows the high and low temperature for the day, along with the times at which they occurred. This screen shows a high temperature of 74°F at 01:58 PM and a low of 66°F at 03:05 AM.

# SCREENS (CONT.)

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## *-Degree Day Counter*

DD #1 50-86° 16  
Since 07/12 2125

This screen shows the information for Degree Day Counter #1. This counter is using a temperature range of 50 to 86°F. So far it has accumulated 16 Degree Days (DD) for today's date and has accumulated 2125 since the counter was started or reset on July 3. Degree Days calculated by the meter are not saved in memory. SpecWare uses stored temperature data to produce its own Degree Day reports.

## *-Time, Date*

## *-Battery Level*

09-08-12 07:09PM  
BATTERY AT 90%

This screen shows the current date, time and battery strength. The current date is 09-08-12 and the time is 07:09 PM. The battery is at 90%.

## *-Disease Name*

## *-Index Values*

BLK ROT=NONE PM:  
ASC=NONE CON=100

This screen shows the current disease risks. This screen will be different for each of the disease models. (See more detailed descriptions on pgs. 30-36) This screen shows no risk for Black Rot, no risk for ascospore infection, and a conidial index of 100.

# DEGREE DAYS/CHILL HOURS

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## Degree Days

Temperature is a key factor contributing to the development of plants, insects and plant diseases. Degree Days are a way to quantify the amount of heat that is available, which is a function of the time the temperature is within a given temperature range. For example, if the base temperature is determined to be 40 degrees and the actual temperature is 41 degrees for 24 consecutive hours, one Degree Day is said to have accumulated ( $41 - 40 = 1$  degree for 24 hours or 1 day). Degree Days indicate the developmental stage of a pest generation. This allows for more precise pesticide recommendations.

The logger's firmware calculates Degree Days using the integral method. Degree Day values are calculated at 15 minute intervals to produce Degree Quarter-Hours (DQH), which are then summed over a full day. DQH are calculated as follows:

$$\text{DQH} = T_{\text{avg}} - T_{\text{base}}$$

Where  $T_{\text{avg}}$  is the average temperature over the 15-minute interval and  $T_{\text{base}}$  is the base temperature. If the average temperature is greater than the upper limit of the temperature range, the upper temperature limit is used instead of the average temperature when calculating DQH. If the average temperature is less than the base temperature, DQH is set equal to zero for that interval.

## Chill Hours

Chill hours are calculated as the amount of time spent below a base temperature. Chill hours accumulations are used to estimate dormancy for tree fruit.

# ACTIVATING OPTIONAL DISEASE MODELS

If you have purchased a disease model option for the 2000 Series data logger, this option must be activated with SpecWare. This will require an authorization code that can be obtained by calling Spectrum Technologies. You will be asked for the Serial and Registration numbers that appear on the “Spec9 Pro” information screen (see figure below). This screen is brought up by selecting the “About SpecWare” option from the **Help** menu on the SpecWare main screen.

Once a disease model has been activated on a station, the infection risk will be available on the LCD at all times. Once the data is downloaded, more complete reports can be run within SpecWare itself. Only one disease model can be activated on a logger at a time, but there is no limit on the number of disease reports or plant growth reports that can be run within SpecWare.

SpecWare 9 Pro

**Spec 9 Pro**  
For WatchDog Products

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OK

# **ACTIVATING OPTIONAL DISEASE MODELS (CONT.)**

---

All disease models require, at least, air temperature and leaf wetness data. Therefore, an additional leaf wetness sensor must be purchased and connected to port B on the logger. If a model 2400 is set for disease models a temperature sensor needs to be plugged in to port D.

Setting the Disease/Report mode is done using the "Report" pulldown on the Properties screen within the WatchDog Manager in SpecWare.

The available disease models are described in pages 30 - 36.



# LIGHT

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The quantum sensor approximates PAR light, the radiation between 400 and 700 nanometers. These are the most influential wavelengths for optimum plant growth. PAR light is necessary for the plant to function properly. Light requirements differ between crops, but the rule of thumb is to allow the maximum amount of light possible. Growers commonly apply shade to decrease temperature and improve foliage. In some crops, such as tomatoes, the yield has been shown to be directly proportional to the amount of light. Limiting light may cause the stomates to close which prevents the leaves from cooling off. The data logger monitors the light available and records it as moles/day (Peet, 2002).

Moles/day is the unit for the Daily Light Integral (DLI); the amount of light present during a day. The DLI varies with the seasons, increasing in the spring and decreasing in the fall. The greenhouse film and structure allow 35-70% of the light to reach the plants. Environmental factors like dust and dew can also block light. Light transfer is hard to assess using the human eye because it adjusts immediately to the current light level. The only way to verify light quantity is to use a light meter (Faust, 2002).

## **Installation of light sensors**

- Position the sensor in an appropriate area to monitor plant conditions.
- Make sure the quantum sensor is not being shadowed or blocked.
- Use the bubble level to ensure the sensor is horizontal.
- Inspect the sensors frequently to make certain they are clear of obstructions.

Contact your cooperative extension agricultural agent for further suggestions on field placement.

# PLANT-SPECIFIC LIGHT REQUIREMENTS

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Light quantity is measured in a daily light integral (DLI) which refers to the total amount of light a plant receives in one day. A plant requires a minimum DLI just like it requires a certain amount of rainfall. The following values were obtained from a set of experiments performed at Clemson University.

## SPRING EXPERIMENT

The spring experiment measured plant development at 0% shade (18 mol/day), 25% shade (12 mol/day), 50% shade (6 mol/day), and 75% shade (3 mol/day).

| <b>Plant</b> | <b>Commercially Acceptable Quality</b> | <b>Highest Quality</b> |
|--------------|--|------------------------|
| Begonia      | 6 mol/day                              | 12 to 18 mol/day       |
| Pansy        | N/A                                    | 18 mol/day             |
| Marigold     | 6 mol/day                              | N/A                    |
| Angelonia    | 12 mol/day                             | 18 mol/day             |
| Petunia      | N/A                                    | N/A                    |
| Impatiens    | 3 mol/day                              | 6 to 12 mol/day        |

# PLANT-SPECIFIC LIGHT REQUIREMENTS

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## SUMMER EXPERIMENT

The summer experiment measured outdoor plant development at 0% shade (38 mol/day), 50% shade (15 mol/day), 70% shade (6 mol/day), and 90% shade (3 mol/day).

| Plant   | Commercially Acceptable Quality | Highest Quality |
|---------|---------------------------------|-----------------|
| Agertum | 15 mol/day                      | > 15 mol/day    |
| Vincia  | 7 mol/day                       | N/A             |
| Zinnia  | N/A                             | 38 mol/day      |

## FALL EXPERIMENT

The fall experiment measured outdoor plant development at 0% shade (30 mol/day), 50% shade (13 mol/day), 70% shade (8 mol/day), and 90% shade (3 mol/day).

| Plant       | Commercially Acceptable Quality | Highest Quality |
|-------------|---------------------------------|-----------------|
| Geranium    | 13 mol/day                      | 30 mol/day      |
| Melampodium | 8 mol/day                       | 30 mol/day      |

# GENERAL LIGHT REQUIREMENTS

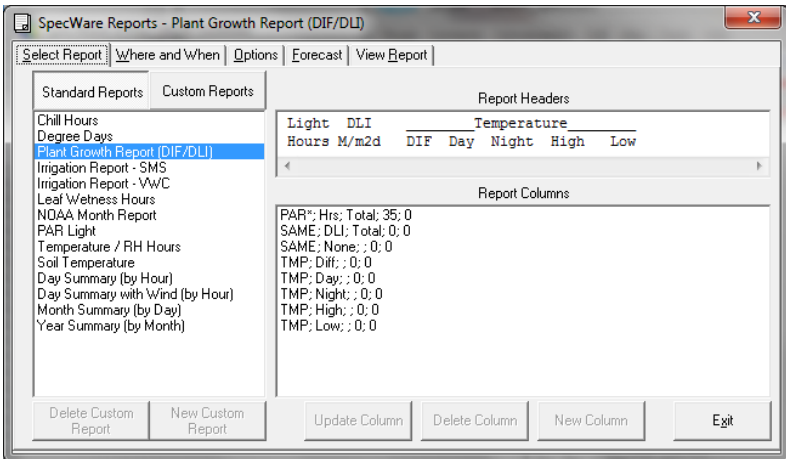
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| <b>Light Quantity</b><br>(Daily Light Integral-DLI) | <b>Results</b>  |
|---|---|
| < 5 mol/day   | Produces poor quality plants  |
| 5-10 mol/day  | Produces commercially acceptable plants<br>Produces high quality plants for shade-adapted species |
| 10-20 mol/day                                       | Produces high quality plants  |

# DIF

The model 2475 includes temperature, relative humidity and light sensors. This unit displays DIF, which is the average day temperature minus the average night temperature. This value is used to determine stem elongation. When day temperature is warmer than night temperature (positive DIF value) plants will become taller. When day temperature is cooler than night temperature (negative DIF value) less stem elongation will occur.

To view a DIF report, select Reports in the dropdown menu from Tools on the menu bar in SpecWare. Select Plant Growth Report (DIF/DLI) in Standard Reports. Use the Where and When tab to change the dates of data used to generate the report, and the View Report tab to view DIF values.



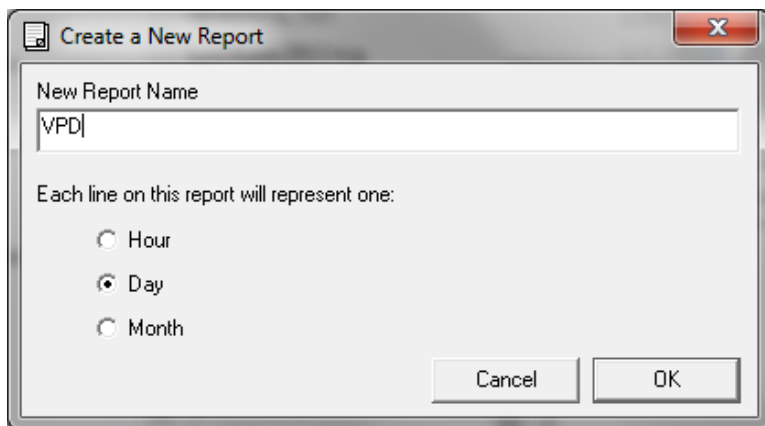
# VPD

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The model 2475 Plant Growth Station displays VPD on the unit. VPD can be calculated in SpecWare Custom Reports for all models. Firmware 3.8 and SpecWare 9 Pro or higher is needed to use VPD.

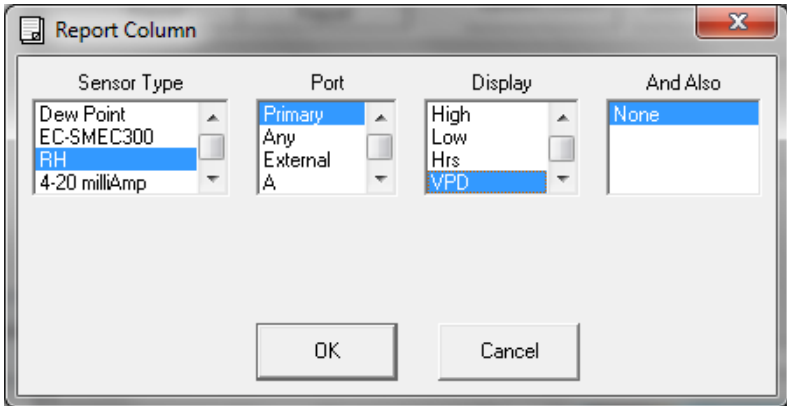
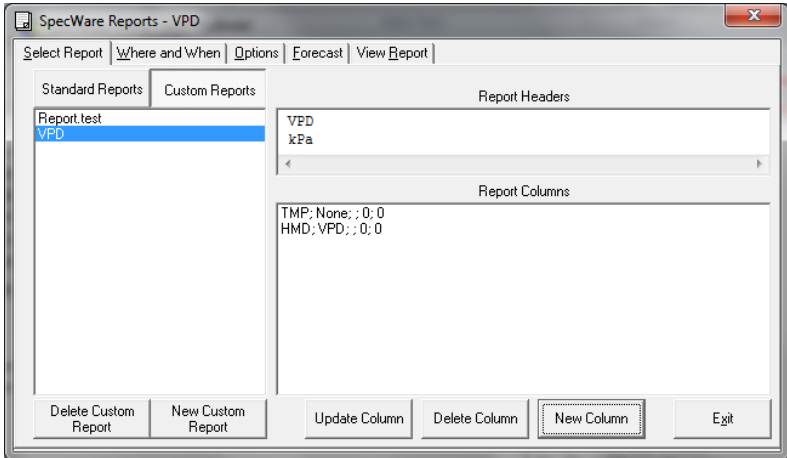
VPD (vapor pressure deficit) is the difference between how much water vapor is in the air and how much water vapor the air can hold at saturation. It predicts the rate of water vapor movement from the plant to the surrounding air and is a useful tool in plant watering decisions.

To view a VPD report, select Reports from the Tools dropdown menu on the SpecWare menu bar. Select the Custom Reports tab on the Select Report tab. Press the New Custom Report button. This will bring up the Create a New Report window (see image below). Assign a name and reporting interval and press OK.



Select the newly created report and press the New Column button. Select RH, Primary, and VPD. Press OK.

Use the Where and When tab to change the dates of data used to generate the report, and the View Report tab to view VPD values.



# GRAPE POWDERY MILDEW

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This option predicts two infectious stages, an ascospore stage and a conidial stage (Thomas, Gubler, and Leavitt 1994; Weber, Gubler, and Derr 1996) Ascospores are released in the spring from the structure in which the disease overwintered. Conidial spores are the result of an ascospore infection. Ascospores cause primary infections and conidial spores cause secondary infections. Your State Agricultural Extension Service can advise you about which stage is important in your area.

**Ascospore Infection** risk is determined using the daily average temperature and the hours of leaf wetness. A modified Mills Table (2/3 the original Mills leaf wetness value) is used to determine the development of a **'Heavy' Ascospore Infection**, the point at which treatment should begin.

Three consecutive days with 6 consecutive hours of temperatures between 70°F and 85°F are required to initiate the **Conidial Index**. Thereafter, the index increases by 20 with each day having six consecutive hours between 70°F and 85°F. The index decreases by 10 on days with less than six consecutive hours in the range of 70°F to 85°F and on days with a maximum temperature greater than 95°F. The index will always be between zero and 100.

## *Infection Severity Screen*

|                                      |
|--------------------------------------|
| BLK ROT=NONE PM:<br>ASC=NONE CON=010 |
|--------------------------------------|

This screen shows the risk for Black Rot and Powdery Mildew. The Powdery Mildew ascospore infection is none, and the conidial index is 10.



# GRAPE MILLS TABLE

| Daily Average Temperature (F) | Hours of Leaf Wetness required for heavy ascospore infection (2/3 original Mills value) |
|-------------------------------|---|
| 42                            | 40  |
| 43                            | 34  |
| 44                            | 30  |
| 45                            | 27.3  |
| 46                            | 25.3  |
| 47                            | 23.3  |
| 48-49                         | 20  |
| 50                            | 19.3  |
| 51                            | 18  |
| 52                            | 17.3  |
| 53                            | 16.7  |
| 54-55                         | 16  |
| 56-57                         | 14.7  |
| 58-59                         | 14  |
| 60-61                         | 13.3  |
| 62                            | 12.7  |
| 63-75                         | 12  |
| 76                            | 12.7  |
| 77                            | 14  |
| 78                            | 17.3  |

## Conidial Index:

- 0 - 30 = **Light** infection risk
- 40 - 50 = **Medium** infection risk
- 60 - 100 = **Heavy** infection risk

# GRAPE BLACK ROT

**Black Rot** is a disease caused by the fungus *Guignardia bidwelli*. It overwinters in in old mummified berries. In spring, the primary inoculum is released which starts the initial round of infection. Those initial spores are dispersed by rain and wind. After the initial infection period, secondary infections are spread by rain splash. This model predicts infection periods of Black Rot based upon the Spotts model.

This model uses **temperature** and **leaf wetness** period to estimate the onset of an infection period. The temperature is compared with the period of leaf wetness needed to produce an observable infection. If the wetness period exceeds the required period for that temperature, the word **RISK** will appear

## *Infection Severity Screen*

|                                      |
|--------------------------------------|
| BLK ROT=RISK PM:<br>ASC=NONE CON=010 |
|--------------------------------------|

This screen shows a risk for Black Rot as well as Powdery Mildew. This screen shows a risk for Black Rot.

| Temperature (F) | Hours of Leaf Wetness |
|-----------------|-----------------------|
| 50              | 24                    |
| 55              | 12                    |
| 60              | 9                     |
| 65              | 8                     |
| 70              | 7                     |
| 75              | 7                     |
| 80              | 6                     |
| 85              | 9                     |
| 90              | 12                    |

Source R.A. Spotts, Ohio State University

# APPLE SCAB SOOTYBLOTCH FLYSPEC

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This option predicts the approximate “Infection Degree” for **Apple Scab**. The infection severity (None, Light, Medium, or Heavy) is triggered by the accumulation of sufficient hours of leaf wetness that occur between the base and upper temperature limits. The Weather Tracker uses the Mills **Apple Scab** model as modified by A.L. Jones 1980. A modified Mills table is shown on the following 2 pages.

## *Infection Severity Screen*

|                                    |
|------------------------------------|
| SBFS MILLS=NONE<br>000hrs WSU=NONE |
|------------------------------------|

This screen shows the infection risk for the day. The risk on this screen is light. The apple scab risk is calculated daily.

# APPLE MILLS TABLE

| Approximate numbers of hours of wetting required for primary apple scab infection at different air temperatures |                           |        |       |
|---|---------------------------|--------|-------|
| Average Temp.   | Degree of Infection (hrs) |        |       |
| (°F)  | Light                     | Medium | Heavy |
| 78  | 13                        | 17     | 26    |
| 77  | 11                        | 14     | 21    |
| 76  | 9.5                       | 12     | 19    |
| 63 to 75  | 9                         | 12     | 18    |
| 62  | 9                         | 12     | 19    |
| 61  | 9                         | 13     | 20    |
| 60  | 9.5                       | 13     | 20    |
| 59  | 10                        | 13     | 21    |
| 58  | 10                        | 14     | 21    |
| 57  | 10                        | 14     | 22    |
| 56  | 11                        | 15     | 22    |
| 55  | 11                        | 16     | 24    |
| 54  | 11..5                     | 16     | 24    |
| 53  | 12                        | 17     | 25    |
| 52  | 12                        | 18     | 26    |
| 51  | 13                        | 18     | 27    |

# APPLE MILLS TABLE

---

| Approximate numbers of hours of wetting required for primary apple scab infection at different air temperatures |                           |        |       |
|---|---------------------------|--------|-------|
| Average Temp.   | Degree of Infection (hrs) |        |       |
| (°F)  | Light                     | Medium | Heavy |
| 50  | 14                        | 19     | 29    |
| 49  | 14.5                      | 20     | 30    |
| 48  | 15                        | 20     | 30    |
| 47  | 15                        | 23     | 35    |
| 46  | 16                        | 24     | 37    |
| 45  | 17                        | 26     | 40    |
| 44  | 19                        | 28     | 43    |
| 43  | 21                        | 30     | 47    |
| 42  | 23                        | 33     | 50    |
| 41  | 26                        | 37     | 53    |
| 40  | 29                        | 41     | 56    |
| 39  | 33                        | 45     | 60    |
| 38  | 37                        | 50     | 64    |
| 37  | 41                        | 55     | 68    |
| 33 to 36  | 48                        | 72     | 96    |

# TOM-CAST

This option uses **Tom-Cast**, a tomato disease forecasting program designed to predict Early Blight, Septoria Leaf Spot, and Anthracnose. (Pitblado ~1985; Bolkan and Reinert 1994) **Tom-Cast** calculates a disease severity value (**DSV**) to predict the development of these diseases.

An increasing number of leaf wetness hours and a higher temperature cause the **DSV** to increase at a faster rate. A **Cumulative DSV** of 15 to 20 is usually viewed as the threshold for initiating a spray program. Contact your State Agricultural Extension Service for further information regarding disease management in your area.

## *Infection Severity Screen*

|                                |
|--------------------------------|
| TOMCAST DSV<br>DAY=2 ACCUM=010 |
|--------------------------------|

This screen shows the DSV values for the day as well as the accumulated DSV values. The daily DSV on this screen is 2 and the number of DSV's accumulated since the reset is 10.

| Disease Severity Value Chart            |                               |      |       |       |     |
|---|-------------------------------|------|-------|-------|-----|
| Average Temp During Leaf Wet Hours (°F) | Hours of Leaf Wetness per Day |      |       |       |     |
| 55-63                                   | 0-6                           | 7-15 | 16-20 | 21 +  |     |
| 64-69                                   | 0-3                           | 4-8  | 9-15  | 16-22 | 23+ |
| 70-78                                   | 0-2                           | 3-5  | 6-12  | 13-20 | 21+ |
| 79-84                                   | 0-3                           | 4-8  | 9-15  | 16-22 | 23+ |
| Daily DSV =                             | 0                             | 1    | 2     | 3     | 4   |

# REFERENCES

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- Bolkan, M. A. and W. R. Reinert. (1994). Developing and Implementing IPM Strategies to Assist Farmers: An Industry Approach. Plant Disease, 78:545-550.
- Faust, James E. "Light Management in Greenhouses" 2002. [http://www.firstinfloriculture.org/pdf/2002-5\\_LightManagement\\_pt\\_1.pdf](http://www.firstinfloriculture.org/pdf/2002-5_LightManagement_pt_1.pdf) (2002-Nov-26)
- Holcombe, Veronda B., Kelly Lewis, and James E. Faust. "How Much Light Do Bedding Plants Really Need?" *Greenhouse Product News* July 2001:26-30.
- Jones, A. L., et al. (1980). A Microcomputer-based Instrument to Predict Primary Apple Scab Infection Periods. Plant Disease, 64:69-72.
- Peet, Mary M, "Greenhouse Vegetable Production" 2002. [http://www.ces.ncsu.edu/depts/hort/greenhouse\\_veg/more\\_info\\_/stress3.html](http://www.ces.ncsu.edu/depts/hort/greenhouse_veg/more_info_/stress3.html) (2002-Nov-26).
- Pitblado, R.E. (1985). A Weather-timed Fungicides Spray Program for Field Tomatoes in Ontario. TOM-CAST, The Model. Ridgetown College of Agricultural Technology. Ridgetown, ON.
- Spotts, R. A., (1977). Effect of Leaf Wetness Duration and Temperature on the Infectivity of *Guignardia Bidwellii* on Grape Leaves. Phytopathology 67:1378-1381.
- Thomas, C. S., W. D. Gubler, and G. Leavitt. (1994). Field Testing of a Powdery Mildew Disease Forecast Model on Grapes in California. Phytopathology, 84:1070 (abstract)
- Weber, E., D. Gubler, and A. Derr. (1996). Powdery Mildew Controlled with Fewer Fungicide Applications. Practical Winery & Vineyard, January/February.

# WARRANTY

This product is warranted to be free from defects in material or workmanship for one year from the date of purchase. During the warranty period Spectrum will, at its option, either repair or replace products that prove to be defective. This warranty does not cover damage due to improper installation or use, lightning, negligence, accident, or unauthorized modifications, or to incidental or consequential damages beyond the Spectrum product. Before returning a failed unit, you must obtain a Returned Materials Authorization (RMA) from Spectrum. Spectrum is not responsible for any package that is returned without a valid RMA number or for the loss of the package by any shipping company.

## DECLARATION OF CONFORMITY



Spectrum Technologies, Inc.  
3600 Thayer Court  
Aurora, IL 60504 USA

Model Numbers: 3683WD, 3684WD, 3685WD, 3686WD  
Description: WatchDog Mini Station  
Type: Electrical Equipment for Measurement, Control, and Laboratory Use

The undersigned hereby declares that the above referenced product is in conformity with the provisions of:

Directive: 2004/108/EC  
Standards: EN 61326-1:2006  
EN 61000-4-2:1995, including A1:1998 and A2:2001  
EN 61000-4-3:2002  
EN 55011:2007

A handwritten signature in black ink, appearing to read 'Michael J. Dunning'.

Michael J. Dunning  
Weather Products Manager

March 25, 2009

# **Spectrum<sup>®</sup>** **Technologies, Inc.**

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