Statewide Monitoring Study to Determine Relationship between Navel Orangeworm (NOW) Egg and Male Moth Capture

Project No.: **14-ENTO13-Tollerup**

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Dani Lightle, UCCE - Glenn/Tehama Counties

Objectives:

1. Evaluate navel orangeworm (NOW) population dynamics over the almond-production region of California from the southern San Joaquin Valley (Kern County) to the Sacramento Valley region (Glenn/Tehama counties).
   a. Determine biofix dates for egg-laying and male-moth capture at several sites throughout the almond-producing regions.
      i. Evaluate the relationship between egg-capture and male-moth capture biofixes.
      ii. Evaluate relationship between intra-season male-moth and egg-laying data.
   b. Evaluate applicability of the UC IPM navel orange worm degree-day model using a male-moth capture biofix.

Interpretive Summary:

During the first year of this study, the 2014 season, we collected male moth and egg trapping data from 18 sites located in eight counties: Kern, Fresno, Madera, Merced, Stanislaus, San Joaquin, Yolo, and Glenn. Trapping began between the first and third week of March at all 18 sites. We began capturing male moths within the first week that traps were placed in the orchards and therefore could not establish a biofix based on male moth capture (**Figure 1 A – G**). Interestingly, other researchers reported capturing male navel orangeworm from late 2013 and throughout early 2014 with only a two-week hiatus during mid-December when low temperatures dropped below freezing. Unlike many other lepidopterous pest species, navel orangeworm does not have a diapause stage (Michelbacher, et al. 1961). The mild winter of 2013-2014 likely played a role in not observing the beginning of male flight i.e., a biofix. With the exception of one site (site forty-eight) egg biofix occurred during April (**Table 1)** and tended to lag behind, a slight peak of male capture (**Figure 1 A – G**). At this first year stage of the study, data do not provide a complete enough picture to determine a relationship between male moth and egg captured, furthermore, 2015 season data have yet to be analyzed.

Materials and Methods:

Sampling Protocol

a. We selected two to three orchards in each of the four growing regions, southern, central, and northern San Joaquin Valley; and Sacramento Valley region for monitoring NOW monitoring using egg traps (ET) and pheromone traps (PT).
   i. ETs consisted of Trécé black NOW egg traps filled with whole almond meal purchased from an almond processor.
   ii. PTs consisted of Suterra or Trécé white-top wing traps baited with a Suterra NOW sex pheromone lure.
   iii. A monitoring set consisted of four ET and a single PT.
      1. Within-set trap spacing was 100 ft between traps and approximately 5 -6 feet above the soil surface in an (ET PT ET ET) configuration. Monitoring sets were placed within tree-rows.
      2. Total ET: (4 regions) x (3 orchards/region) x (3 monitoring sets/orchard) x (4 ET/set) = 144 ET.
      3. Total PT: (4 regions) x (3 orchards/region) x (3 monitoring sets/orchard) x (1 PT/set) = 36 PT
b. Monitoring sets were established in orchards by mid-February; we counted egg and moth numbers weekly from mid-February through September.
   i. White-top wing trap bottoms were replaced as needed.
   ii. Almond meal and pheromone lures were replaced every four weeks.
c. At each orchard site, a HOBO weather data logger was placed within a monitoring set.
d. Data was entered according to a SAS-readable format and sent to Kris Tollerup for analysis.

Results and Discussion:

Pheromone traps began capturing male moths at all 18 sites within the first week of being placed in orchards (**Figure 1 A – G**) therefore we could not establish a biofix based on male moth capture. Biofix base on egg capture (Zalom, et al. 2014) occurred at all sites except one site located in Fresno Co (**Table 1**). With the exception of site forty-eight (Kern Co), egg biofix occurred within a 2-week period between 10 and 21 April (weeks 15 through 17). At site forty-eight egg biofix occurred on 29 April, unusually late. One reason for this observation is that egg traps do not have adequate attraction to detect egg-laying at low populations. Throughout the season, mean male moth capture at site forty-eight remained below two moths per trap.

For discussion in this report, we have included figures of weekly mean (± SEM) male moth and egg capture data from seven sites, a single orchard located in each county (**Figure 1 A – G**). The data represented show typical egg and male moth capture across all sites. Moth capture followed the expected trend of the overwintering, and the 1st, 2nd, and 3rd, generation flights (**Figure 1 A – G**). The overwintering moth populations among the sites was not exceptionally large; weekly male capture typically did not exceed a mean of 75 moths per trap. A decrease in male capture typically occurred over the first generation (**Figure 1 A – G**), then increase during the second and third generation flights (**Figure 1 A – G**). Egg capture followed a similar trend; weekly mean egg capture at all but La Grande did not exceed one egg per trap over the first generation flight. Egg capture again increased during the late second and third flight (**Figure 1 A – G**).

Other than degree days accumulating more rapidly than in previous seasons, degree day heat units accumulated to 1056 by 25 to 30 June at the Kern, Madera, Merced, Yolo, and Glenn counties, and early July at the San Joaquin sites (**Table 1**).

The initiation of egg laying in relationship to male flight was relatively consistent across sites. Our results suggest that the likelihood of egg capture increases when orchard populations reach some threshold; in this case, indicated via male capture exceeding approximately 15 – 20 moths per trap. Additionally, egg capture tended to lag slightly behind upswings of male capture (**Figure 1 A – G**).

At this first year stage of the study, data do not provide a complete enough picture to determine a relationship between male moth and egg capture. However, the data support earlier studies showing that egg traps have a low resolution at low populations. Our data suggest that egg capture may have a predictable lag period once a male moth capture threshold is exceeded. A logistic model may provide a tool for developing a relationship between egg biofix and male moth capture. Such a model could be used to predict the probability that eggs will be captured once a male capture threshold is reached. The benefit of this model is that several independent categorical variables can be employed (UCLA Institute for digital research and education 2014) such as: geographical region, level of sanitation, proximity to pistachio can be added. As this project progresses, we will explore how a logistic and or other models can be used.

Research Effort Recent Publications:

We do not have any recent publications.

References Cited:

Michelbacher, A. E., et al. 1961. The navel oragenworm in northern California. journal of Economic Entomology 3: 559 - 562.

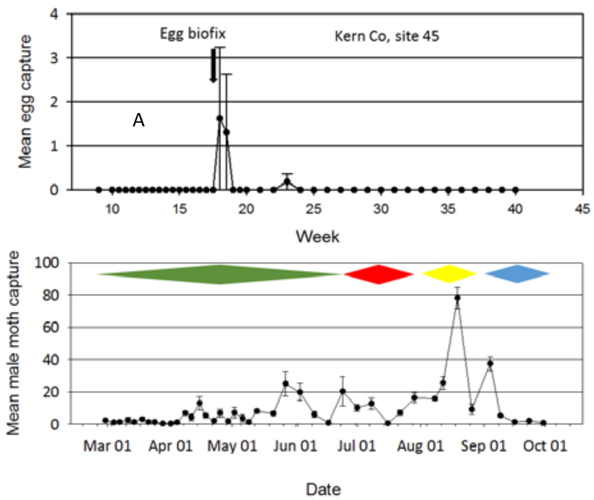
UCLA. Institute for digital research and education 2014. Introduction to SAS. University of California, Los Angeles, http://www.ats.ucla.edu/stat/sas/seminars/sas_logistic/logistic1.htm.

Zalom, F., et al. 2014. UC IPM Online, UC IPM pest management guidelines: almond. U. C. Div. Ag. & Nat. Res. Publ. 3431, Sacramento, CA.

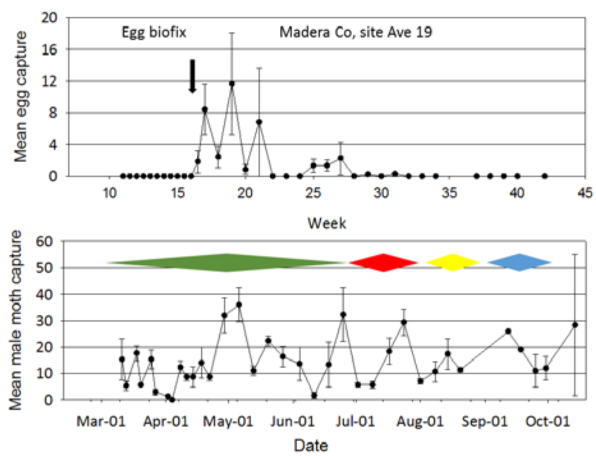
Table 1. Navel orangeworm egg biofix date and date that at which 105-106 degree-day heat units was reached for 17 sites located in seven counties. 2014 season.

Site	County	Biofix (egg)	week	Mean (± SEM) male capture at egg biofix	Date (1056 DD from biofix)
Forty-five	Kern	11-Apr	15	11.2 (2.8)	28-Jun
Forty-eight	Kern	29-Apr	18	1.8 (.5)	30-Jun
Selma	Fresno	no biofix			
Ave 21	Madera	14-Apr	16	26.3 (3.7)	26-Jun
Ave 19	Madera	19-Apr	17	14 (5.9)	28-Jun
Atwater	Merced	14-Apr	16	27.3 (3.1)	24-Jun
B	Merced	14-Apr	16	46 (8.5)	24-Jun
G	Merced	14-Apr	16	0.66 (0.33)	24-Jun
La Grand	Merced	14-Apr	16	63.3 (8)	24-Jun
R	Stanislaus	14-Apr	16	11 (1.7)	24-Jun
Gz	Stanislaus	17-Apr	16	11.7 (2.7)	25-Jun
G	Stanislaus	14-Apr	16	8 (4.4)	26-Jun
Flat Dog	San Joaquin	18-Apr	16	34 (11.1)	4-Jul
DC	San Joaquin	21-Apr	17	18 (1.5)	5-Jul
GB	Yolo	11-Apr	15	5.7 (0.9)	25-Jun
MA	Yolo	10-Apr	15	6.3 (2.8)	25-Jun
H	Glenn	14-Apr	16	35 (5.4)	26-Jun
Vg	Glenn	10-Apr	15	13.3 (2.6)	26-Jun

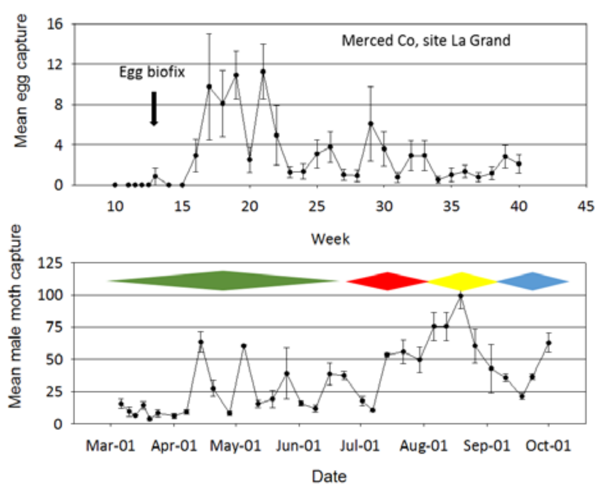
Figure 1 (A – G). Mean male and egg capture during 2014 at seven sites located in A (Kern), B (Madera), C (Merced), D (Stanislaus), E (San Joaquin) F (Yolo), and G (Glenn) counties. Green, red, yellow, and blue diamond indicate overwintering generation, and first, second, and third generations respectively. 2014 Season.



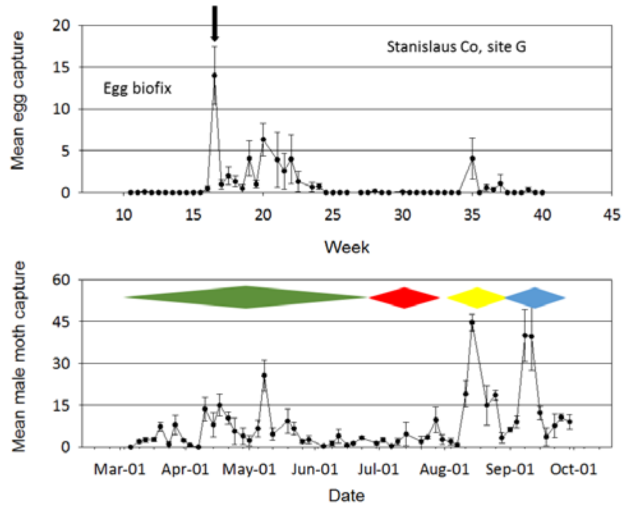
A



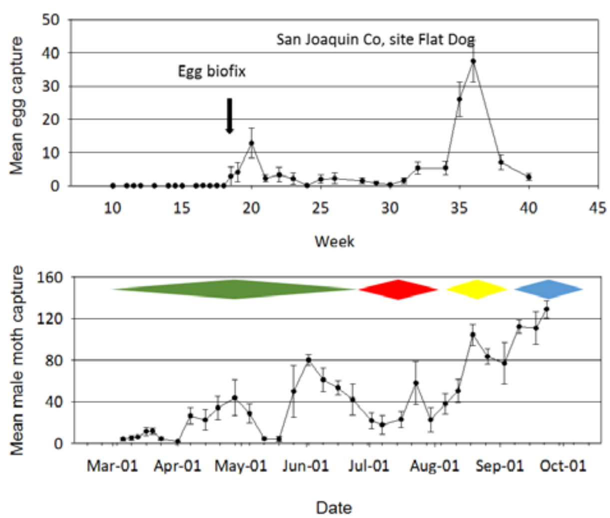
B



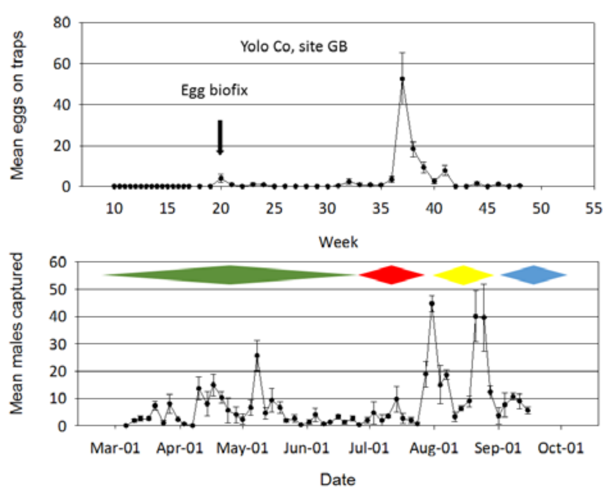
C


Stanislaus Co, site G
Egg biofix
Mean egg capture
Week
Mean male moth capture
Date
Mar-01 Apr-01 May-01 Jun-01 Jul-01 Aug-01 Sep-01 Oct-01

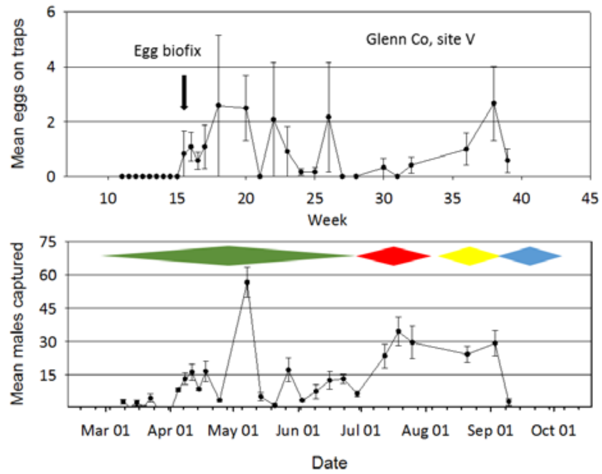
D


San Joaquin Co, site Flat Dog
Egg biofix
Mean egg capture
Week
Mean male moth capture
Date
Mar-01 Apr-01 May-01 Jun-01 Jul-01 Aug-01 Sep-01 Oct-01

E


Yolo Co, site GB
Egg biofix
Mean eggs on traps
Week
Mean males captured
Date
Mar-01 Apr-01 May-01 Jun-01 Jul-01 Aug-01 Sep-01 Oct-01

F


Mean eggs on traps
Egg biofix
Glenn Co, site V
Week
Mean males captured
Date

G