Codling Moth Development and Model Predictions

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Introduction

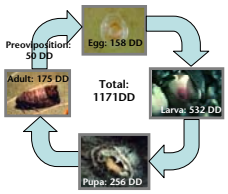
An insect's development is primarily controlled by temperature.

- No physiological means to control body temperature
- Metabolic rates are controlled by external temperature
- Temperature is a better predictor of development than calendar days

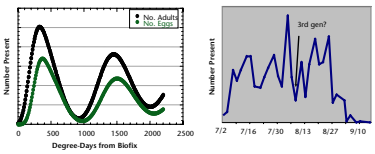
Degree-day (DD) models allow you to predict an event which is difficult to observe but important to IPM, or give advanced warnings of problems

- Predict CM egg hatch to help time insecticide applications
- Size of 3rd CM generation

It is necessary to describe DD requirements for each life stage in the laboratory and validate with field observations. Observations are usually made on undisturbed populations, where temperature is the primary variable.

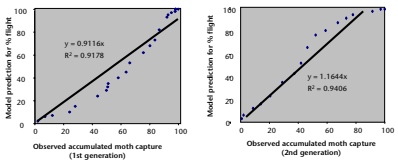


Codling moth
Lower threshold: 50°F
Upper threshold: 88°F



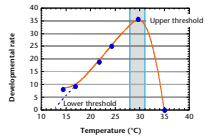
- The mathematical model generates a smooth curve for predicted flight and oviposition
- Normal observations can be extremely variable, and dependent temperature and inspection intervals

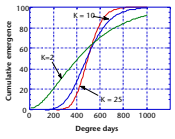
TFREC 2003



✓**The codling moth degree-day model accounted for 90-95% of the the variation in population development at TFREC, Wenatchee.**

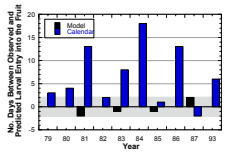
Normal Development





- Development rate increases with temp
- Lower threshold- is temperature where development rate=0
- Upper threshold is between optimal temp and temp where development stops

- Mathematical formulas can be adjusted to match predicted emergence with field observations

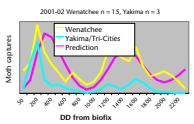


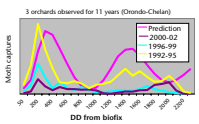
✓**Degree-day models should improve on calendar predictions.**

✓**The ultimate goal for the codling moth model is to predict larval entries.**

How Degree-day Models Work

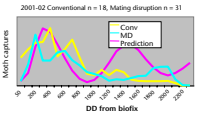
Variations from Prediction

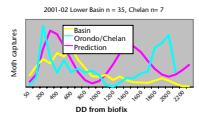




- Model predictions remain consistently accurate for many orchards.

- Variation can occur over time, possibly due to a change in management practices or an influence from outside sources.





- Mating disruption may influence trap captures. A late flight (blue) could be observed as dispensers lose effectiveness.

- Typical variations from prediction can appear as a late emerging 1st generation (yellow) or a prominent late 2nd flight (blue).

Sources of Error

Degree-day models predict development of an undisturbed population. There are several potential sources of error in predicting development at individual orchards.

Some errors can be traced to human mistakes:

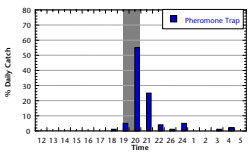
- Not setting the real biofix. Requires a high trap density in low pressure orchards.
- Poor weather data. Errors can have a cumulative effect through the season.

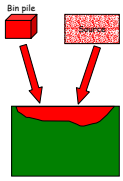
Weather patterns are extremely variable:

- 9 mph wind or 0.8" rain/hr stops flight all together
- Temperatures above development threshold of 50°F, but below flight threshold (62.5°F) at dusk. Adults continue to emerge, when temperatures go over the flight threshold it appears like a large number of moths emerged all at once.
- Winter temperatures can influence overwintering chill-unit accumulations and influence spring emergence.

Normal orchard management can influence model predictions:

- Pesticide applications, overhead cooling and mating disruption may delay normal observations
- Bin piles (see drawing) or other outside sources can introduce a population that is not synchronized with model predictions.





The codling moth DD model consistently predicts development in an undisturbed orchard at WSU, TFREC. However, there is evidence that weather, management practices, outside infestations and possibly some yet to be understood cause have resulted in inaccurate predictions. Some simple measures can be followed to help to alleviate management errors due to a reliance on the degree-day model.

✓**Try to maintain a trap density that is sufficient to monitor even low-pressure orchards. Consider 1 trap/2.5-5 acres. Keep a fresh lure and clean sticky liners in the traps.**

✓**A DD model should be viewed as one tool to help manage CM. A grower's and/or consultant's observations and experience are important elements in a successful IPM program.**

Conclusion