Predicting Cross Pollination and Nut Set with the ALMOPOL Model

Project No.: **09-POLL1-DeGrandi**

Project Leader: Dr. Gloria DeGrandi-Hoffman
USDA-ARS, Carl Hayden Bee Research Center
2000 East Allen Road
Tucson, AZ 85719
(520) 670-6380 ext. 104
E-mail: Gloria.Hofman@ARS.USDA.GOV

Project Cooperators and Personnel:
Dr. Ruben Alarcon, UC- Channel Islands
Bruce Eckholm, University of Arizona, Tucson, AZ
Robert Curry, Crystal River Inc., Tucson, AZ

Objectives:

1: Determine the progression of bloom for almond cultivars based upon temperature.
2: Estimate the number of bees on trees of different cultivars throughout bloom.
3: Estimate the proportion of bees carrying cross-pollen while foraging almond blossoms
4: Estimate cross-pollination rates and nut set.
5: Start programming the almond pollination software package, and establish an area on the Carl Hayden Bee Research Center WWW site to disseminate information on almond pollination and findings from this project to date.

Interpretive Summary:

A WWW-based program was developed to predict cross-pollination and nut set in almonds. The predictions are based on weather conditions, orchard design (i.e., cultivars and their arrangement), and the number and strength of honey bee colonies. Field data and archived data sets were used to derive equations and develop the logic for the program. We also incorporated components to capture the foraging behavior of *Osmia* spp. on almonds so that their contribution to nut set could be predicted. This enables growers to simulate conditions where both honey bees and *Osmia* are present in orchards and determine the effects on nut set. The program accurately predicts relative amounts of nut set among the cultivars based upon weather and bloom overlap. An initial version of the program is available on the internet at http://gears.tucson.ars.ag.gov/almopol/.

Materials and Methods:

The following data were collected daily during bloom and used to derive equation that were incorporated in the program: the number of open blossoms on trees of each cultivar, the number of honey bees foraging blossoms on trees of each cultivar throughout the day, percentage of bees foraging on trees of each cultivar with compatible pollen on their bodies,

initial and final nut set expressed as the percentage of blossoms setting nuts. In addition, eight years of bloom data for Nonpareil, California varieties, Carmel, Mission, Butte, Padre and Sonora from various orchard locations throughout the almond growing area of California were obtained from Blue Diamond. The data were matched with temperature readings from the CMIS and used to derive and validate equations describing the progression of bloom as a function of temperature. The programming for the ALMOPOL model was designed as a 3-tier architecture that includes a web presentation layer, a model logic layer, and a data access layer. The web presentation layer is based on the ASP.NET technology to allow for a rich internet user experience. The data access layer is interfaced with the MySQL Server database engine. The model logic layer is written in the C# language

Results and Discussion:

The goal of this project was to construct a mathematical model to predict cross-pollination and nut set in almonds. The model is packaged as a WWW-based program that is publicly accessible. The program generates cross-pollination and nut set predictions based upon orchard design and cultivars, weather conditions, and size of the honey bee population foraging on almond trees.

Simulations indicate that cross-pollination by honey bees is affected most by colony strength, weather conditions and the choice of cultivars in the orchard. Honey bee cross-pollination was not very sensitive to the arrangement of cultivars in an orchard but was very sensitive to the number of days when bloom periods between two compatible cultivars overlapped. The model defined the maximum number and strength of colonies needed to optimize nut set for a given orchard design. Using CIMIS weather data, the program also predicted when adding more colonies could not improve nut set because of poor weather. Simulations that included cross-pollination and nut set with Osmia indicated that it is more sensitive than honey bees to the arrangement of cultivar rows. The software package is complete and a working version is available at http://gears.tucson.ars.ag.gov/almopol/. The program can be a valuable tool for designing new orchards and for estimating the size of the bee population needed to optimize nut set under various weather conditions. Thus, growers could base their estimates of the number of colonies needed per acre on their orchard design and possible weather scenarios.

Research Effort Recent Publications:

none