CLIMATE CHANGE AND ITS IMPACT ON PREDICTING CODLING MOTH EMERGENCE

A.L. Knight[1]

[1]Agricultural Research Service, U.S.D.A., Wapato, WA

ABSTRACT

OBJECTIVES

1. Evaluate the effects of warm 'abnormal' warm weather periods during the winter and early spring on the emergence patterns of codling moth.
2. Evaluate whether current predictive models are still accurate during the current period of climate change.

PROCEDURES

Daily maximum and minimum temperature data from three UC weather stations in Kelseyville, Thornton, and Ukiah have been gathered and degree days accumulated with a lower threshold of 10 ^{o}C and an upper horizontal cutoff of 31 ^{o}C from the past ten years have been calculated. Moth catch data from Kelseyville for the past 10 years and from orchards near Thornton for the past seven years have been collected from cooperators. A Biofix date for codling moth was determined for each site based on sustained catch (over two consecutive time periods) across multiple traps and with weather data (daily maximum's > 72 ^{o}F). Degree day accumulations beginning from the first of each month (September to March) until the established Biofix were calculated. The mean DD total from each start date was summed and the coefficient of variation (CV) of the data was determined. A set of reference data (CM eggs and egg hatch) were provided for the Kelseyville site to look at the fit of the Biofix (155 DD are required for egg hatch).

RESULTS

Establishing a Biofix. Several interesting phenomena were observed in this analysis. The start of moth catch in the two sites can range by more than a month between years. There has been a recent trend in earlier flights and more DDs being accumulated during the winter months. The DD totals for the start of flights from the two sites differ, perhaps due to differences in latitude and elevation as suggested by Jones at Washington State. This will be further investigated.

This analysis shows that accumulating DD's from September 1st generates the lowest Coefficient of Variation (least variance among the yearly data sets). This was recently shown in a European study as well. The use of Jan 1st as the start date to accumulate DDs as they do in Washington (DAS) is not as precise as starting in September. These data also show that the last two years have been abnormal with much greater DD summations until Biofix, regardless of the start month compared with the other eight years. At this point, these data suggest that DD accumulations

from a fixed date are not a good approach to predict Biofix. More analysis of this approach as well as defining the decision rules to incorporate daily temperature patterns will be conducted in the upcoming months under this project.

In most years, the established Biofix using moth catches and maximum temperatures was exact. In three cases there were some discrepancies, two minor and one major problem. Explanations for this are likely associated with the ability to sample eggs, the ability of traps under very low moth densities to detect flight, and probably the accuracy of the UC weather station relative to the orchards monitored. Each of these factors can be improved in 2016.

Shape of Emergence Curve. Overwintering CM larvae collected primarily from our pear orchard situated near Moxee, WA have been placed under three temperature regimes that simulate the historical Ukiah site, 2014-2015 Kelseyville, and 2013-2014 Thornton. Grant funds were used to upgrade five Percival units to run daily diurnal temperature curves. The timing of emergence of CM under these different temperature patterns will be determined as they emerge, probably beginning in March. We also have larvae placed outdoors under our 2015-16 temperature data for a fourth data point. Finally, we have just upgraded two more environmental chambers and will use these to simulate a warm versus normal Jan-March temperature regimes using larvae removed from each of the other four regimes. Unfortunately, these data will not be available until after the February 2016 meeting date.

UC IPM Recommendations: The current online information related to CM management will be edited and provided to the Commission later this spring. This will include the latest information for monitoring and managing this important pest.

DISCUSSION

This project has been very successful in accessing CM larvae from our pear orchard, obtaining and setting up environmental chambers with software that can run fluctuating daily temperatures, obtaining 17 years of data for moth flights associated with two weather stations, using maximum temperatures and moth catch to predict a Biofix date for each year, analyze these data across years and the two sites,. The next step of the project will be measuring the emergence curve of the CM cohorts placed under six different temperature regimes. This is expected to begin in March and should mimic the flight patterns of the overwintering CM populations in CA.

It is clear that the ability to predict CM emergence and the shape of the emergence curve is helped by the collection of accurate validation data. Hopefully, in 2016 we will be able to call on cooperators in the CA pear industry to place traps in high-pressure areas earlier than normal, check a select group of traps twice per week, establish the most representative weather stations to use, sex moths to obtain

prediction of male and female Biofix, and to sample CM eggs to determine the start of egg hatch.

Figure 1. Accumulations of DDs from start of each month to established Biofix dates

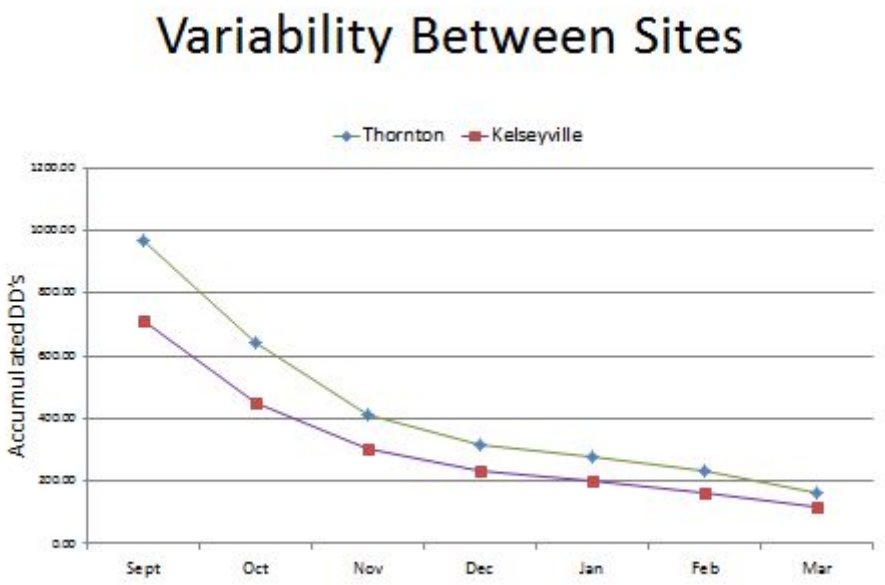

Figure 2. Evaluation of established Biofix dates for Kelseyville backtracking from the date of sampled CM egg hatch.

Year	Stage	DD's from Biofix
2015	Black Egg	106
2014	Hatched egg	154
2013	Hatched	147
2012	Black egg	153
2011	Hatched	79?

2009	Hatched	158
2008	Hatched	120
2007	Hatched	124

Figure 3. The variability (CV) of the mean DD totals beginning at the start of each month until the establish Biofix date.

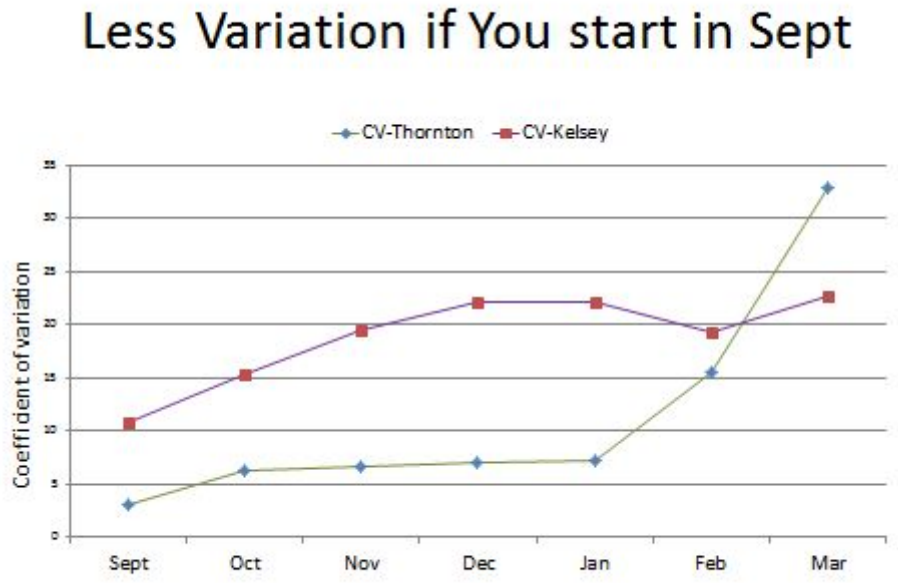

Figure 4. The established Biofix dates for orchards from two pear regions.

Variability in Biofix Dates

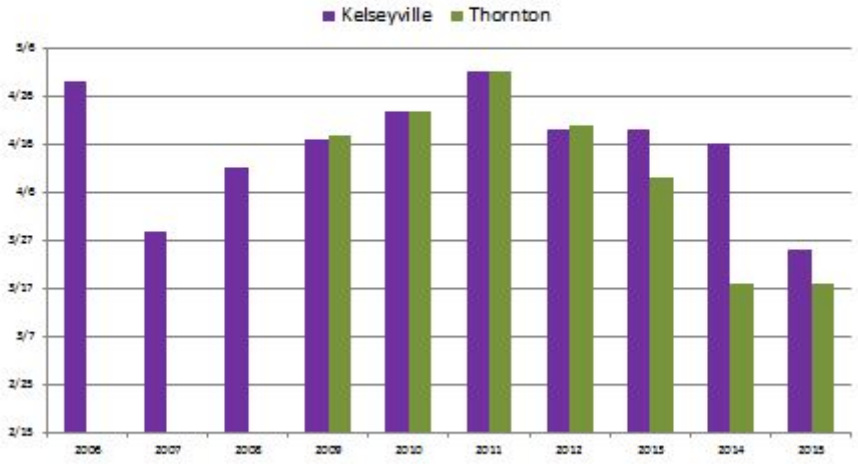

Figure 5. The use of daily maximum temperatures to select Biofix dates