Demonstration of Using Blue Orchard Bees as a Supplement to Honey Bees for Almond Pollination (Joint Report)

Project No.: **08-POLL8-Pickel**
08-POLL8A-Cane/Pitts-Singer

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Interpretive Summary:

Hands-on practical expertise and conceptual understanding of Blue Orchard Bee (BOB) management was delivered by Logan Bee Lab personnel to UC Extension, particularly

Sara Goldman-Smith. Thus trained, she was able to take over adult BOB observation, management, interpretation and guidance for cooperating growers.

In 2008 with good pollination conditions, we were able to increase two of the three BOB populations. These populations flown a second year in almonds originated from Washington (Butte County orchard) and from California (Turlock orchard). A population flown for the first time in almonds (Butte orchard) originating from Utah did not perform well. Normally Washington and Utah populations fly in April and it has be a challenge synchronizing BOB flight with the earlier almond bloom the first year. These transition populations have a compressed wintering time affecting their emergence.

In 2009, all BOB populations were placed in Butte County orchards. Bloom time conditions here were poor, with only 92 bee flight hours vs. 175 for 2008. Hours were tracked from February 1 to March 8. As a result most populations did not perform or increase as well as possible.

Two BOB management / training workshops for interested growers have been organized by the UCCE personnel and are scheduled for December near Modesto and Chico. They will be led by Logan Bee lab personnel.

Objectives:

The primary goals of this project are to: 1) Demonstrate the critical management practices and their timing for practical use of BOBs 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 cool down; 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.

Materials and Methods:

BOBs were introduced and managed at 5 sites in the Sacramento Valley. Three orchards received BOBs produced in CA in 2008 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. After bloom, we brought nesting populations back to Logan, x-rayed and scored their nests for progeny production, and compared them with the known numbers of females that we released. For future work, flowering almonds with controlled bee access will be useful in Logan to evaluate pollen delivered and pollen/nectar removed per virgin flower during single visits by nesting BOBs during natural foraging. A kind grower volunteered almond tree saplings, which were transplanted into the earthen floor of our USDA greenhouse.

Results and Discussion:

To facilitate extension and grower technology transfer, we prepared BOB Demonstration Kits for UCCE personnel and participating growers. The notebooks contained five sections. The first section was an overview: "Orchard management practices using blue orchard bees" to aid grower's understanding of BOB life cycle and management concerns for almond pollination. Each subsequent section gave brief justification and background information, methods and data forms, all with an eye to brevity and simplicity. These sections were: 1) Almond flower counts; 2) Bee counts at almond flowers; 3) Bee counts at nesting sites, and 4) Counts of plugged (completed) nests. Three of the four almond growers (one grower had two orchards separated by several miles and allowed us to use both of them) used the kits as reference material, and one also collected the requested data for us. Sara Goldman-Smith used the kit as her personal reference and mode of data collection, as well as a tool when talking to growers.

Nesting shelters from Logan were deployed in five grower's Butte County orchards. They were properly placed with regard to morning sun and distance from planned apiaries. Nonetheless, in one orchard, a large apiary was later placed directly adjacent to the BOB nesting shelter; local competition hindered progeny production.

2008 Field Studies

Table 1. Summary of emergence and nesting performance of BOB in 2008

Bee source and year in Calif.	*Females Released*	*Progeny (Fem./Male)*	*Cells produced per female*	*Total Cells produced*
Wash. Yr. 1	300	653/1223	8.93	2679
Utah Yr. 1	300	111/206	1.45	
California	300	618/1020	7.8	2341

In 2008 with good pollination conditions, we were able to increase two of the three BOB populations in CA almond orchards (**Table 1**). These were from Washington (Butte County orchard) and from California (Turlock orchard). A population from Utah placed in a Butte County orchard did not perform well.

The 2008 bloom was not monitored in relation to emergence, but as nesting performance indicates, bee-bloom synchrony was good for the Washington and California populations. The Utah population emerged late and emergence was extended, resulting in poor nesting performance.

Good nesting means good pollination. A rough estimate for the Washington population is 2,000 flowers were visited by each female per cell produced. Therefore, each female from this population would have visited over 17,860 flowers in her lifetime, with over 5,358,000 visited for the 2,679 cells produced by this population.

2009 Field Studies

Table 2. Summary of emergence, flight and bloom synchrony, and nesting performance of BOB in 2009

Bee source and year in Calif.	*First flight*	*10% bloom*	*Females Released*	*Progeny (Fem./Male)*	*Cells produced per female*	*Total Cells produced*
Wash. Yr. 1	Feb. 19	Feb 15	300	66/144	0.78	233
Wash. Yr. 2	Feb. 8	Feb. 18	553	333/702	2.13	1176
Utah Yr. 1	Feb. 24	Feb. 19	300	6/16	0.087	26
Utah Yr. 2	Feb. 12	Mar. 1	78	180/357	7.3	572
Calif. Yr. 2	Feb. 19	Feb. 10	191	11/17	0.16	30

In 2009, all BOB populations were placed in Butte County orchards (**Table 2**). Bloom time conditions here were poor, with only 92 bee flight hours vs. 175 for 2008. Hours were tracked from February 1 to March 8. As a result populations did not perform or increase as well as they did in 2008.

Despite advanced wintering of first generation bees from Washington (yr 1) and Utah (yr 1) their emergence was marginally late, missing early almond bloom. Normally Washington and Utah populations fly in April and it has be a challenge synchronizing BOB flight with the earlier almond bloom the first year. These transition populations have a compressed wintering time affecting their emergence.

In contrast, the second generation Washington (yr 2) and Utah (yr 2) populations 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 pollinated 2008 almonds.

Of concern is the late emergence of the California population, which should have been better acclimated to almonds, because the prior generation pollinated 2008 almonds.

Other confounding factors did or could have deterred BOB performance. A malfunctioning incubation box overheated and there was high mortality in the Washington year 1 adults that would have otherwise emerged.

Second, a large number of honey bee hives (~30) were placed near the California year 2 population shelters and there was competition for resources. Although BOB can forage effectively in the orchard with honey bees present, it is likely that the pressure from this large honey bee population had adverse effects on BOB nesting, especially because the flight hours were reduced due to the poor weather, indicating that both honey bees and BOBs were more restricted in their flight, forcing both groups into the closer trees and depleting resources. The orchard was too wet to move the honey bee colonies until quite late.

Lastly, high usage of fungicides during bloom, particularly in the orchard where the California populations were located, could have impacted the BOB. There were 11 fungicide applications in this orchard, compared to 3-5 at the other 4. Prior observations indicate this may be a factor, although there are no data for fungicide impact on BOBs.

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 approx. 180 days. Most will be placed back out in the almond orchard demonstrations in 2010. A subset will be incubated for emergence at the USDA-ARS 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.

Transplanted almond saplings are established and growing in the Logan greenhouse. These trees will be used in 2010 and/or 2011 to precisely measure pollination value of BOBs and forage value of almonds for BOBs under controlled conditions without competition from honey bees.

BOB workshops for interested growers and extension personnel are scheduled for 12/7/09 at the Durham community hall and 12/8/09 at the UCCE Stanislaus office. Cane, Pitts-Singer, and Trostle will provide an overview to the biology and management of BOBs for almonds. Butte Co. growers cooperating in this research are being encouraged to participate in this workshop by sharing a grower's perspective of BOB management and utility. Workshops will last 2 hours each. They will be announced, organized, financed and run by Pickel with help from Goldman-Smith.

Recent Publications:

None to date.