SpecWare ™ 8 Professional

Disease and Insect Guide

Optional Disease Models:

- Apple Scab
- Botrytis
- Black Rot
- Brown Patch
- Cherry Leaf Spot
- Dollar Spot
- Downy Mildew
- Early Blight
- FireBlight
- Late Blight
- Phomopsis Cane Leaf Spot
- Powdery Mildew
- Pythium Blight
- Sooty Blotch/Flyspeck
- Tom-Cast

Optional Insect Models

Spectrum
Technologies, Inc.

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Optional Disease and Insect Models

SpecWare software includes models to predict infection events for the following diseases and for insects. These models are provided FREE for a 30 day evaluation. If the user desires continued use of any of the disease or insect models after the evaluation period, or if any model was purchased initially with SpecWare, the user must contact Spectrum Technologies for a registration number.

Before calling Spectrum, click on the **Help** button on the main toolbar. Then click on “About SpecWare” A dialog box will appear with ***both*** the Serial Number and Registration Number. Call, fax, or e-mail Spectrum with this information to receive your authorization code. The optional disease and insect models are as follows:

Model	**Catalog #**
Apple Scab	3656 AS
Black Rot	3656 BR
Botrytis	3656 BT
Brown Patch	3656 BP
Cherry Leaf Spot	3656 CS
Dollar Spot	3656 DS
Downy Mildew	3656 DM
Early Blight	3656 EB
Fire Blight	3656 FB
Late Blight	3656 LB
Powdery Mildew	3656 PD
Pythium Blight	3656 PT
Sooty Blotch	3656 SB
Tom-Cast	3656 TC
Insects	3656 IN

For detailed descriptions of how to open files and choose the locations and time periods to be modeled, refer to the **SpecWare Software Users Guide**.

The Basics of Computer Modeling

There are practical considerations that must be taken into account when using computer models to predict biological processes such as disease or insect activity. The model must be appropriate for the particular insect or disease. The data for environmental parameters must be acquired to accurately predict the life stages of the organism. The type of crop and its stage of development has an effect on the development of the pest organism. The region in which the model was developed is also important. A useful computer model takes each of these points into account.

Using common names to distinguish one disease or insect from another can lead to errors. For instance, almost every crop plant known to man has a disease called powdery mildew. SpecWare has a model for powdery mildew on grapes caused by the organism with the Latin name *Uncinula necator*. However, the disease organism that causes powdery mildew on apples is *Podosphaera leucotricha* and on blueberries, it is *Microsphaera penicillata*. Disease and insect models that are universally applicable to several different crops are the exception, not the rule. Therefore, disease and insect models are usually developed for a particular crop and a specific pest organism.

Every computer model must include the assumption that the primary environmental conditions that affect the development of the disease or the insect can be measured. SpecWare uses a variety of environmental sensors to model the progression of plant diseases. SpecWare uses only degree days to model insect phenology. The author of the disease or insect model must do a sensitivity analysis to assure that the model is being driven by the most important environmental data. For instance, the development of apple scab is believed to be affected by some wavelengths of red light. However, the inclusion of red light data has minimal added effect on the accurate modeling of apple scab. The development of apple scab is primarily driven by temperature and leaf wetness.

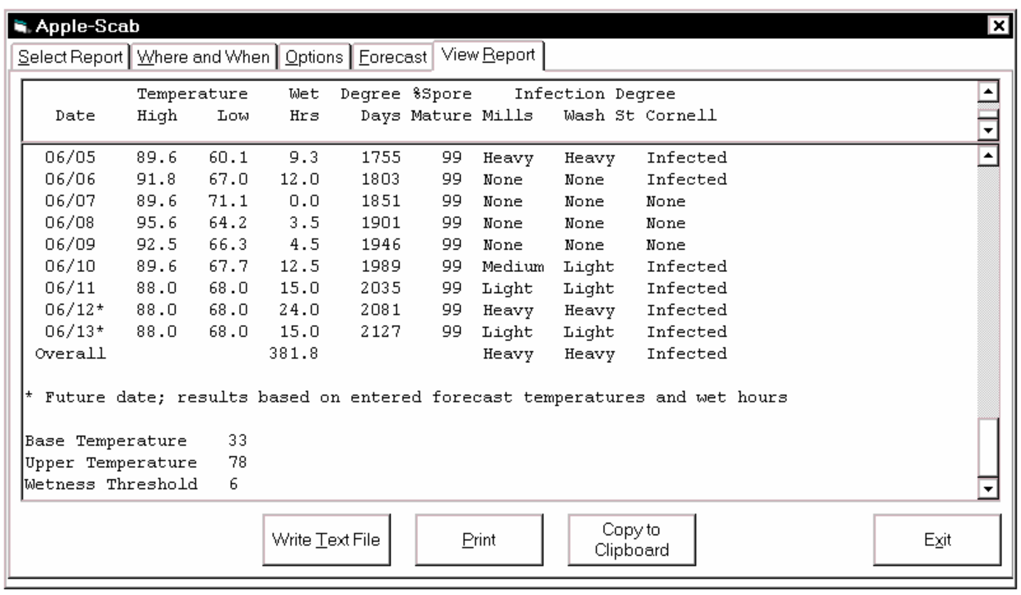
Many conditions directly related to the host plant affect insect and disease development. These conditions may include the availability of insect-preferred fruit on which to feed or lay eggs or the type of plant structure that the insects use as cover from their enemies. Diseases may be affected by plant nutritional status or the presence of non-disease fungal species that compete with the disease-causing organism for space or resources. Pears and apples can both be infected with fire blight and SpecWare allows the user to specify apples or pears in the fire blight model. This feature is present because the rate of infection is different for apples versus pears. In fact, the rate of infection is slightly different even among different varieties of apples. To carry this example further, soft rapidly growing tissue is more susceptible to fire blight than is older, harder tissue. In this case, the grower's experience concerning how much nitrogen to apply and the effects of that fertilizer application for a particular cultivar should be considered as part of the IPM program to control fire blight.

Developing disease and insect models must necessarily be accomplished at some particular geographic location. This is important because for each region of the country different climatic conditions exist, different organisms that compete for space are present, and slightly different genetic variations occur in the pest species. For that reason, some models such as apple scab and fire blight specify that they are from New York or Washington or Maryland. Also, for reasons of regional differences, the insect models show the location in which they were developed. For example, an insect or disease model developed for grapes in California probably is useful for grapes in New York. The local university extension service should be contacted to verify that the model is appropriate for a particular region.

Apple Scab

SpecWare will predict the approximate “Infection Degree” for **Apple Scab**. The infection severity (Light, Medium, Heavy, or Infected) is triggered by the accumulation of sufficient hours of leaf wetness that occur between the base and upper temperature limits. The software includes three **Apple Scab** models:

Mills (modified by A.L. Jones 1980)
Washington State University (Mills 1944)
Cornell University (Gadoury, Seem, and Stensvand 1994)



The **Apple Scab** models require **temperature** and **leaf wetness** data.

For information concerning the **Select Report, Where and When,** and **Forecast** screens, please refer to the **Tools** section of the **SpecWare Software Users Guide**.

Apple Scab (continued)

In the **Options** screen, enter the low and high limits of the temperature range in the **Base** and **Upper Limit** boxes. The generally accepted temperature range is between 33° and 79° F. Enter the **Wetness Threshold** above which you desire the software to consider the foliage “wet.” Consult your State Agricultural Extension Service for assistance in determining the appropriate temperature and leaf wetness values for your area. These parameters can be saved by clicking on the **Save Parameters** button.

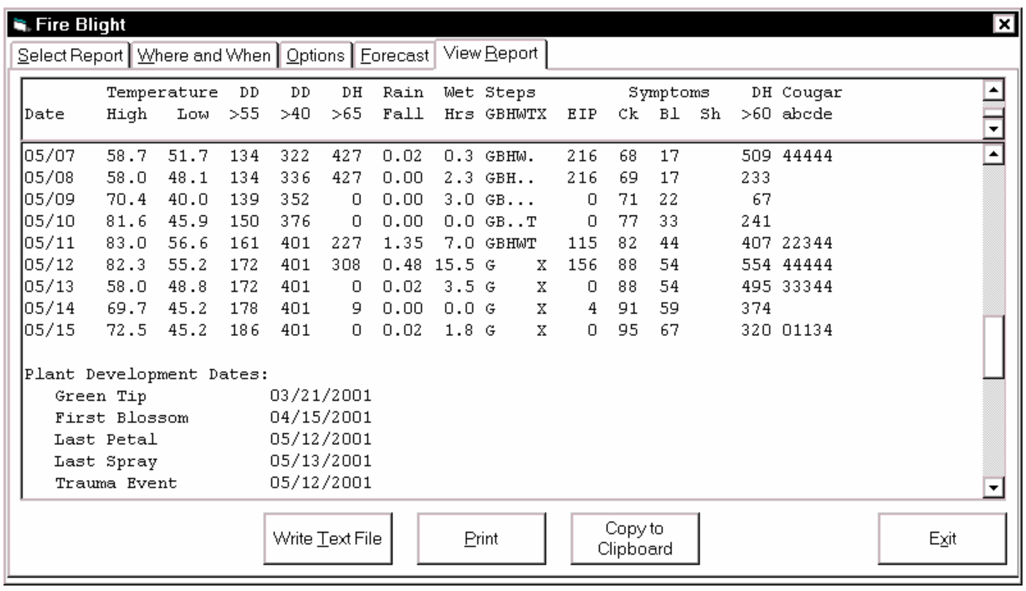
On the **View Report** screen, the infection severity for **Apple Scab** appears. The **Mills** and **Washington State** models denote either no infection potential or a **Light**, **Medium**, or **Heavy** infection potential. The **Cornell** model only designates **Infected** when an infection is predicted.

The **Mills** model, as modified by Jones, requires fewer hours of leaf wetness at average temperatures 47°F or below to signal a risk for infection than does the **Washington State** model. Both of these models denote a **Light**, **Medium**, or **Heavy** infection risk depending on the number of hours of leaf wetness at a given average temperature. The **Cornell** model requires the fewest number of leaf wetness hours at all given temperatures and simply indicates **Infected** or not. The **Cornell** model signals **Infected** with fewer leaf wetness hours than the other two models require to even signal a **Light** infection.

Fire Blight

SpecWare will predict the onset of **Fire Blight** symptoms in apples and pears using two models.

University of Maryland (Steiner and Lightner 1996)
Cougar Blight (Smith 1993)



The **Fire Blight** models require **air temperature** and **leaf wetness** data.

For information concerning the **Select Report, Where and When,** and **Forecast** screens, please refer to the **Tools** section of the **SpecWare Software Users Guide**.

On the **Options** screen, choose **Apple** or **Pear**. As the season progresses, enter the **50% Green Tip Date**, **First Bloom Date**, and **Last Petal Fall Date**. Whenever a **Spray Date** or a **Trauma Event Date** occurs, enter those as well. After each entry, click the **Save Parameters** button to avoid having to re-enter the dates.

Fire Blight (continued)

On the **View Report** screen, the results of the **University of Maryland** model and the Washington State University model **Cougar Blight** appear.

University of Maryland
Model developed by P.W. Steiner and G.W. Lightner

SpecWare will predict specific infection events and the appearance of blossom, canker, and shoot blight symptoms. The model uses three cumulative heat unit measures to indirectly monitor development of the host, the pathogen, insect vectors, and **Fire Blight** symptoms.

Steps

G Green Tip; from green tip date until Canker blight symptoms
B Blossom; from first blossom date until Blossom blight symptoms
H 198 Degree Hours > 65ºF requirement met
W Wetness (dew or rain) requirement met
T Average Temperature ≥ 60ºF

G is initiated by entering a 50% green-tip date on the options screen. **B**, **H**, **W**, and **T** are active only during the bloom period as entered on the options screen.

EIP

EIP, Epiphytic Infection Potential, is an index for infection risk. EIP is the percentage of 198 DH>65ºF that have accumulated in the last 80 DD>40ºF (apple) or 120 DD>40ºF (pear). An EIP of 100 is the threshold for infection.

Symptoms

Cumulative DD>55ºF are used to predict symptom development once infection has occurred. The number in the symptom column represents

Fire Blight (continued)

the percentage of the threshold met by the conditions. A symptom value of 100 indicates that symptoms are present. That is, 100% of the temperature or degree day requirements have been met for the blossom, canker, or shoot blight symptoms to be readily apparent. The following describes the symptom and the threshold.

Ck - Canker Blight
Canker blight is predicted with the accumulation of at least 196 DD>55ºF after green tip.

Bl - Blossom Blight
The model assumes an abundance of inoculum. Four conditions need to be met for a blossom infection to occur.

1. Flowers, with stigmas and petals intact, need to be present.
2. Accumulation of at least 198 DH>65ºF within the last 80 DD>40ºF (apple) or 120 DD>40ºF (pear).
3. Occurrence of dew or rain of 0.10 inch or more during the current or previous day.
4. Daily average temperature greater than or equal to 60ºF.

When all minimum conditions are met in sequence, infection occurs and the first blossom blight symptoms can be seen after an additional accumulation of 103 DD>55ºF. The cumulative DH>65ºF are reduced by one-third, one-half or reset to zero if the temperature does not surpass a threshold of 64F during one, two or three days, respectively. However, once 400 DH>65ºF have accumulated (EIP=200), no negative adjustments are made.

Sh - Shoot Blight
The program forecasts only very early shoot blight symptoms. These early symptoms usually develop with the accumulation of 103 DD>55ºF following the first appearance of either blossom or canker blight symptoms in the immediate area. The average daily temperature must be 60ºF or greater.

Fire Blight (continued)

Cougar Blight
Model developed by T.J. Smith

Under the **Cougar** heading, there is a lettered **Pathogen Potential** (**a** to **e**) that is used to estimate the presence of **Fire Blight** innoculum. For each level of innoculum present, a numbered **Infection Risk** (**0** to **4**) predicts the severity of an infection.

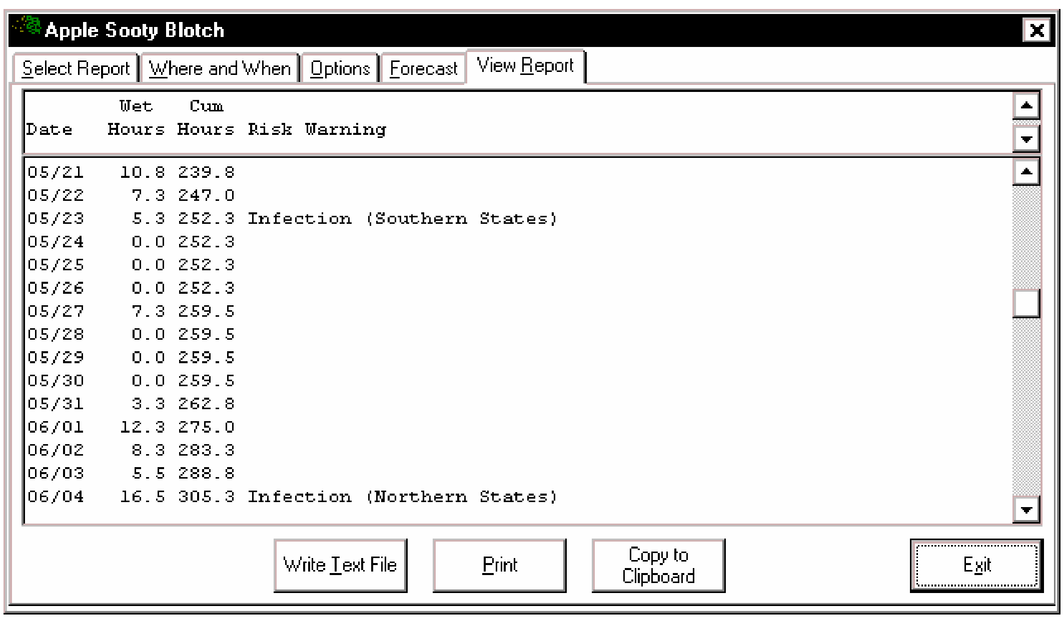
Pathogen Potential
a: No Fire Blight in area in past two seasons
b: Fire Blight in local area in past two seasons
c: Fire Blight in local area last year
d: Fire Blight in orchard last year
e: Active cankers present nearby

Infection Risk
0: Very Low
1: Low
2: Low-Moderate
3: Moderate
4: High

Sooty Blotch and Flyspeck

Sooty blotch is a disease complex (i.e. it is composed of more than 1 pathogen) of two fungi, *Peltaster fruticola* and *Leptodontium elatius*.

Flyspeck is caused by another fungus, *Zygiophiala jamiacacenis*. SpecWare predicts the period of risk for infection based on leaf wetness after apple flower petal fall. Both fungi are dispersed by rainfall and their spores germinate in water (Jones and Sutton 2001).



Both models require **air temperature** and **leaf wetness** data.

For information concerning the **Select Report** and **Where and When** screens, please refer to the tools section of the **SpecWare Software Users Guide**.

On the **Options** screen, specify the leaf **Wetness Threshold**. A typical setting is 3 so noise is not included in the readings. The sensor range is from 0-15. This is a relative scale so no value is attached to the reading.

Sooty Blotch and Flyspeck (continued)

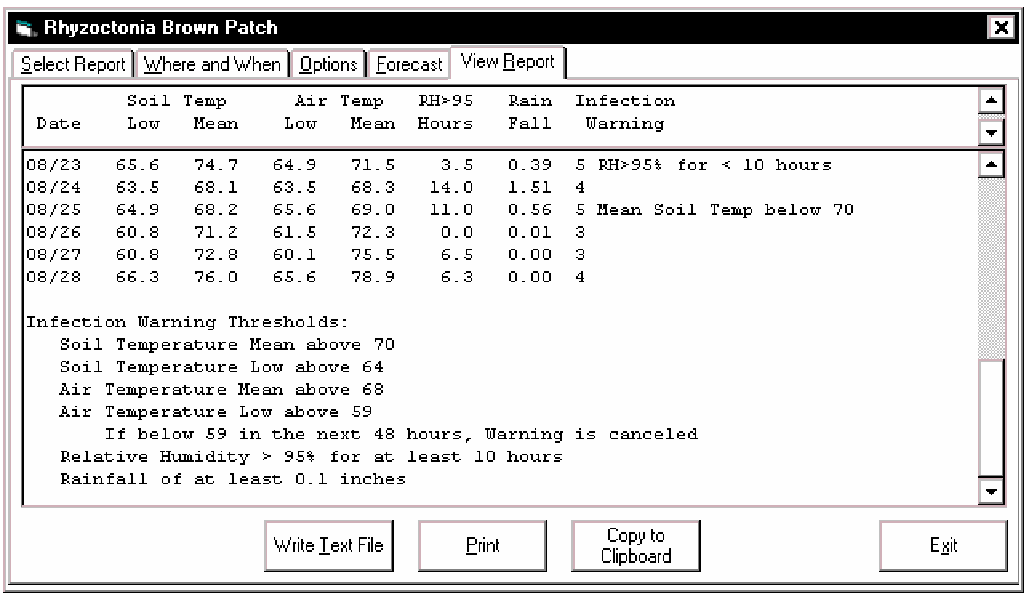
The model starts after 259 hours of leaf wetness have been accumulated. Only leaf wetness periods of at least 3 hours are counted (less than 3 hours are not included). After the 259 hours have accumulated, the model starts. Any 3-hour leaf wetness period after the start signals a possible infection period.

Different areas of the country may require a different number of leaf wetness hours to start the model. Presently, we use only the most conservative model (i.e. the one that will give the earliest warning). Individual users of the models can choose to ignore those infection predictions and run the model from the data by themselves.

On the **View** report, the user can see the measured wetness hours, the accumulated wetness hours and any messages noting the start of an infection period.

Brown Patch

SpecWare will indicate specific infection events for the onset of **Rhyzoctonia Brown Patch** in turf. (Schumann, Clarke, Rowley, and Burpee 1994)



The **Brown Patch** model requires **air temperature**, **soil temperature**, **relative humidity**, and **rainfall** data.

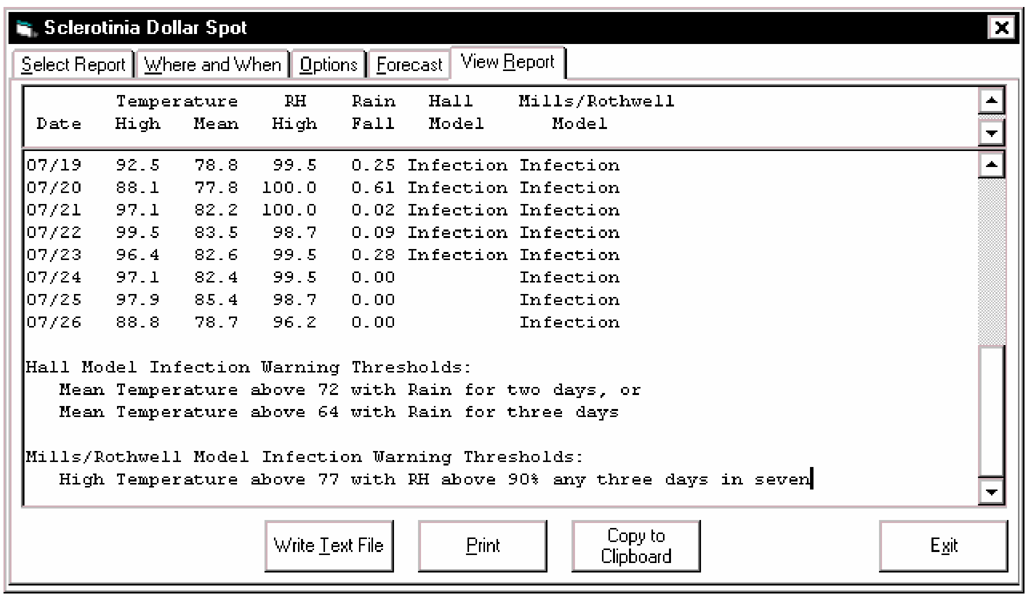
For information concerning the **Select Report, Where and When,** and **Forecast** screens, please refer to the **Tools** section of the **SpecWare Software Users Guide**. There are no **Options** to be entered for **Brown Patch.**

On the **View Report** screen for **Brown Patch**, an **Infection Warning** appears. The infection warning column will indicate how many of six thresholds have been met for the onset of **Brown Patch**. If most of the thresholds for infection have been met, information concerning the remaining unmet thresholds will be given. The **Infection Warning Thresholds** are listed at the end of the disease report screen.

Dollar Spot

SpecWare will indicate specific infection events for the onset of **Sclerotinia Dollar Spot** in turf. The software includes two **Dollar Spot** models:

Hall Model (Hall 1984)
Mills/Rothwell Model (Mills and Rothwell 1982)



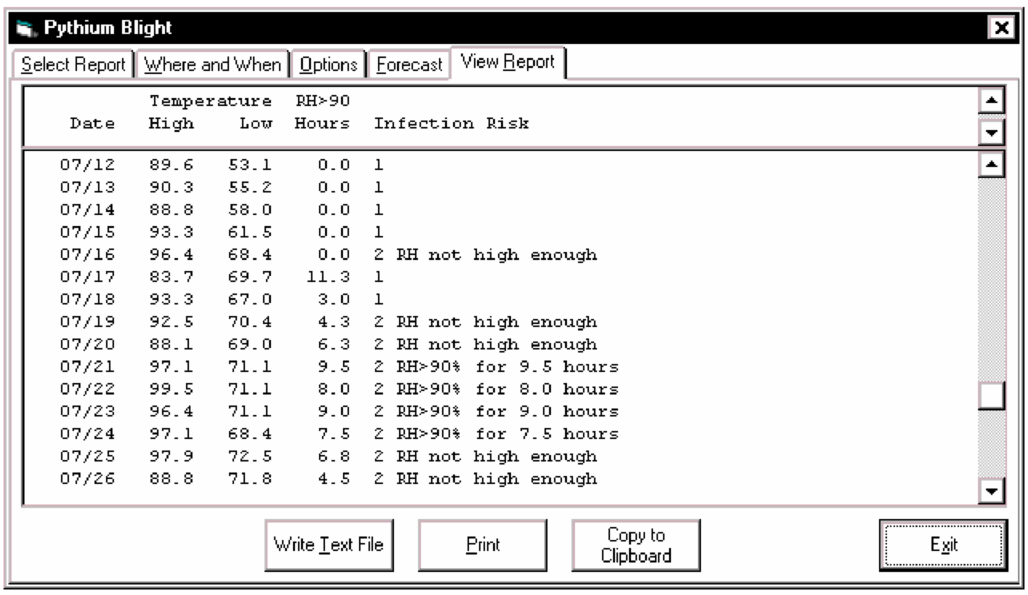
The **Dollar Spot** model requires **air temperature**, **relative humidity**, and **rainfall** data.

For information concerning the **Select Report, Where and When,** and **Forecast** screens, please refer to the **Tools** section of the **SpecWare Software Users Guide**. There are no **Options** to be entered for **Dollar Spot.**

On the **View Report** screen, the **Hall Model Infection Warning Thresholds** and the **Mills/Rothwell Model Infection Warning Thresholds** are listed. If these thresholds are met, the software will display **Infection**; otherwise the warning section remains blank.

Pythium Blight

SpecWare will indicate specific infection events for the onset of **Pythium Blight** in turf. (Nutter, Cole, and Schein 1983)



Date	Temperature High	Low	RH>90 Hours	Infection Risk
07/12	89.6	53.1	0.0	1
07/13	90.3	55.2	0.0	1
07/14	88.8	58.0	0.0	1
07/15	93.3	61.5	0.0	1
07/16	96.4	68.4	0.0	2 RH not high enough
07/17	83.7	69.7	11.3	1
07/18	93.3	67.0	3.0	1
07/19	92.5	70.4	4.3	2 RH not high enough
07/20	88.1	69.0	6.3	2 RH not high enough
07/21	97.1	71.1	9.5	2 RH>90% for 9.5 hours
07/22	99.5	71.1	8.0	2 RH>90% for 8.0 hours
07/23	96.4	71.1	9.0	2 RH>90% for 9.0 hours
07/24	97.1	68.4	7.5	2 RH>90% for 7.5 hours
07/25	97.9	72.5	6.8	2 RH not high enough
07/26	88.8	71.8	4.5	2 RH not high enough

The **Pythium Blight** model requires **air temperature** and **relative humidity** data.

For information concerning the **Select Report** and **Where and When** screens, please refer to the **Tools** section of the **SpecWare Software Users Guide**. The ability to **Forecast** weather data is not available for **Pythium Blight**.

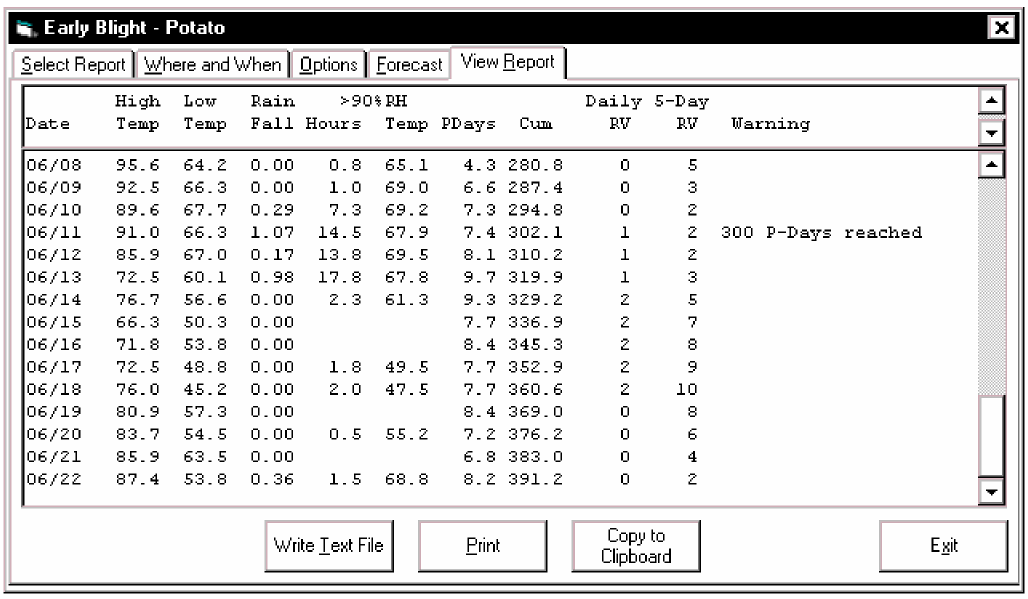
Both the low and the high temperatures must attain a certain level. On the **Options** screen, specify the **Low Temperature Over** and **High Temperature Over** limits. Also specify the **Minimum Hours > 90% RH**. The generally accepted temperatures are 68°F and 86°F. The generally accepted hours of relative humidity greater than 90% needed to trigger **Pythium Blight** range from 9 to 18. Consult with your State Agricultural Extension Service for further information regarding appropriate values for your area.

Pythium Blight (continued)

On the **View Report** screen, the **Pythium Blight** disease model will give an **Infection Risk** index of 0-3. There are three thresholds that need to be met for the onset of **Pythium Blight**. If none or one are met, the Infection Warning will be blank. If 2 or 3 of the thresholds are met, the software will tell you how many are met, and which still need to be met for the continued progression of the disease.

Early Blight - Potato

SpecWare will predict sporulation and thereby the secondary spread of the **Early Blight** pathogen on potato leaves. (Stevenson, Binning, Connell, Wyman, and Curwen 1996)



Date	High Temp	Low Temp	Rain Fall	>90%RH Hours	Temp	PDays	Cum	Daily RV	5-Day RV	Warning
06/08	95.6	64.2	0.00	0.8	65.1	4.3	280.8	0	5	
06/09	92.5	66.3	0.00	1.0	69.0	6.6	287.4	0	3	
06/10	89.6	67.7	0.29	7.3	69.2	7.3	294.8	0	2	
06/11	91.0	66.3	1.07	14.5	67.9	7.4	302.1	1	2	300 P-Days reached
06/12	85.9	67.0	0.17	13.8	69.5	8.1	310.2	1	2	
06/13	72.5	60.1	0.98	17.8	67.8	9.7	319.9	1	3	
06/14	76.7	56.6	0.00	2.3	61.3	9.3	329.2	2	5	
06/15	66.3	50.3	0.00			7.7	336.9	2	7	
06/16	71.8	53.8	0.00			8.4	345.3	2	8	
06/17	72.5	48.8	0.00	1.8	49.5	7.7	352.9	2	9	
06/18	76.0	45.2	0.00	2.0	47.5	7.7	360.6	2	10	
06/19	80.9	57.3	0.00			8.4	369.0	0	8	
06/20	83.7	54.5	0.00	0.5	55.2	7.2	376.2	0	6	
06/21	85.9	63.5	0.00			6.8	383.0	0	4	
06/22	87.4	53.8	0.36	1.5	68.8	8.2	391.2	0	2	

The **Early Blight - Potato** model requires **air temperature**, **relative humidity**, and **rainfall** data.

For information concerning the **Select Report, Where and When,** and **Forecast** screens, please refer to the **Tools** section of the **SpecWare Software Users Guide**. There are no **Options** to be entered for **Early Blight.**

On the **View Report** screen, the **P-Days** and **RV**'s (Rating Values) are shown. The **P-Day** is a measure of the temperature conditions contributing to potato growth. Potatoes grow between 45°F and 86°F with the optimum temperature being 70°F. The calculation of P-Days

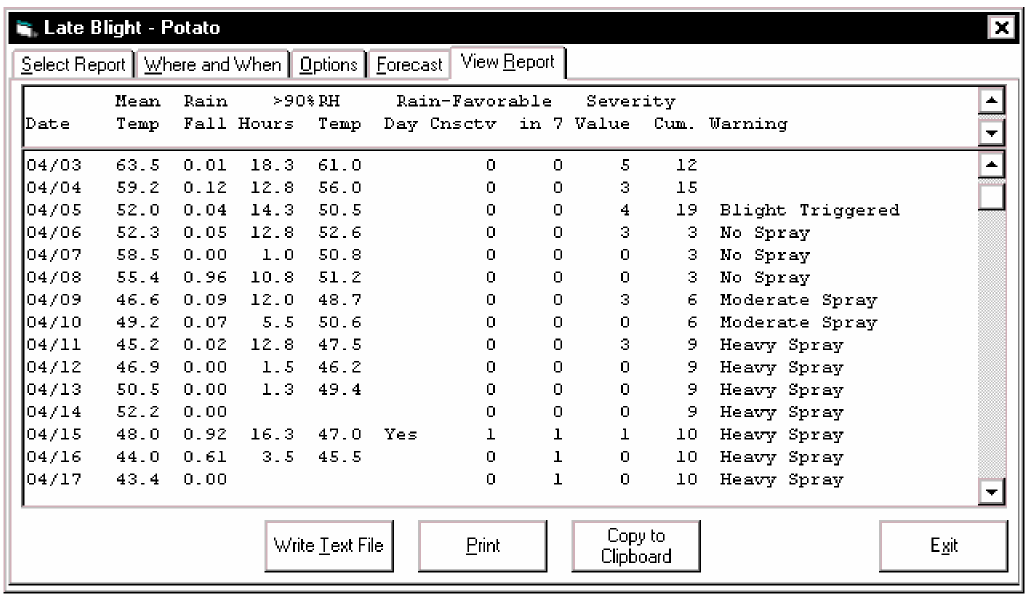
Early Blight - Potato (continued)

assumes that the plants spend three hours at the maximum temperature for the day, five hours at the minimum temperature for the day and the remaining 16 hours between the daily maximum and minimum temperature. No **P-Days** are accumulated below 45°F or above 86°F. Spray applications are not recommended for **Early Blight** control until **300 P-Days** have accumulated. The **Warning** column indicates when this threshold has been reached.

The spray interval for **Early Blight** is indicated by the **RV** (Rating Value). The **RV** is a result of the accumulation of P-Days, hours of relative humidity, and rainfall. The **5-day RV** is used to establish the appropriate spray interval for the crop. Contact your State Agricultural Extension Service for more information about using the **RV** for timing **Early Blight** sprays.

Late Blight - Potato

SpecWare predicts the spread of the **Late Blight** pathogen on potato leaves using BLITECAST (Krause, Massie, and Hyre 1975).



Date	Mean Temp	Rain Fall	>90%RH Hours	Temp	Rain-Favorable Day	Cnsctv	in 7	Severity Value	Cum.	Warning
04/03	63.5	0.01	18.3	61.0		0	0	5	12	
04/04	59.2	0.12	12.8	56.0		0	0	3	15	
04/05	52.0	0.04	14.3	50.5		0	0	4	19	Blight Triggered
04/06	52.3	0.05	12.8	52.6		0	0	3	3	No Spray
04/07	58.5	0.00	1.0	50.8		0	0	0	3	No Spray
04/08	55.4	0.96	10.8	51.2		0	0	0	3	No Spray
04/09	46.6	0.09	12.0	48.7		0	0	3	6	Moderate Spray
04/10	49.2	0.07	5.5	50.6		0	0	0	6	Moderate Spray
04/11	45.2	0.02	12.8	47.5		0	0	3	9	Heavy Spray
04/12	46.9	0.00	1.5	46.2		0	0	0	9	Heavy Spray
04/13	50.5	0.00	1.3	49.4		0	0	0	9	Heavy Spray
04/14	52.2	0.00				0	0	0	9	Heavy Spray
04/15	48.0	0.92	16.3	47.0	Yes	1	1	1	10	Heavy Spray
04/16	44.0	0.61	3.5	45.5		0	1	0	10	Heavy Spray
04/17	43.4	0.00				0	1	0	10	Heavy Spray

The **Late Blight - Potato** model requires **air temperature**, **relative humidity**, and **rainfall** data.

For information concerning the **Select Report, Where and When,** and **Forecast** screens, please refer to the **Tools** section of the **SpecWare Software Users Guide**. It is recommended that the earliest **Process Date** on the **Where and When** screen be the date that distinct green rows are seen in the field.

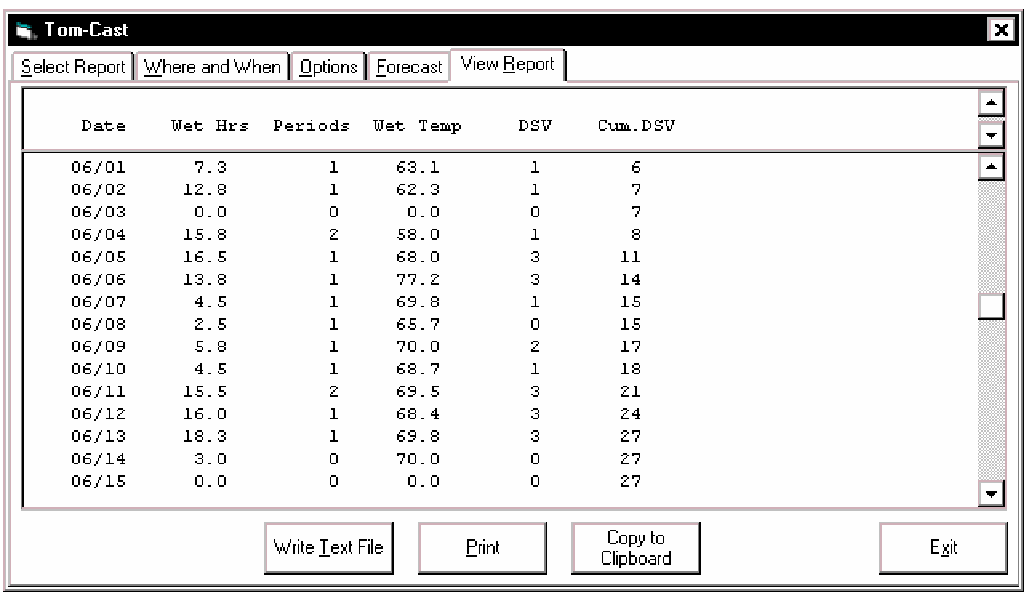
On the **Options** screen, enter the **Blight First Forecast Date** (as predicted or observed) to limit the calculation for the progression of the disease only to later dates. The ability to enter the **Blight First Forecast Date** allows SpecWare to avoid having to spend time recalculating the initial infection date every time the model is used. Enter the **Last Spray Date** as a record of spray activity. Click on **Save Parameters** to avoid having to re-enter the dates.

Late Blight - Potato (continued)

On the **View Report** screen, **Rain-favorable Days**, **Severity Value** and spray **Warning** are reported. Cool, wet weather with periods of relative humidity greater than 90% provide ideal growing conditions for **Late Blight**. **Hyre** and **Wallin** have each developed methods for predicting the initial occurrence of **Late Blight**. Once **Late Blight** is triggered, a single method, common to both Hyre and Wallin, is employed to predict the progression of the disease. Accumulation of **Rain-favorable Days** and **Severity Values** begins at plant emergence. **Severity Values** are based on the average temperature and the number of hours the crop experiences 90% or greater relative humidity during that period. The warning, **Blight Triggered**, initially occurs with the accumulation of 10 consecutive **Rain-Favorable** days or with the accumulation of a **Severity Value** of 18. Spray warnings are the result of further accumulations of **Rain-Favorable** days and **Severity Values**.

Tom-Cast

SpecWare uses **Tom-Cast**, a **TOM**ato disease fore**CAST**ing 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.



Date	Wet Hrs	Periods	Wet Temp	DSV	Cum.DSV
06/01	7.3	1	63.1	1	6
06/02	12.8	1	62.3	1	7
06/03	0.0	0	0.0	0	7
06/04	15.8	2	58.0	1	8
06/05	16.5	1	68.0	3	11
06/06	13.8	1	77.2	3	14
06/07	4.5	1	69.8	1	15
06/08	2.5	1	65.7	0	15
06/09	5.8	1	70.0	2	17
06/10	4.5	1	68.7	1	18
06/11	15.5	2	69.5	3	21
06/12	16.0	1	68.4	3	24
06/13	18.3	1	69.8	3	27
06/14	3.0	0	70.0	0	27
06/15	0.0	0	0.0	0	27

The **Tom-Cast** model requires **air temperature** and **leaf wetness** data.

For information concerning the **Select Report** and **Where and When** screens, please refer to the **Tools** section of the **SpecWare Software Users Guide**. The ability to **Forecast** weather data is not available for **Tom-Cast**.

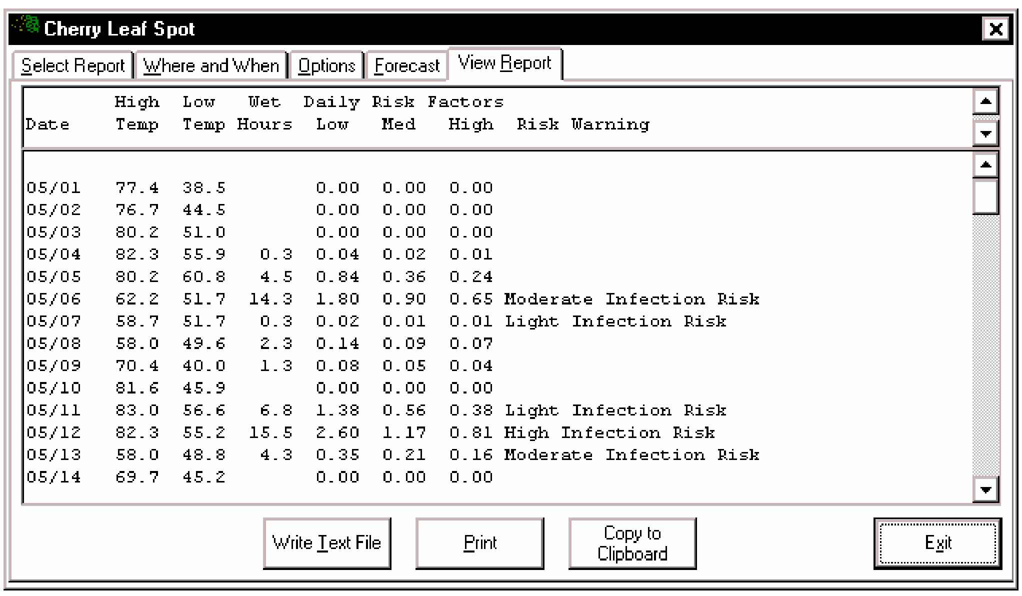
On the **Options** screen, Specify the **Temperature Base**, **Upper Limit** and leaf **Wetness Threshold**.

Tom-Cast (continued)

On the **View Report** screen, an increasing number of leaf wetness hours and a higher temperature cause the **DSV** (disease severity value) 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.

Cherry Leaf Spot

The pathogen responsible for **Cherry Leaf Spot** is *Blumeriella jaapi*. It is a fungus that overwinters in diseased leaves. Primary inoculum spores are released into the air. The secondary inoculum (that which follows the first infection) is splash dispersed. The ability of the inoculum to infect depends on temperature and leaf wetness (Jones and Sutton 2001).



Date	High Temp	Low Temp	Wet Hours	Daily Risk Factors Low	Med	High	Risk Warning
05/01	77.4	38.5		0.00	0.00	0.00	
05/02	76.7	44.5		0.00	0.00	0.00	
05/03	80.2	51.0		0.00	0.00	0.00	
05/04	82.3	55.9	0.3	0.04	0.02	0.01	
05/05	80.2	60.8	4.5	0.84	0.36	0.24	
05/06	62.2	51.7	14.3	1.80	0.90	0.65	Moderate Infection Risk
05/07	58.7	51.7	0.3	0.02	0.01	0.01	Light Infection Risk
05/08	58.0	49.6	2.3	0.14	0.09	0.07	
05/09	70.4	40.0	1.3	0.08	0.05	0.04	
05/10	81.6	45.9		0.00	0.00	0.00	
05/11	83.0	56.6	6.8	1.38	0.56	0.38	Light Infection Risk
05/12	82.3	55.2	15.5	2.60	1.17	0.81	High Infection Risk
05/13	58.0	48.8	4.3	0.35	0.21	0.16	Moderate Infection Risk
05/14	69.7	45.2		0.00	0.00	0.00	

Cherry Leaf Spot requires **temperature** and **leaf wetness** to assess the degree of infection.

For information concerning the **Select Report**, **Where and When** and **Forecast** screens, please refer to the tools section of the **SpecWare Software Users Guide**.

On the **Options** screen, specify the leaf **Wetness Threshold**. A typical setting is 6. The sensor range is from 0-15. This is a relative scale so no value is attached to the reading.

Cherry Leaf Spot (continued)

An unusual aspect of the model is the “risk factor”. The models were originally designed to determine the risk of infection at a constant temperature for a certain period of leaf wetness. However, in the field, temperature is rarely constant. Unfortunately, there is no data on this subject and shifts in temperature create a situation where an infection interval is not flagged because the average temperature was too low while the actual temperature during a portion of the wetness period was sufficient for an infection. A tool for assessing the temperature shifts during a wetness period is the “risk” rating. Basically, if the model is run on a 15 minute interval, the risk of infection at that point is calculated. For example if at a certain temperature, 8 hours of wetness are required and it is wet at that temperature for 1 hour, the risk is 1/8. If the sum of the risks is 1 or greater, there has been, in all likelihood, an infection period and the period is flagged as such.

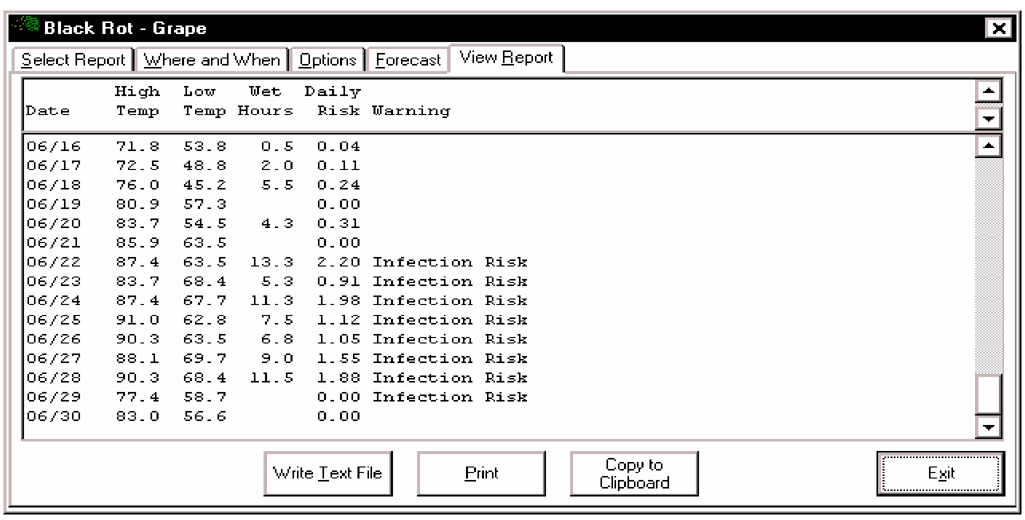
There are three levels of infection risk; light, moderate and high. The user can decide what risk level is acceptable for economic control.

The **View** option gives a report of the **temperature, leaf wetness, infection flag/ warning**, and the **risk factor**.

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 (Spotts 1977)



The **Black Rot** model requires **air temperature** and **leaf wetness** data.

For information concerning the **Select Report**, **Where and When** and **Forecast** screens, please refer to the tools section of the **SpecWare Software Users Guide**.

On the **Options** screen, specify the **Wetness Threshold** or the point on the scale the operator wishes to consider the leaf to be wet (the scale is 0-15). A typical threshold is 6.

Black Rot (continued)

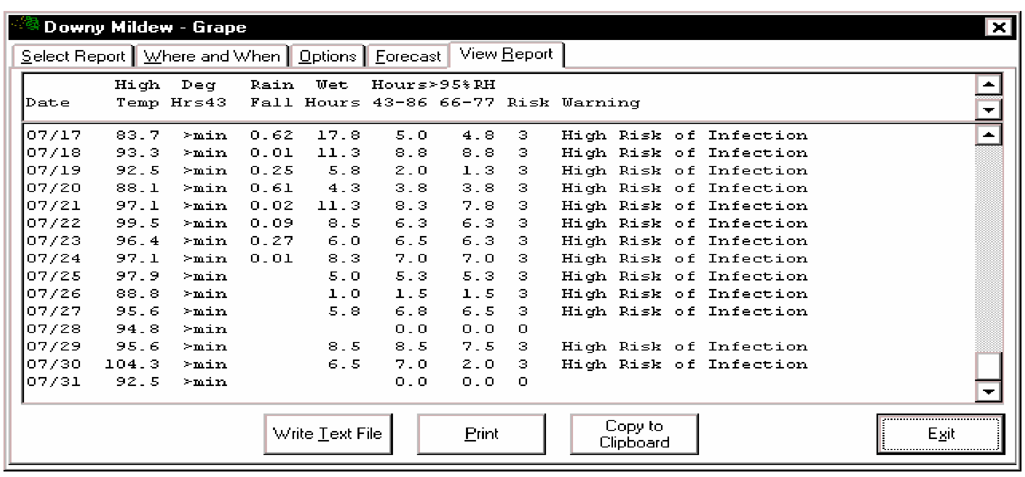
This model uses **temperature** and **leaf wetness** period to estimate the onset of an infection period. The temperature is compared with the period of leaf wetness needed to produce an observable infection. If the wetness period exceeds the required period for that temperature, the period is given an **infection flag/ warning.**

An unusual aspect of the model is the "risk factor." The models were originally designed to determine the risk of infection at a constant temperature for a certain period of leaf wetness. However, in the field, temperature is rarely constant. Unfortunately, there is no data on this subject and shifts in temperature create a situation where an infection interval is not flagged because the average temperature was too low while the actual temperature during a portion of the wetness period was sufficient for an infection. A tool for assessing the temperature shifts during a wetness period is the "risk" rating. Basically, if the model is run on a 15 minute interval, the risk of infection at that point is calculated. For example, if at a certain temperature, 8 hours of wetness are required and it is wet at that temperature for 1 hour, the risk is 1/8. If the sum of the risks is 1 or greater, there has been, in all likelihood, an infection period and the period is flagged as such. This approach is more conservative than constant temperature since it may include borderline events.

The **View** option gives a report of the **temperature, leaf wetness, infection flag/ warning**, and the **risk factor**.

Downy Mildew

Downy Mildew is caused by the pathogen *Plasmapora viticola.* The pathogen overwinters in dead leaves and sometimes in dead berries and shoots. The initial inoculum or liberated spores are splash dispersed. After the initial round of infection, a secondary cycle of spores is started which are splash or wind dispersed. Once a secondary spore lands on a leaf (or twig or grape cluster), it can germinate in a short period of time if a thin film of water is present. Depending on humidity and temperature, the infection takes 5 to 18 days to develop new inoculum. An understanding of the wetness periods when infection might occur will help in the proper timing of fungicide applications. This model notes when primary infection could occur and when secondary infection is possible. The model is based on Cornell University, UC-Davis, and University of Illinois spray recommendations.



Date	High Temp	Deg Hrs43	Rain Fall	Wet Hours	Hours>95%RH 43-86	66-77	Risk	Warning
07/17	83.7	>min	0.62	17.8	5.0	4.8	3	High Risk of Infection
07/18	93.3	>min	0.01	11.3	8.8	8.8	3	High Risk of Infection
07/19	92.5	>min	0.25	5.8	2.0	1.3	3	High Risk of Infection
07/20	88.1	>min	0.61	4.3	3.8	3.8	3	High Risk of Infection
07/21	97.1	>min	0.02	11.3	8.3	7.8	3	High Risk of Infection
07/22	99.5	>min	0.09	8.5	6.3	6.3	3	High Risk of Infection
07/23	96.4	>min	0.27	6.0	6.5	6.3	3	High Risk of Infection
07/24	97.1	>min	0.01	8.3	7.0	7.0	3	High Risk of Infection
07/25	97.9	>min		5.0	5.3	5.3	3	High Risk of Infection
07/26	88.8	>min		1.0	1.5	1.5	3	High Risk of Infection
07/27	95.6	>min		5.8	6.8	6.5	3	High Risk of Infection
07/28	94.8	>min			0.0	0.0	0	
07/29	95.6	>min		8.5	8.5	7.5	3	High Risk of Infection
07/30	104.3	>min		6.5	7.0	2.0	3	High Risk of Infection
07/31	92.5	>min			0.0	0.0	0	

The **Downy Mildew** model requires **leaf wetness, RH,** and **temperature** data to calculate the appearance of spores after the initial infection. For information concerning the **Select Report**, **Where and When** and **Forecast** screens, please refer to the tools section of the **SpecWare Software Users Guide**.

Downy Mildew (continued)

On the **Options** screen, specify the leaf **Wetness Threshold**. A typical setting is 6. The sensor range is from 0-15. This is a relative scale so no value is attached to the reading.

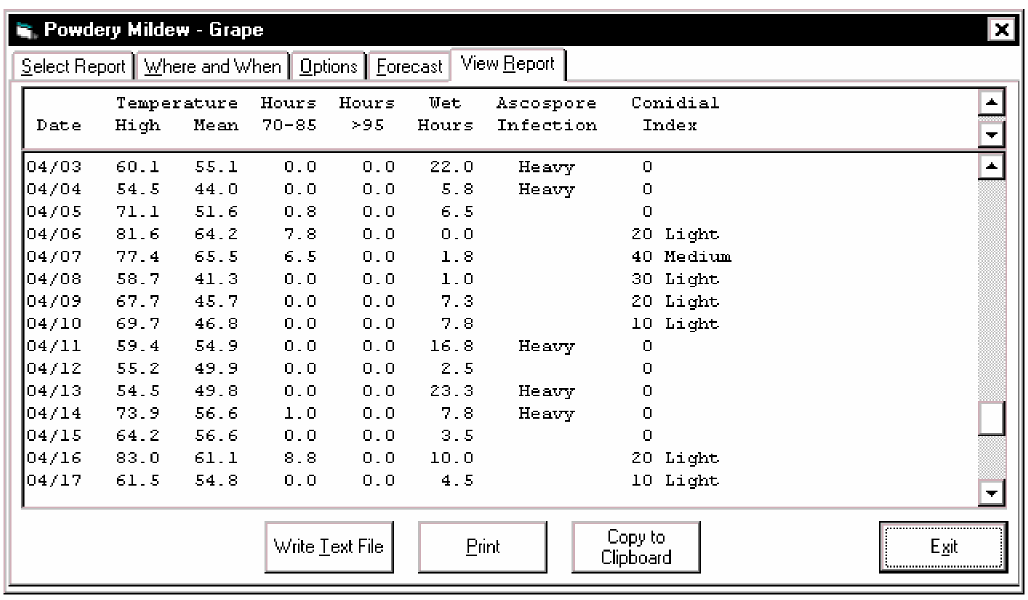
The model estimates three levels of infection likelihood. The grower can determine which level is appropriate for his/ her operation. In general, the IPM program usually begins when the minimum risk level is achieved.

The risk is measured on a scale of 1 to 3. Level 1, or **Possible Infection,** means that an infection can occur but conditions (or at least 1 condition) are not optimal. Thus, the infection could be lighter or the risk is the lowest possible while still having a chance of infection. Level 2 represents **Medium Risk of Infection.** Level 3, or **High Risk of Infection,** means that conditions are optimal for infection. Individual growers can assess which level of risk meets their vineyard's management needs.

The model begins at any point above 43ºF. The primary infection starts at that point. From then on, the model estimates the risk of infection from secondary inoculum resulting from the primary infection.

Powdery Mildew - Grape

SpecWare 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



The **Powdery Mildew** models require **air temperature** and **leaf wetness** data.

For information concerning the **Select Report** and **Where and When** screens, please refer to the **Tools** section of the **SpecWare Software Users Guide**. The ability to **Forecast** weather data is not available for **Powdery Mildew**.

On the **Options** screen, specify the **Temperature Base, Upper Limit** and leaf **Wetness Threshold**.

Powdery Mildew - Grape (continued)

On the **View Report** screen, **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 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 hours between 70°F and 85°F. The index decreases by 10 on days with less than six 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.

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

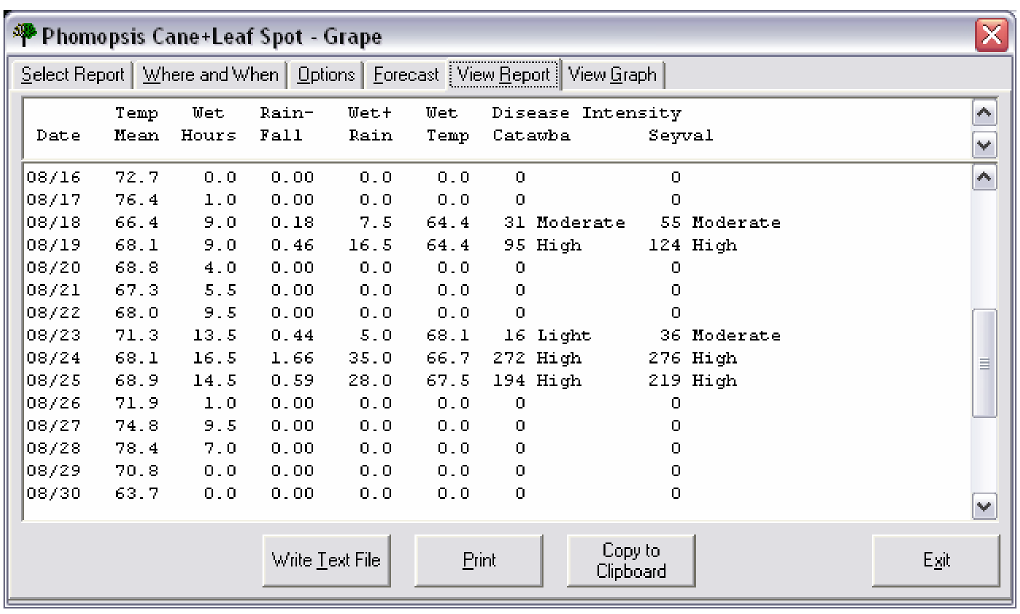
Phomopsis Cane Leaf Spot - Grape

SpecWare has one model for Phomopsis Cane Leaf Spot. (Nita et al. 2006) It shows the risk of this disease as tested on two different varieties, Catawba and Seyval. Based on weather parameters, SpecWare will calculate the risk as expected number of lesions per leaf.

1 – 30 = light infection risk

31 – 90 = medium infection risk

90 + = heavy infection risk



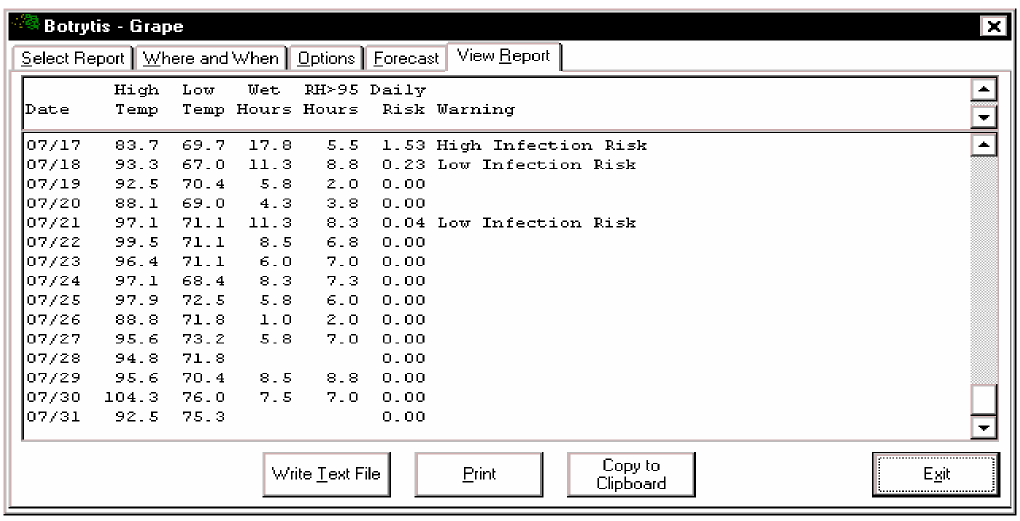
Date	Temp Mean	Wet Hours	Rain-Fall	Wet+ Rain	Wet Temp	Disease Intensity Catawba	Seyval
08/16	72.7	0.0	0.00	0.0	0.0	0	0
08/17	76.4	1.0	0.00	0.0	0.0	0	0
08/18	66.4	9.0	0.18	7.5	64.4	31 Moderate	55 Moderate
08/19	68.1	9.0	0.46	16.5	64.4	95 High	124 High
08/20	68.8	4.0	0.00	0.0	0.0	0	0
08/21	67.3	5.5	0.00	0.0	0.0	0	0
08/22	68.0	9.5	0.00	0.0	0.0	0	0
08/23	71.3	13.5	0.44	5.0	68.1	16 Light	36 Moderate
08/24	68.1	16.5	1.66	35.0	66.7	272 High	276 High
08/25	68.9	14.5	0.59	28.0	67.5	194 High	219 High
08/26	71.9	1.0	0.00	0.0	0.0	0	0
08/27	74.8	9.5	0.00	0.0	0.0	0	0
08/28	78.4	7.0	0.00	0.0	0.0	0	0
08/29	70.8	0.0	0.00	0.0	0.0	0	0
08/30	63.7	0.0	0.00	0.0	0.0	0	0

The **Phomopsis Cane Leaf Spot** model requires **air temperature, leaf wetness**, and **rain** data.

For information concerning the **Select Report** and **Where and When** screens, please refer to the **Tools** section of the **SpecWare Software Users Guide**.

Botrytis-Grape

The disease **Botrytis** is caused by the pathogen *Botrytis cinerea*. The pathogen is spread in the air and infects primarily post veraison berries and flowers. The disease develops best in cool humid weather. It appears as gray, cottony structures on the infected plant parts.



Date	High Temp	Low Temp	Wet Hours	RH>95 Hours	Daily Risk	Warning
07/17	83.7	69.7	17.8	5.5	1.53	High Infection Risk
07/18	93.3	67.0	11.3	8.8	0.23	Low Infection Risk
07/19	92.5	70.4	5.8	2.0	0.00	
07/20	88.1	69.0	4.3	3.8	0.00	
07/21	97.1	71.1	11.3	8.3	0.04	Low Infection Risk
07/22	99.5	71.1	8.5	6.8	0.00	
07/23	96.4	71.1	6.0	7.0	0.00	
07/24	97.1	68.4	8.3	7.3	0.00	
07/25	97.9	72.5	5.8	6.0	0.00	
07/26	88.8	71.8	1.0	2.0	0.00	
07/27	95.6	73.2	5.8	7.0	0.00	
07/28	94.8	71.8			0.00	
07/29	95.6	70.4	8.5	8.8	0.00	
07/30	104.3	76.0	7.5	7.0	0.00	
07/31	92.5	75.3			0.00	

The **Botrytis** model requires **air temperature** and **leaf wetness** data.

For information concerning the **Select Report**, **Where and When** and **Forecast** screens, please refer to the tools section of the **SpecWare Software Users Guide**. There are no **Options** to be entered for **Botrytis**.

The model is based on work done at the University of California at Davis. The model is adjusted for temperature and does not calculate values for temperatures greater than 40C. UC-Davis recommends taking action at an index of 0.5 or above.

There are three levels of infection risk; light, moderate and high. The user can decide what risk level is acceptable for economic control. The **View** option gives a report of the **temperature, leaf wetness, infection flag/ warning**, and the **risk factor**.

Disease Model References

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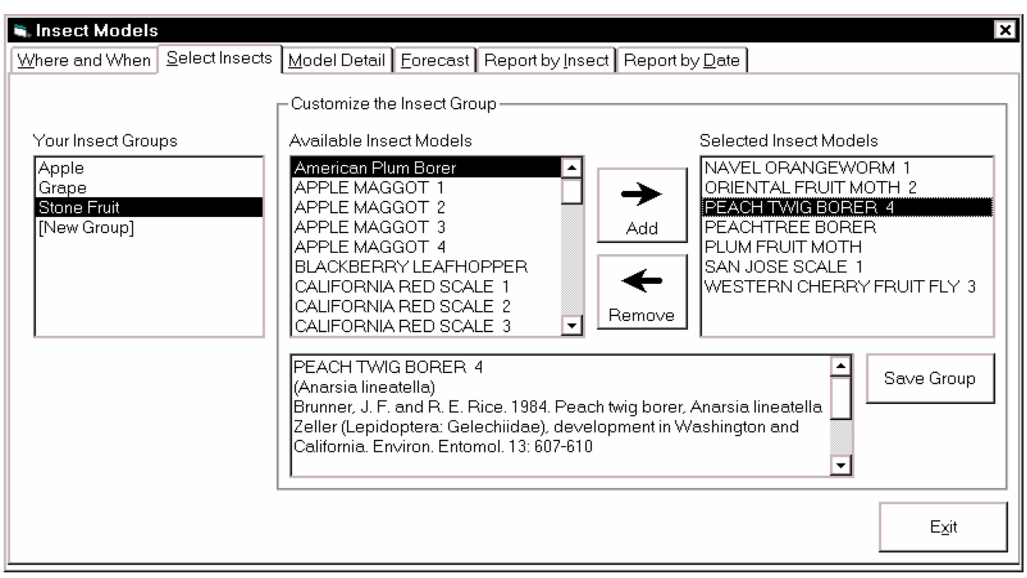
Insect Models

SpecWare uses degree days to predict specific events in the life cycles of pest insects. Pages 40 through 42 of this manual contain a list of the publications that describe each **Insect Model** in significant detail. For information concerning the **Where and When** and **Forecast** screens, please refer to the **Tools** section of the **SpecWare Software Users Guide**.

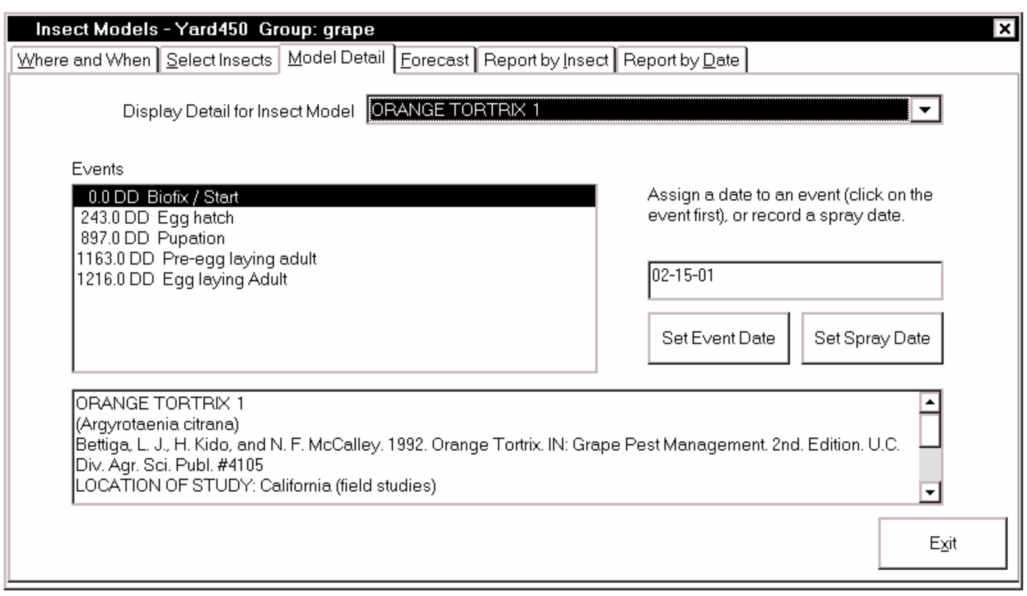
To build a list of crop-specific insects to monitor through the growing season, highlight **[New Group]** on the **Select Insects** screen in the left-hand window. As the **Available Insects** are chosen in the middle window, the citation for that insect model is shown in the text box below the list of insects. Also in the text box is information concerning where the model was developed and on what host plant it was developed. Click the **Add** button to include the model in the **Group**. The maximum number of insect models that can be chosen for each group is twenty. Clicking on a **Selected Insect** in the right-hand window will again display the citation for that model. Highlight and click the **Remove** button to delete an insect from the **Group**. After adding or deleting insects in a **Group**, click on **Save Group**.



Insect Models (continued)

NOTE: To remove a previously saved **Group** from the **Select Insects** screen, use the **Remove** button to remove all of the insect models from the **Group** and then exit **Insect Models**. Upon re-launching **Insect Models**, the **Group** will no longer be present.

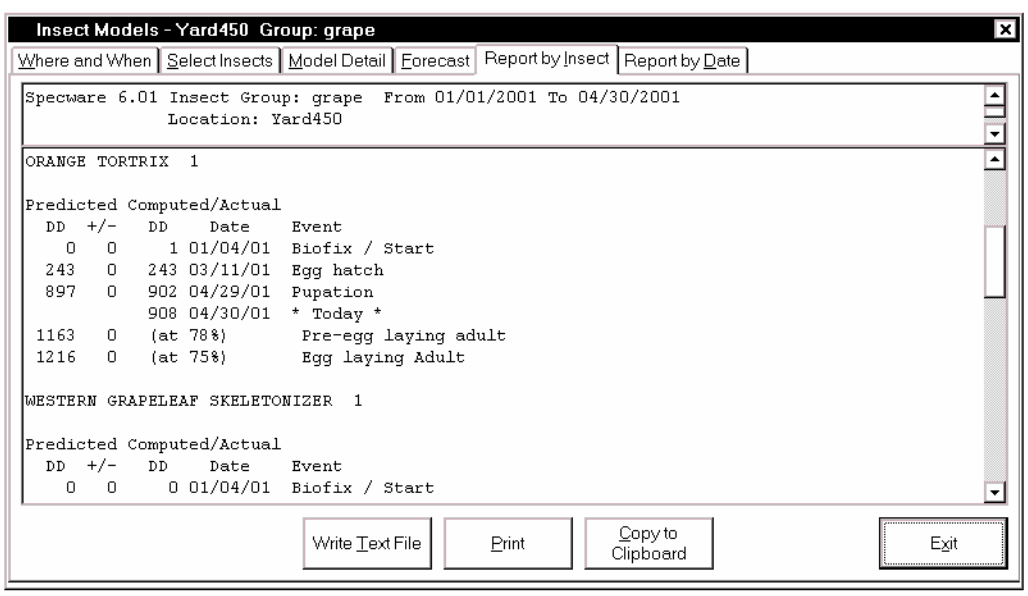
Choosing an **Insect Group** on the **Select Insects** screen and then going to the **Model Detail** screen allows the user to enter separate **Event** and **Spray Dates** for each insect at each logger location. A drop-down menu at the top of the screen lists each of the insects in the chosen **Group**. The left-hand and lower text boxes display the degree day targets for each **Event** and supporting information for each insect model in the **Group**. Highlight the **Event** or **Biofix** in the left-hand box and enter the **Event Date** in the right-hand box. Click **Set Event Date** to record the date. Highlighting **Biofix/Start** and entering a date will cause all subsequent **Events** to be calculated using that date as a starting point. To mark **Spray Dates** in the reports, enter the date in the right-hand box and click **Set Spray Date**.



Insect Models (continued)

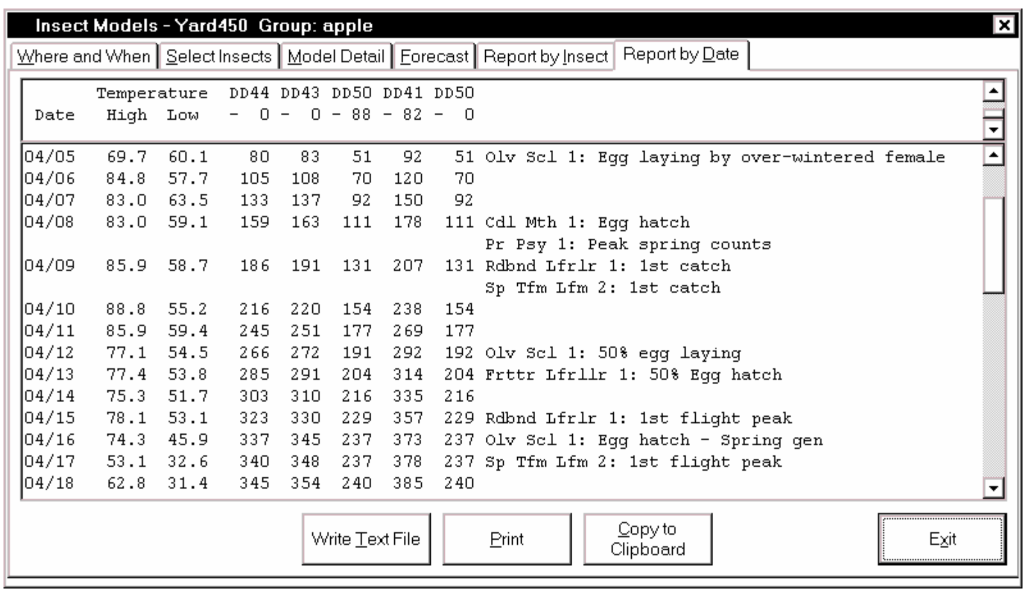
IMPORTANT: It is possible to have multiple generations of a particular insect per year. As the season progresses, not all generations will develop at the same rate. This is due to differences in food quality and in parameters such as relative humidity. Therefore, no attempt was made to extrapolate data from a model published for a single generation to include second and third generations. However, based on the user's personal observations of insect activity as the season progresses, events in subsequent generations can be approximated by updating the **Biofix Date** on the **Model Details** screen.

The **Report by Insect** screen lists the insects in the chosen **Group** and their associated **Events**. For each individual insect model, the first two columns display the **Predicted** degree day accumulations and the range of those degree day predictions for each event. The third and fourth columns show the **Computed** degree day accumulations that have been associated with a particular event and the **Date** of occurrence. For **Events** that have yet to occur, the **Percent** amount of the target degree days that have been met is shown. The fifth column displays the **Event**.



Insect Models (continued)

The **Report by Date** screen displays the modeled insects and their associated events in the sequence in which those events occurred. The **Date** and the daily **High** and **Low** temperatures are shown to the left of the columns of accumulated degree day data. If **Spray Dates** have been entered on the **Model Details** screen, they are also displayed on the **Report by Date** screen.



For both the **Report by Insect** and the **Report by Date** screens, the heading in the upper text box displays the logger **Location** and **Process Dates**. Pertinent information for each model is shown at the bottom of the lower text box.

NOTE: If the upper limit for the temperature range for degree day calculations is displayed as zero (0), the published model did not specify an upper temperature limit and none was assumed.

Insect Model References

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