Demonstration of Using Blue Orchard Bees as a Supplement to Honey Bees for Almond Pollination

Project No.: **09-POLL8-Pickel**
09-POLL8A-Cane/Pitts-Singer

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Objectives:

The primary goals of this project were to: 1) Demonstrate the critical management practices and their timing for practical use of Blue Orchard Bees (BOB) as almond pollinators in the presence of honey bees; 2) Refine the summer and fall handling of BOB progeny with regard to proper timing of prewinter cooldown; 3) Anticipate or address the practical problems that arise when these bees are put in the hands of attentive almond growers; 4) Indirectly estimate BOB's additional contribution to almond yields in the presence of honey bees.

Interpretive Summary:

Hand's-on practical expertise and conceptual understanding of Blue Orchard Bee (BOB) management was delivered by Logan Bee Lab personnel to UCCE, particularly Sara Goldman-Smith. Thus trained, she was able to take over adult BOB observation, management, interpretation and guidance for cooperating growers. Bee performance in 2010 was mixed as expected, given the poor weather for bee flight and pollination, although nonetheless, some BOB populations in some orchards did increase in number. Sustainable management in bad weather years will require avoidance of detrimental practices (e.g., nearby placement of apiaries, use of likely harmful pesticides). Population sustainability is also more attainable with the second (or later) generations of BOB used in almond pollination. In previous years with good weather during almond bloom, we reliably increased BOB populations at every site. Two BOB management/training workshops for interested growers were organized by the UCCE personnel and held in December 2009 near Modesto and Chico, led by Logan Bee lab personnel.

Materials and Methods:

BOB populations were introduced and managed at 5 sites in the Sacramento Valley. Three orchards received BOBs produced in CA in 2009 whose parental populations were from CA, WA and UT. The other two orchards received BOBs directly sourced from WA or UT (the regions of most commercial trap-nesting) that had been managed for early-season flight. We recorded flight initiation time and 10% bloom for each respective orchard when possible. After bloom, we brought the majority of the nesting populations back to Logan, where they were reared in an incubator with temperatures that reflected the actual weather in Stockton, CA. Nests were x-rayed and scored for progeny production, and compared with the known numbers of female BOBs that we had released. A small subsample was kept in Butte County, to be reared under local ambient conditions. For future work, flowering almonds with controlled bee access will be used in our Logan greenhouse to evaluate pollen delivered and pollen/nectar removed per virgin flower during single visits by nesting BOBs during natural foraging. Almond saplings provided by a generous grower and transplanted into the earthen floor of our USDA greenhouse in 2008 have reached the roof, with several trees blooming in March 2010.

Floral resources of flowering quince, *Chaenomeles japonica*, were evaluated as a practical in-row shrub to grow in or near orchards that will reliably bloom just before almonds to feed early emerging BOBs.

Results and Discussion:

To further extension and grower technology transfer, two half-day BOB workshops were held for interested growers, bee managers and extension personnel in early December 2009 in Butte County and at the UCCE Stanislaus office. Cane, Pitts-Singer, and Trostle provided overviews of the biology and management of BOBs for almonds. Several Butte County growers cooperating in this research also participated.

At both venues, rooms were completely filled (60+ in each audience), each workshop going for four hours. Visuals, nests, handouts, and nesting materials were displayed.

In February 2010 nesting shelters from Logan were placed in five grower's Butte County orchards. They were properly oriented with regard to morning sun and distance from planned apiaries. BOBs overwintered in Logan were allowed to emerge at the shelters. This second year of BOB deployment in almond orchards afforded replication that confirms that the bee emergence schedule and performance depends strongly on whether or not a first BOB generation had been produced in almonds. Despite advanced wintering of first generation bees from different source regions, their emergence was again marginally late and prolonged, exacerbated by the long wet spring. In contrast, the second and third generations from WA (yr 2-3) and Utah (yr 2-3) emerged in good timing to service the entire bloom period of almonds, yet not so early as to risk starvation. The first generation of these populations flew in almonds in 2008 and their vastly superior nesting success is evident from their productivity (**Table 1**). Especially in years with foul spring weather, we now conclude that it may be more reliable to produce the first generation of BOBs in a later flowering fruit crop (e.g., cherries, apples or a "bee pasture" tailored for BOBs with annual flowers that we have evaluated and recommended). Thereafter, subsequent generations of those BOBs can be produced sustainably in almonds, remembering that the earlier the parent generation flies, the more time the offspring have for sufficient wintering and early emergence.

Table 1. **2010** Source, fate and productivity of BOBs in commercial almonds

Bee source and year in Calif.	*First flight*	*10% bloom*	*Females Released*	*Progeny*	*Sex ratio Male:Female*
Wash. Yr. 1	Feb 17	Feb 17	300	532	1.5:1
Wash. Yr. 2-3	Feb 13	Feb 17	300	345	1.5:1
Utah Yr. 1	Feb 18	Feb 19	300	No return	n/a
Utah Yr. 2-3	Feb 17	Feb 21	186	640	2.1:1
Calif. Yr. 1	unknown	Feb 15	50	No return	n/a

Butte County weather during bloom in 2010 was wet, cold, windy and generally unfavorable to bees and pollination. In response to the wet spring, fungicides were used extensively. Because growers need to rotate different fungicides, and sprayed often, some orchards received fungicides suspected of harming nesting bees and/or their progeny. These same orchards did have fewer BOBs successfully nesting.

In 2009 field studies, weather at bloom time was poor also; most days were cold and rainy, significantly delaying emergence of the first generation populations from WA and UT. In WA and UT, normally BOBs fly in April and may not accumulate enough wintering time to emerge quickly. These transition populations continue to be challenging to synchronize for the early almond bloom the following year. The year 2

bees from WA and UT emerged quickly and began mating and foraging, producing many nests while pollinating the flowers (**Table 2**).

Table 2. Summary of emergence, flight, and nesting performance of BOBs in 2009

Bee source and year in Calif.	*First flight*	*10% bloom*	*Females Released*	*Progeny (Fem/Male)*	*Total cells produced*
Wash. Yr. 1	Feb 19	Feb 15	300	66/144	233
Wash. Yr. 2	Feb 8	Feb 18	553	333/702	1176
Utah Yr. 1	Feb 24	Feb 19	300	6/16	26
Utah Yr. 2	Feb 12	Mar 1	78	180/357	572
Calif. Yr. 1	Feb 19	Feb 10	191	11/17	30

Other factors may have adversely affected BOB performance in 2009, including an incubator box which malfunctioned and overheated killing many WA year 1 adults still in the cocoons. Also, unplanned placement of approximately 30 honey bee hives near the CA year 2 nesting shelters created a high level of competition in that area and muddy orchard floor conditions limited access.

Weather during almond bloom in Northern California is unpredictable as shown by large variations in “bee flight hours” which are defined as the number of hours above 55 degrees when wind is less than 15 mph, with a sufficient level of sunlight and no rain. Tracked from Feb. 1 to Mar. 8, flight hours for 2007 were 140, for 2008 were 175, for 2009 were 92, and for 2010 were 84. This somewhat explains why we saw a high level of productivity in smaller studies in 2008 but not in 2009 or 2010.

Surviving progeny from all three BOB source regions flown in the five almond orchards are being incubated in Logan and soon will be wintered at constant temperature (4-7°C) for approximately 180 days. Depending on funding, most will be placed back out in the almond orchard demonstrations in 2011. A subset will be incubated for emergence at the USDA Logan lab, recording the sex of adults, plus female longevity. Adult longevity is predictive of fitness at emergence, indicating lifetime reproductive success of BOBs, and so their promise for sustainable management in commercial almond orchards.

Flowering quince plants produce generous floral rewards for bees. Two varieties were nearly identical in producing 5.6 micoliters of nectar and 78,000 pollen grains per flower. Their nectar sugar content is about 10x that reported per flower for almond; pollen yields are 2-3x that of almond. Quince have been bred for profuse bloom, so a single shrub can feed many BOB bees early in the season when they are drinking nectar for energy and eating pollen to mature their first eggs. Flowering quince are tough, hardy shrubs that can fit here and there in rows of almonds without affecting management.

The enthusiastic response to our 2009 workshops was mostly from producers of BOBs, with smaller numbers of almond growers attending. These growers seem to be very interested in the possibilities of using BOBs for pollination, but do not have the extra time to manage the bees themselves. In conclusion, there is a large supply of BOBs available for pollination, but seemingly no one to manage them in the orchard. A future direction for this work could be increasing the number of either beekeepers or growers who will actually place the bees in the orchard, service them as needed, and collect the nests at the end of bloom.

Recent Publications: None to date.