Almond Board Project No. 79-B1: Modelling Population Dynamics
Project Leaders: J. K. Oddson and S. Aggarwal, Department of Mathematics, UCR.

Interpretive Summary

A preliminary version of a computer simulation model that will simulate the population dynamics of a navel orangeworm infestation as it develops in an almond orchard has been developed. In the next phase of the research, we intend to validate and fine tune this model using precise field and laboratory data.

Some Features of the Model: The computer model follows the development of the n.o.w. population throughout the season, keeping track of the insects as they age through the different stages of their life cycle. It includes the following features:

(1) Insect development is based upon day-degree (heat unit) summation which is performed automatically by the computer, from daily maximum and minimum temperature data inserted by the user.

(2) Females oviposit nightly, at a rate which is also keyed to heat unit accumulation, unless the temperature is below the calling/oviposition flight threshold.

(3) Separate tracks are maintained for insect development on tree mummies, ground mummies, and the new crop (after hull-crack) with insects assigned to tracks on the basis of ovipositional preferences and empirical data on crop densities, mummy drop, hull-crack, and the dates of knock and harvest. A distinction between Non-Pareil and pollinator trees has been included but is not yet fully implemented.

(4) Simulation runs may be performed over any period during the year by specifying the start and stop times, and supplying the model with an initial population profile. Such a profile is most easily obtained from pre-season (February) mummy sampling in the orchard, when the population is small and closely grouped within the larval and pupal stages. Later modification of the model may permit the use of egg trapping data in a similar manner.

(5) The model provides the option of inserting chemical sprays, either larvicidal or those which are effective against adults, at times to be specified by the user. Simulation of the effects of other control methods, such as winter knocking and clean-up, are contemplated but not yet implemented.

(6) In operation, the model is presented to the user through interactive software which permits communication in ordinary English. The computer thus queries the user in English for data that is needed for the simulation run and then generates the output data.

Use of the Model: Once the model has been properly validated, it can be used experimentally to aid in determining correct control strategies. Experimentation with the model would be as follows:

(1) Input data necessary for the model (early season insect population profiles) would need to be obtained. If there is uncertainty in this data, several runs with various estimated profiles would be carried out.

(2) Predicted weather data would be used for the simulation run. This could be obtained by averaging over previous seasons or by using meteorological forecasts. Several runs would be made using various expected temperature sequences. As the season progresses, the actual weather data would be added to the model, and more accurate estimates could be made.

(3) The model would be used to give an estimate of spring n.o.w. emergence. Sprays at various times could be simulated in order to obtain a small infestation level at harvest time.

(4) When the model is completed, estimates of the utility of knocking at various times can also be generated.

(5) The simulation model can be used to get a idea of the initial population profile for the next season.

Model Validation: A complex computer model needs to be properly validated before it can be used in a predictive mode. Thus, although the preliminary model is now operating and looks promising, it would be an error to use it experimentally before at least one season of testing against complete field data. There are also many biological assumptions that are used in the model that need to be confirmed. Once this is done, an informed pest control advisor can use the model in conjunction with his experience to advise on proper pest control strategies.