Monitoring and modeling oriental fruit moth in California

Richard E. Rice □ William W. Barnett □ Donald L. Flaherty
Walter J. Bentley □ Richard A. Jones

Oriental fruit moth, *Grapholitha molesta* (Busck), has been an important pest of peaches and nectarines in California since the mid-1950s. It is also an occasional pest of other stone and pome fruits and quince. In 1972, development of a sex pheromone trap for oriental fruit moth (OFM) led to increased efforts to monitor OFM populations so that timing of sprays to control the insect could be improved. The following report briefly describes suggested standard OFM trapping techniques. Also discussed is use of a simplified phenology model (showing the relation between climate and the insect's biology) in conjunction with pheromone trap data in making decisions for management of OFM.

The most efficient trap presently available for monitoring OFM is Zoecon's Pherocon I-C trap. These traps consist of a wire frame and hanger, a plastic-coated cardboard top, and a cardboard bottom coated on the inner surface with adhesive material. A rubber cap impregnated with the OFM pheromone is placed within the trap on the sticky bottom.

Traps should normally be placed in orchards by March 1 to collect the first emerged male moths of the season. These early collections are important in later use of the OFM phenology model. The traps should be positioned 6 to 7 feet high on the north or east side of the tree, 1 to 3 feet inside the dripline.

At least two, and preferably three, traps should always be used per orchard or varietal block, regardless of how small the size. Single traps often produce inaccurate data. Suggested optimum trap densities for different acreages are: one trap per each 5 acres, up to 20 to 30 acres; one trap per each 10 acres for 30 to 80 acres; and one trap per each 20 acres in orchards larger than 80 acres. Oriental fruit moth pheromone traps used in this manner will produce typical seasonal collection data similar to those in figure 1.

Traps should be checked and serviced twice weekly, and three times per week during critical flight periods (early March and early May). In most commercial orchards, trap bottoms (liners) are replaced at four-week intervals or when 250 to 300 moths have accumulated and have been removed from a liner over a period of time. The OFM pheromone dispenser (rubber cap) should also be replaced every four to six weeks.

Using seasonal collection and temperature data from California and Michigan for 1972 through 1978, entomologists at Michigan State University were able to develop a fairly simple phenology model for OFM. The threshold and day-degree (D°) values for OFM life stages used in this model are shown in table 1.

In 1979, six peach and nectarine orchards in the central San Joaquin Valley were monitored for OFM, and D° values for each flight

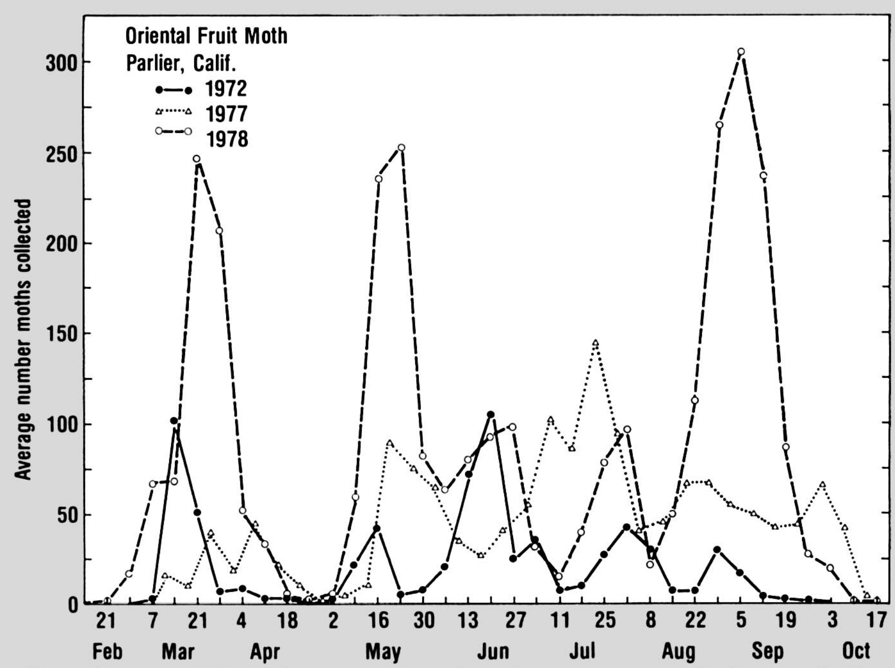

Fig. 1. Seasonal OFM flight patterns based on pheromone trap collections at Parlier, Fresno County; 1977 flights were delayed when compared with other years.

TABLE 1. Threshold and day-degree (D°) values used in the oriental fruit moth phenology model *

OFM development		D° values
Lower threshold	:	45° F
Upper threshold	:	90° F
Pre-oviposition female	:	50 D°
Egg	:	143 D°
First moth to egg hatch	:	193 D°
Larval development	:	387 D°
Pupal development	:	283 D°
Average generation	:	963 ± 46 D°

*The lower threshold is the temperature below which the insect's development stops; the upper threshold the temperature above which the development rate begins to decrease. The amount of heat between the two thresholds that is needed for the insect to develop from one stage to the next is calculated in day-degrees—the degrees of temperature above a threshold for each day.

during the season were calculated using the 45° and 90° F thresholds (see table 2). The observed OFM flights and calculated D° values agree fairly well with the expected D° for a generation. The data in table 2 also show a tendency for the D° values to become somewhat greater with each successive generation. This shift toward higher D° values is thought to be caused by hotter temperatures in mid-summer, but is not of enough concern to invalidate the model.

Another method of comparing observed OFM flights and calculated D° values per generation is shown in figure 2. These data, taken from an untreated mixed block of stone fruits at Parlier, show the accumulated D° between the first moths collected on March 5, and the first moths of each succeeding flight (5/10, 6/15, 7/22, and 8/24). When the D° values are thus plotted along with the moth flight curves, a better understanding of the accuracy of the OFM phenology model can be gained.

After development of this model, the next step is to find ways to use it to advantage in OFM management programs, particularly in relation to the timing of chemical treatments. Dormant sprays do not affect overwintering

Oriental fruit moth adult.

OFM larvae, and foliar sprays in March and April have been difficult to time properly because of inclement weather patterns. The standard approach to OFM control over the years has been to treat the second flight and larval hatch in May, followed by additional treatments as necessary on later flights.

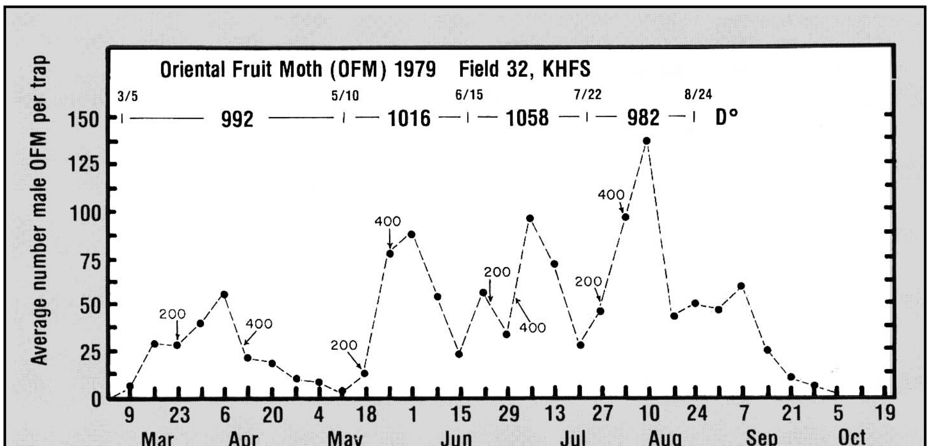

Fig. 2. Day-degree accumulations per OFM generation in untreated stone fruits, Parlier. Dates on upper scale are first moth collection in each flight; numbers 200, 400 on flight curve are D° points after first moth collected in each flight.

TABLE 2. Comparison of day-degree accumulations for the first four oriental fruit moth flights in six central San Joaquin Valley peach and nectarine orchards, 1979

		Day-degrees per generation			
Orchard	First male collected	OW gen.*	1st gen.	2nd gen.	3rd gen.
1	March 6	1009	990	955	1035
2	March 8	732	1027	1084	1164
3	March 6	959	953	926	1036
4	March 10	923	925	1003	1019
5	March 5	992	1016	1058	982
6	March 3	906	1086	1050	895
Average		920	999	1013	1022

*Overwintered generation.

The following hypothetical situation is an example of how the OFM model could be put to commercial use. We know that oriental fruit moth requires approximately 200 D° from the time the first moths are collected in pheromone traps in any given generation until the first eggs begin to hatch in that same generation (table 1). At the same time we know that first egg hatch is generally too early to use as optimum timing for control of hatching larvae in that generation. Therefore, rather than timing chemical control treatments at the beginning of egg hatch (200 D°), we could begin treatment after an additional 200 D° into the generation (fig. 2). The total of 400 D° from first moth would put the time of treatment closer to the observed or expected moth flight peak (current standard practice), and also when first-hatched larvae are in approximately the late second or early third instar stage. Using these criteria, timing of chemical treatments in the first moth flight (March-April) or the preferred second flight (May-June) should provide good control of OFM larvae.

This concept of treating specific generations based on accumulated D° following observed first moth flight and egg hatch has yet to be fully tested under field conditions. But comparisons of these D° values, superimposed upon prior years' observed moth flights, at least provides a point at which to begin evaluating such chemical treatments.

As future models are developed, some data gaps will need to be addressed. In particular, additional data are needed on the effect of high (95° to 110° F) summer temperatures on OFM egg and larval development. The model presently uses an upper threshold value of 90° F, but it is believed that the hot summer temperatures (above 90° F) in the San Joaquin Valley may suppress egg and larval development. This effect would tend to extend the observed generation time for oriental fruit moth into 1100 to 1200 D° accumulated values rather than the expected values of about 920 to 1010 D°. However, in spite of this apparent late-season deficiency in the present model, the consensus is that it is still valid and can be used for many field applications.

Richard E. Rice, Entomologist, Department of Entomology, Davis, is located at the University of California San Joaquin Valley Research and Extension Center, Parlier; William W. Barnett is Area IPM Specialist, Fresno County; Donald L. Flaherty and Walter J. Bentley are Farm Advisors in Tulare and Kern counties, respectively; and Richard A. Jones, Staff Research Associate IV, Department of Entomology, Davis, is located at Parlier.

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