Degree-day accumulations used to time insecticide treatments to control 1st generation European grapevine moth.

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There are several degree-days models in the European literature that differ in the amount of accumulated heat units needed for each life cycle stage of the European grapevine moth. We are validating the predictions of these models with field observations of various events in the life cycle of the insect during each generation. Field validation is critical. We have preliminary validations from data collected during the 2010 season in California. Here, we provide some predictive degree-days. Once a week, we will post degree-day accumulations from several CIMIS[1] and PestCast stations around the State and we will also post validations as the season progresses (Table 1). We strongly encourage you to continue visiting these websites as we fine-tune the degree-day predictions under California conditions.

Degree-days for this insect are accumulated starting from January 1st with a lower and upper threshold of 10º and 30ºC, respectively (50º and 86ºF). All of the literature reports degree-days in Celsius. To enable us to more easily compare models, we will post degree-day accumulations in Celsius. To obtain degree-day accumulations in Fahrenheit (ºDF) from values provided in degree-days accumulated in Celsius (ºDC) multiply by 1.8 (eg. 150ºDC = 270ºDF).

Timing treatments for the 1st generation

If applying a conventional insecticide for the first generation of European grapevine moth (EGVM) make the application between 250 and 350ºDC (450-594ºDF). This is a period that spans from peak flight (=peak egg laying) to 10% egg hatch.

Central Valley growers opting for two applications for the first generation, make the first application at 250ºDC and the second 14 to 21 days later.

If applying organic insecticides for the first EGVM generation, begin at approximately 300ºDC (540ºDF) and continue weekly depending on population levels.

Accumulated Degree-Days

Because arthropods are cold-blooded, their development is influenced by ambient temperature. Each species requires a specific temperature range for development to occur. If temperatures are too low or too high development stops. The minimum and maximum developmental thresholds have been determined for some species. In warmer weather organisms develop more quickly than in cool weather, but the overall amount of heat required to complete a given organism's development does not vary. The combination of temperature (between thresholds) and time is expressed in units called degree-days. One degree-day results when the average temperature for a day is one degree over the minimum threshold. The accumulation of degree-days begins with either an arbitrary date (eg. January 1st) or a biofix (a biological event). Accumulated degree-days are used to predict when an insect will reach a certain stage in its life cycle.

[1] California Irrigation Management Information System. http://wwwcimis.water.ca.gov/cimis/welcome.jsp

Explanation for this treatment timing MUST READ

The best time to control the first generation is when the highest proportion of larvae are about to emerge from eggs. We know larva emergence is eminent when its black head (cap) is visible inside the egg. Peak flight is when the majority of the eggs are laid. Shortly after peak flight the proportion of eggs with visible black caps increases; shortly after that larvae begin to emerge.

To accurately time insecticide applications for the 1st generation of EGVM, the best approach is to follow the flight and observe egg development. This practice is still used in many regions of Europe. Thus, for conventional insecticides the application is made at 20% black-cap egg stage and for organic or strictly larvicide insecticides when emergence is observed (see CAPCA April 2011 article in our websites for a detailed explanation).

Because EGVM populations in many areas of California are very low, following flights and observation of egg development is not feasible. Therefore we are providing the current best estimate to time the application using degree-days.

Given that insecticides are combined with a powdery mildew treatment, we provide a window for applying a conventional insecticide between peak egg laying when few black-cap eggs are present (250ºDC) and 10% emerged larvae (350ºDC).

The majority of the insecticides currently on the market for conventional and organic production kill the larvae. There are a few **conventional** insecticides that are primarily larvicidal with some ovicidal activity. To maximize the ovicidal properties of these ovicidal/larvicidal insecticides, they must be applied before egg deposition through presence of first larval stage.

However, during the first generation applying an insecticide before egg deposition is not practical because the flower cluster is rapidly expanding (thus coverage is poor) and the egg deposition period is over 4 weeks. Thus if a single treatment is used, it is best to make the application in the period following peak egg laying (250º to 350ºDC). Ovicidal/larvicidal insecticides in addition to killing a percentage of the eggs have a long residue that will last through larva emergence period. If opting to apply two sprays against the first generation, place the first spray at 250ºDC and the second 14 to 21 days later.

Insecticides registered for **organic** production are larvicidal and should be targeted for the beginning of egg hatch (300ºDC). Due to the short residue of organic materials, two or more applications are warranted starting at egg hatch and continuing weekly for as long as larvae are detected.

Validations from 2010

Although a few moths emerged as early as February in 2010 and 2011, some European references state that consistent trap catches begin at approximately 150ºDC from January 1st. Consistent trap catches in the Napa Valley in 2010 started in mid-March at 150ºDC (see Figure 1). As of this writing we have passed 150ºDC in Oakville, Napa County and yet few moths have been caught.

Some references cite peak first flight at 250ºDC ± 56 (Coscolla 1989). Depending on weather, 56ºDC may be ± 6 days at this time of year. In 2010 peak flight in Oakville was on April 19 at 250ºDC and coincided with the first observation of eggs in the black cap stage.

CAUTION when using degree-day accumulations

1) You **cannot use** programs that accumulate degree-day on a 15-minute interval. Degree-day models were developed in the 1980's when methods of accumulating degree-days over a period less than 24 hours were not available. You need to use the minimum and the maximum for the day.
2) **Do not project more than 1 week ahead**. Programs such as the UC IPM degree-day calculator use 30-year averages of daily minimum and maximum temperatures to project future degree-days. These projections are helpful when projecting short periods (a week or so), but are not intended for projecting future conditions over three or more weeks. Daily temperatures differ from a 30-year average, thus the farther into the future the prediction the lower the accuracy.
3) **Continue to check with these websites as we validate the models.** Field sampling and validation are critical components of these models. In 2010, we found that some of the most accurate predictors were not based solely on the flight. For example, to accurately predict the start of the 2nd flight, we needed to know pupation date for the 1st generation larvae.

Figure 1. Male moths caught in Napa County during the first European grapevine moth flight in 2010. Egg laying was first observed at the end of March; peak flight/black-cap was first observed on April 19; and emergence was first observed in early May. Moth catch data provided by USDA, APHIS, PPQ European Grapevine Moth Program.

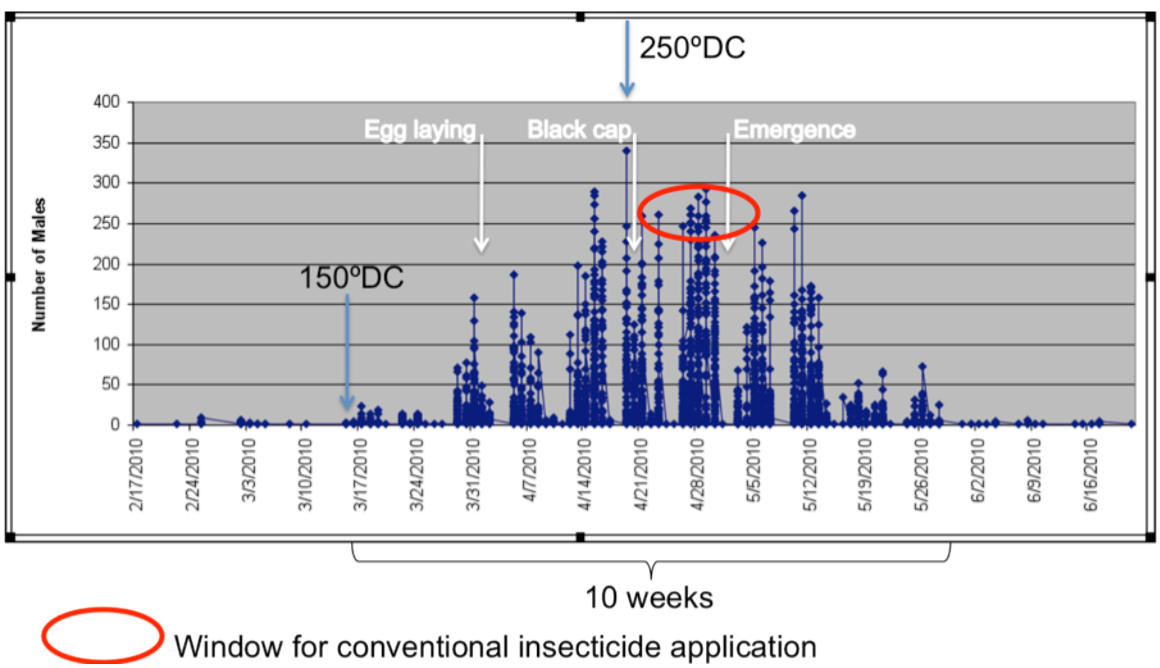

Table 1. Degree-days accumulated from January 1, 2011 in Celsius*

Station**	County	Degree-days (2011)								
		3/13	3/20	3/27	4/3	4/10	4/17	4/24	5/1	5/8
Oakville #77	Napa	160.0	171.1	177.7						
Carneros #109	Napa	153.8	169.2	179.9						
Suisun Vly #123	Solano	147.8	173.5	198.1						
Windsor #103	Sonoma	129.5	136.9	142.4						
Santa Rosa #83	Sonoma	120.7	129.1	134.9						
Bennett Vly #158	Sonoma	134.2	139.2	143.6						
Hopland #106	Mendocino	142.2	148.0	151.6						
Ruddick Ukiah	Mendocino	136.0	140.1	142.3						
Lodi West #166	San Joaquin	115.6	132.2	142.0						
Cressey #41	Merced	93.2	113.1	121.0						
Del Rey (DELF)	Fresno	117.3	141.6	152.1						

*Generated using University of California Integrated Pest Management Program (UC IPM) degree-day calculator, with 10º and 30ºC as minimum and maximum thresholds, respectively. http://www.ipm.ucdavis.edu/WEATHER/ddretrieve.html

**All stations are in the CIMIS or PestCast Networks and daily minimum-maximum temperature data reside on the UC IPM web site.