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

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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.

Interpretive Summary:

Almonds require cross-pollination for nut set. Honey bees are primarily responsible for cross-pollinating almond blossoms. Foraging bees move pollen among almond blossoms while collecting nectar and pollen. Colonies of honey bees are introduced into orchards just prior to bloom to insure that sufficient populations of pollinators exist.

Since honey bee colonies are expensive to rent and potentially in short supply, it is critical for almond growers to obtain better estimates of the pollinating potential of bee populations. Estimates of the percentage of blossoms that have been cross-pollinated can be generated by mathematically describing bloom progression and bee foraging activity based upon weather conditions. The key to accurately estimating the rate that blossoms are being cross-pollinated and setting nuts is determining the size of the population of bees carrying cross-pollen while foraging on almond trees.

Though many bees might be foraging almond blossoms, only those carrying cross-pollen (i.e., pollen from an almond cultivar other than the one being foraged) are potentially setting nuts. Honey bees can obtain pollen from many different almond cultivars in the hive through nestmate contacts (DeGrandi-Hoffman et al. 1984; 1986; 1992). Thus, honey bees can cross-pollinate the first few blossoms they visit on a foraging trip even if they return to the same cultivar of almond throughout the day. When honey bees were sampled while foraging on almond blossoms, most had at least two different cultivars of almond pollen on their bodies (DeGrandi-Hoffman et al. 1992). Thus the population of honey bees that can cross-pollinate almond blossoms can be about as large as the population of bees foraging on almond trees.

The purpose of the proposed research is to develop a mathematical model to predict cross-pollination and nut set in almond orchards based upon orchard design, weather conditions during bloom, and the size of the bee population. The first year of the study will begin with bloom in 2008. The model we design will be packaged as a software program and made available free of charge through our Laboratory and the Almond Board of California WWW sites. The Carl Hayden Bee Research Center has a history of developing software programs that are available for download by beekeepers and growers. In addition to using the proposed software program to predict nut set, the program also could be used as a management tool in 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.