Predicting Cross-Pollination and Nut Set in Almond Orchards Using Weather, Orchard Design and the Size of the Pollinator Population

Project No.: **07-POLL1-DeGrandi**

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Interpretive Summary:

Data were collected that will be incorporated into a web-based software package to predict nut set based upon orchard design, weather conditions, and size of the honey bee population foraging on almond trees. The 2008 almond bloom season was the first year of data collection. The structure of the model has been determined. Data analysis and entry of equations derived from the data are under way.

Objectives:

Objectives 1:

Determine the progression of bloom for almond cultivars based upon temperature.

Objective 2:

Estimate the number of bees on trees of different cultivars throughout bloom.

Objective 3:

Estimate the proportion of bees carrying cross-pollen while foraging almond blossoms

Objective 4:

Estimate cross-pollination rates and nut set.

Materials and Methods:

The following data were collected daily during bloom: 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.

Results and Discussion:

Data were collected to derive equations describing the progression of bloom in almond cultivars. The orchard used during the 2008 bloom season contained Nonpareil, Fritz, and Monterey. Nonpariel bloomed first followed by Monterey and then Fritz. The number of days where there was bloom overlap thus enabling cross-pollination to occur was 8 days for Nonparel and 15 days for Monterey and Fritz. Suitable flight weather occurred for 8 days during the pre-full bloom period. Cross-pollination was possible for 4 days for Nonpareil, and 7 days for Monterey and Fritz. A fungicide spray was applied to the trees just after full bloom and this halted bee activity. Data on foraging activity on each cultivar, identification of bees with cross-pollen on their bodies and intial and final nut set are either yet to be collected or are being analyzed.

The structure of the model has been completed. Weather conditions will be used to predict the number of open blossoms daily on trees of each cultivar. The number of open blossoms in conjunction with weather conditions and number of honey bee colonies and number and size of the trees in the orchard will be used to predict the number of bees foraging on trees of each cultivar. The ratios and numbers of bees foraging trees of each cultivar will be used to generate the population of honey bees carrying cross-pollen relative to each cultivar (i.e., the cross-pollinating population on each cultivar). Nut set will be predicted by combining the number of cross-pollinated blossoms as a function of the size of the cross-pollinating population with the time during bloom when blossoms are cross-pollinated. Previous studies indicate that blossoms that open during the pre-full bloom period have the best chance of setting nuts if cross-pollinated. Also, blossoms that are cross-pollinated in the first 4 days after opening have a better chance of setting nuts compared to blossoms that have been open longer.

In addition to the cross-pollination and nut set predictions, collaboration with Antoine Champetier (a graduate student in the Agriculture Economics Department at U. C.

Davis), has been established to include an economics component to the model. This component will predict possible value of the crop and advantages of increasing colony numbers and cost relative to potential increases in nut set.

Based upon bloom overlap and the number of days when foraging weather occurred, the basic model structure would predict that nut set on Fritz and Monterey would be higher than Nonpareil. This is because there were more days when bees could forage, but more importantly, compatible pollen was available for cross-pollination of Monterey and Fritz blossoms from the first day of bloom. The model would also predict that set on Fritz would be higher than Monterey. This is because there would be compatible pollen from both Nonpareil and Monterey available early in Fritz bloom. Foraging populations would be established on Nonpareil and Monterey and if significant pollen transfer in the hive was occurring, most of the pollen on the bodies of foragers would be from those two cultivars. Thus, the first Fritz blossoms visited on each foraging trip would be cross-pollinated. Indeed Nonpareil initially set only 39% of its blossoms into nuts compared with 48% for Monterey and 67% for Fritz.

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