PROJECT #: OSCC-5

TITLE: Development and Validation of a Phenology Model for Predicting Cherry Fruit Fly Emergence and Oviposition in the Mid-Columbia Area.

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M. Omeg, Wy'East RC & D, The Dalles
S. Castagnoli, OSU/ MCAREC, Hood River
L. Long, OSU, The Dalles

JUSTIFICATION:
Detecting and tracking western cherry fruit fly (CFF), *Rhagoletis indifferens*, emergence is critical for successful control. Fluorescent-yellow adhesive traps baited with an ammonia-releasing substance are widely used for monitoring cherry fruit fly. Because of intensive sanitation and control efforts in The Dalles, the principal cherry-growing district in the Mid-Columbia, cherry fruit fly populations are at very low levels. As a result, it has become difficult and unreliable in the last few years to detect first emergence with traps. An alternative to the use of traps for determining when the first fruit flies are present and sprays must be applied is to predict spring emergence of CFF with a degree-day model.

In 1995/96, the cherry research commission funded work to evaluate available predictive CFF models (Jones *et al*. 1991; AliNiazee 1976, 1979) and determine if they can be applied to the local conditions in the Mid-Columbia area. Unfortunately, none of these predictive models proved satisfactory. The probable reason why these models failed to provide accurate information is that they are based on locally collected empirical data which are not transferable to other regions, and because of certain biological assumptions which do not apply to our conditions.

In the fall of 2002, we submitted a research proposal to the cherry research commission to develop a more reliable phenological predictive model for CFF emergence and egg-laying for the Mid-Columbia cherry-growing districts (see last years proposal for justification and objectives). This proposal was funded and research began in the spring of 2003. A new predictive model was developed which is based on the time-varying distributed delay concept (Manetsch & Park 1974). Unlike the existing degree-day models, the new model can simulate the whole process of CFF phenology including post-diapause pupal development, adult emergence, egg-laying, and larval development. The model also has the capability to simulate the effect of control measures on the CFF population.

While evaluating existing models and organizing/validating the new phenology model, it became apparent that additional biological information, not available from the literature, was needed for inclusion in this model to make it more biologically meaningful and reliable. Therefore, additional data need to be collected about adult longevity, egg-laying as a function of age, larval development,

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and, most importantly, about the factors influencing development of overwintering pupae. This work needs to be continued and brought to completion so growers have a reliable tool to know with reasonable accuracy when to begin and when to terminate CFF sprays.

A modified and slightly simplified version of the currently developed phenology model will be made available as a degree-day model through the IFP*net* website in The Dalles and through the IPPC web site at Oregon State University. Growers will be able to obtain cherry fruit fly predictions for their orchards by linking the model with temperature data from the established weather networks in The Dalles and Hood River.

OBJECTIVES:

1. To further develop and improve a predictive phenology model for cherry fruit fly in the Mid-Columbia area.

2. To obtain data from original experiments about adult longevity, egg-laying, and about pupal development in the spring for inclusion in the phenology model.

3. To further validate cherry fruit fly model predictions using trap catch and weather data from The Dalles and Hood River collected in 2003 and 2004.

4. To make the cherry fruit fly model predictions available to all cherry-growing districts in the Mid-Columbia area via the Internet at The Dalles IFP*net* web site and Oregon State University's IPPC web site and link them to weather data from weather networks in The Dalles and Hood River.

METHODS:

1. Obtaining biological developmental information.

   (1) Adult longevity and egg-laying: Adults will be placed in small cages, provisioned with sugar water and presented with small red wax balls to determine longevity and age-specific egg-laying activity.

   (2) Adult emergence, trap catches and egg-laying in the field: Emergence from the soil will be monitored with cages, and flight activity with yellow sticky traps. Fruit will be examined for egg-laying punctures. These data will be used for model validation.

   (3) Pupal development: Pupae will be collected at weekly intervals from infested trees to assess how time of pupation affects subsequent emergence.
2. The new model parameters derived from the experiments will be incorporated in the new phenology model. Model predictions will be validated with trap catch data collected in previous years in the lower Hood River Valley and with historical first emergence records in The Dalles and Hood River. During the 2004 season additional data will be collected for model validation.
3. Phenology predictions which will show dates of first emergence or other phenological events (e.g., beginning or termination of egg laying) for the different districts will be made from temperature data in the Mid-Columbia cherry-growing districts.
4. In cooperation with L. Coop (IPPC/OSU, Corvallis) and M. Omeg (IFP Coordinator, Wy'East RC&D, The Dalles) a web-based predictive CFF model and phenology maps will be developed and linked to real-time weather information provided through the weather station networks in The Dalles and Hood River.

PROPOSED SCHEDULE OF ACCOMPLISHMENTS:

2003/04: Collect overwintering pupae. Begin experiments on pupal mortality and emergence. Measure adult longevity, egg-laying patterns and egg development by using emerged adults from overwintering pupae. Improve and test the time-varying distributed delay phenology model.

2004/05: Collect CFF pupae at weekly intervals from infested trees and observe fly emergence to determine the variability in pupal development and the key factors responsible for this variability. Derive model parameters from the experimental results and modify the phenology model. Collect field development data for model validation. Validate model with field data and historical trap records. Make CFF prediction model available through Internet. Write report. Note: Some field and laboratory experiments may carry over into the 2005 season depending on availability of pupae.

LITERATURE:

1. AliNiazee, M. T. 1976. Thermal unit requirements for determining adult emergence of the western cherry fruit fly in the Willamette Valley of Oregon. Environ. Entomol. 5: 397-402
2. AliNiazee, M. T. 1979. A computerized phenology model for predicting biological events of *Rhagoletis indifferens* (Diptera: Tephritidae). Can. Ent. 111: 1101-1109.
3. Jones, V.P., D. G. Alston, J. F. Brunner, D. W. Davis, M. D. Shelton. 1991. Phenology of the western cherry fruit fly (Diptera: Tephritidae) in Utah and Washington. Ann. Entomol. Soc. Am. 84: 488-492.
4. Manetsch, T. J. and G. L. Park. 1974. Simulation of Time Delay, chapter 10, *In:* Systems Analysis and Simulation with Application to Economic and Social Systems. Department of Electrical Engineering and System Science, Michigan State University, East Lansing, Michigan.

BUDGET

PROPOSAL TITLE: Development and Validation of a Phenology Model for Predicting Cherry Fruit Fly Emergence and Oviposition in the Mid-Columbia Area.

PI: Helmut Riedl

CO-PI: Yoohan Song

DURATION: 2003/4

CURRENT YEAR: 2004

PROJECT TOTAL (2 years): $17,500

CURRENT REQUEST: $ 10,000

Current year breakdown:

Item	Amount
Salaries – for research assistant	$9,000
Service and supplies: traps, lures, etc.	$500
Travel to experimental plots	$500
Total	$10,000