SPRING EMERGENCE PATTERN OF NAVEL ORANGEWORM FROM PISTACHIO AND ALMOND MUMMIES

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The navel orangeworm (NOW, *Amyelois transitella* Walker) is a multivoltine pest that appeared in California's Central Valley in the late 1940's, infesting almonds, figs, pistachios and walnuts; currently it is the primary pest of pistachios and almonds in California. A dramatic expansion of both pistachio and almond plantings (during 1995-2004), to over 251,000 hectares of almonds and 50,000 hectares of pistachios in California has coincided with their increased value (ca. 2.92 billion dollars combined in 2005) which has led to an increased demand to reduce NOW damage.

NOW overwinters in the previous season's crop residue (mummies) without apparent diapause. Emerging females lay eggs on other mummies to continue their life cycle; in subsequent flights, females oviposit on new-crop nuts. New crop almonds become susceptible to infestation approx. late June and NOW development on new crop almonds is faster than on mummies; emerging adults may infest more almonds before harvest. In pistachios, shells open inside the intact hull, therefore most pistachios are not susceptible to NOW infestation until their hulls degrade, typically starting in late August. However, some nuts known as "early splits" become susceptible by early August and in addition, there are numerous small pistachios that we term "pea-split" nuts. These nuts have partially formed shells and readily pop open, beginning late June / early July. Our research goals were to quantify NOW emergence from pistachio and almond mummies, and to determine if late emerging females can oviposit on new-crop nuts.

Pistachio and almond mummies collected from southern Madera County in 2002-2003 were exposed to variable temperature regimes by holding them outdoors fully exposed to ambient conditions; adults were collected twice weekly. For constant temperature regimes we utilized pistachio mummies collected in 2004 in Madera County; and in 2006 almond and pistachios mummies from Madera and Kern counties. These mummies were placed in screen-topped buckets at 26.7 °C; adults were counted weekly. For both variable and constant temperatures, degree-day (DD °C) accumulation from January 1st of each year was determined using the University of California IPM web-based degree day calculator. Degree day

accumulation for outdoor temperature regimes utilized California Meteorological Instrument Stations (CMIS) temperatures. For nuts held at constant temperature, DD accumulation was calculated as: (incubator temp. minus 12.8°C) times # days elapsed; temperatures were recorded with data loggers.

In the variable temperature regime experiment, adult emergence in pistachios showed a single emergence peak and when it ended 75% of the adults had emerged, whereas in almonds there were three emergence peaks and 75% adult emergence occurred at the end of that third peak (Fig. 1). At constant temperatures, NOW emergence from pistachios and almonds followed the same pattern as emergence under variable temperature regimes. Pistachios collected from Madera County had a single emergence peak whereas almonds had two distinct emergence peaks (Fig. 2); but emergence from pistachios ceased 160 degree-days sooner than in almonds. In Kern County mummies (Fig. 3), emergence from almonds lasted an additional 150 degree-days. When the data from both counties were combined, mean emergence (± SD) occurred 19.7% sooner in pistachios ($P < 0.0001$, F with 1 Df = 1,230), 283.4 ± 84.7 DD °C (7,004 adults) compared to almonds, 353.1 ± 151.1 DD °C (10,431 adults). In these pooled datasets, over 9% of the adults emerged during the degree day equivalent of early to late June and in pistachios the last recorded emergence was on the degree-day equivalent of July 15. In 2004-05, pistachios had a single emergence peak (Fig. 4); emergence ceased at the degree-day equivalent of July 15 and was more protracted than in the samples from the other years. About 10% of emergence occurred at the degree-day equivalent of July 1st- to- 15th.

We have demonstrated here that the pattern of NOW adult emergence differed between pistachios and almonds. For both years of the outdoor studies, adult emergence continued into June. Ten-fold larger samples of pistachio and almond mummies held under constant temperature conditions indicated a long tail-out of the emergence and the last moths emerged in the DD-equivalent of June and into early July in two years. Clearly, elements of the first flight (overwintering NOW) "bridge" directly into new crop nuts in some years and perhaps every year in pistachios since "pea-splits" are available early and the number of mummies per acre greatly exceeds our "large" samples. Control of this insect is particularly challenging because the adults from overwintering immatures may emerge for 5 months. Pistachios may be a better target for spring insecticide treatment(s) than almonds because peak emergence is compressed. However, movement between these two nut crops necessitates the development of a coordinated control strategy in order to effectively suppress NOW populations in pistachios and almonds.

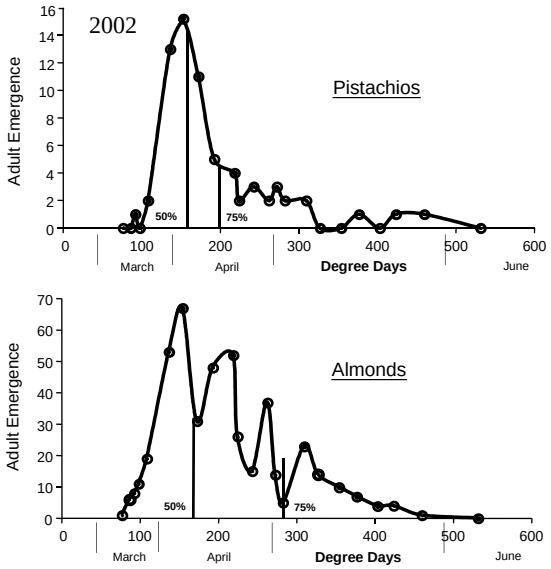

Figure 1. Adult NOW emergence from pistachios and almonds collected in January 2002 from Madera County, CA. Degree-days calculated using CMIS 39.

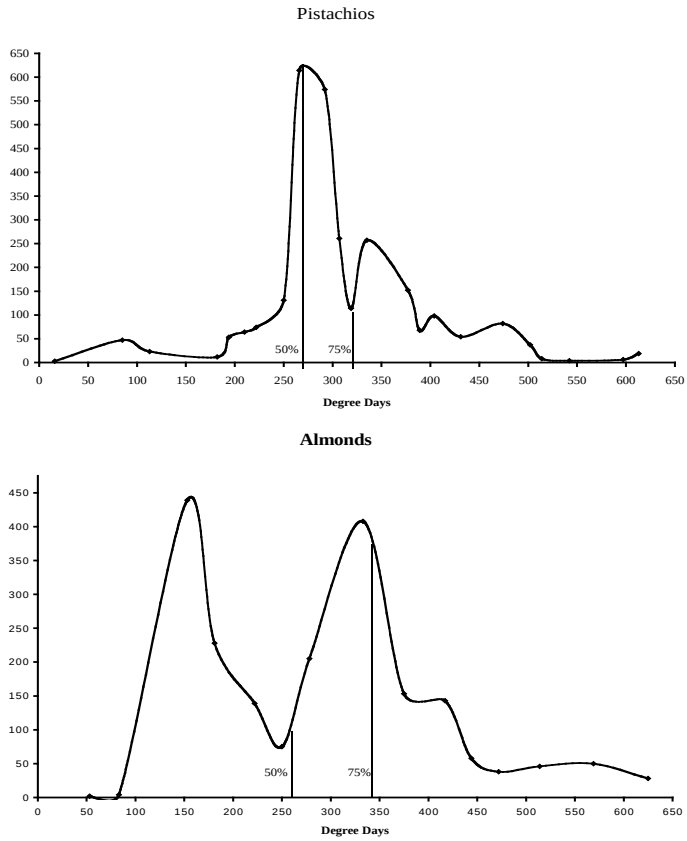

Figure 2. Comparison between adult NOW emergence from almonds and pistachios collected in adjacent orchards in Madera County, CA, January, 2006. Emergence continued in through the degree-day equivalent of June 26, using CMIS 145.

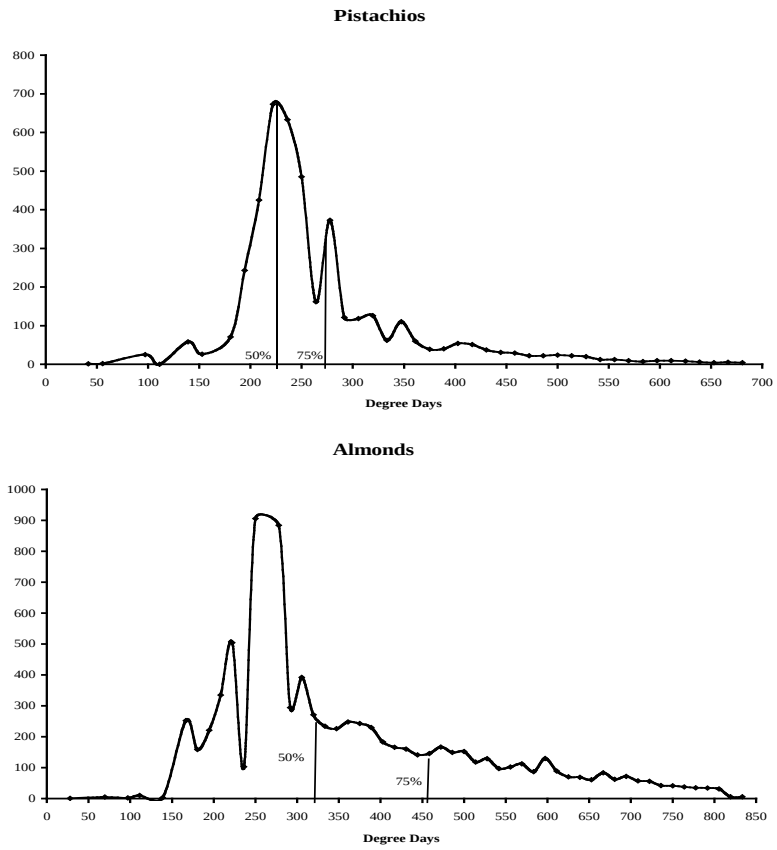

Figure 3. Comparison between adult NOW emergence from almonds and pistachios collected in Kern County, CA, January, 2006. Emergence continued in almonds until the DD equivalent of July 2 and in pistachios until the DD equivalent of June 22, 2006, using CMIS 54.

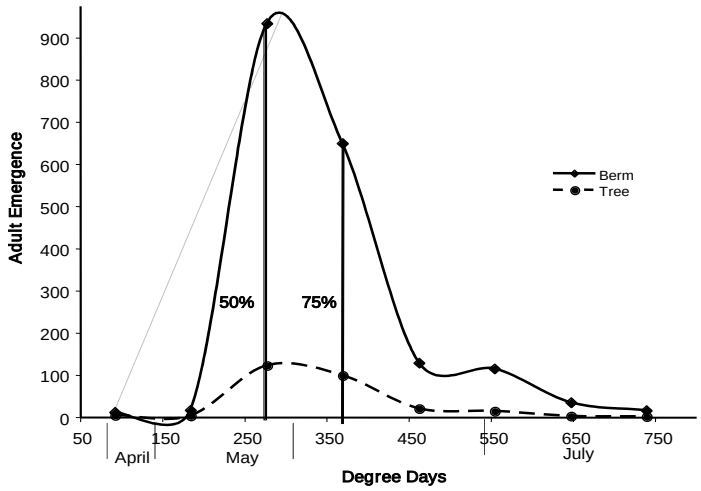

Figure 4. Contrasting NOW emergence from pistachios collected on the ground (berm) and trees from an orchard in Madera County, December, 2004. Emergence continued until the degree-day equivalent of July 15, 2005 using CMIS 145.