Sourcing and Feeding of Blue Orchard Bees for California Almond

Project No.: 06-POLL10-Cane

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Interpretive Summary:

The blue orchard bee (BOB) presents an attractive supplemental or alternative pollinator for almonds. Sustaining BOBs in commercial almonds may require ways to extend or supplement their foraging season both pre- and post-bloom, using suitable flowering crops. These BOB populations may also need to be supplemented in some years by "ranching" the bees off-site with early flowering annuals. Of the six early flowering annuals tried, BOBs nesting in our greenhouse strongly preferred provisioning nest cells with *Collinsia heterophylla* pollen. They also frequently visited flowers of *Nemophila maculata* and *Phacelia tanacetifolia* for nectar, as well as *C. heterophylla* and *P. campanularia*. They ignored canola. Nectar production and pollen production was quantified for all species. Early blooms produced more pollen. . Lifetime bloom production per plant ranked *N. maculata*> *C. heterophylla*> *N. menziesii*; flower production per unit area is being calculated and carrying capacity for the blue orchard bee will be calculated in time for the December meeting.

Our greenhouse bees produced approximately 315 viable offspring from 64 California female parents, or a 5-fold increase. With our years of trap-nesting experience, we were able to obtain 1326 males and 847 females from 673 wild nests of BOBs in valley and foothill habitats around the Central Valley, whose potentially superior climatic adaptation for pollinating almonds will be evaluated in 2008.

Objectives:

1) Evaluate promising early spring flowering species grown in the greenhouse, and open-field trials. The test species are *Brassica rapa* (canola) and five early-flowering natives: California bluebells (*Phacelia campanularia*) and its relative, *P. tanacetifolia*; California five spot (*Nemophila maculata*) and baby blue eyes (*N. menziesii*); and Chinese houses (*Collinsia heterophylla*). Measure each wildflower species' nectar and pollen production, bloom production per plant and unit area, bloom timing and duration. Evaluate foraging and nesting success of BOBs with availed of these plants.

2) Acquire nests of BOBs by deploying nesting in the foothills surrounding the Central Valley and evaluate for the numbers of healthy overwintering females that are present.

Materials and Methods:

Drilled, strawed wooden nest blocks were deployed in February of 2006 and recovered in October of 2006, with permissions as necessary. **5** sites were chosen, 20 blocks (50 holes each) nailed to standing trees. X-rays of recovered nests were interpreted for their contents, placed in a temperature cabinet to approximate average California temperatures throughout the fall and winter. 200 females were shipped to AgPollen December 12 2006 for release in caged spring annuals. Emergence timing was monitored from this group (plus three others entities in California).

For greenhouse bloom trials, seed was purchased from S&S seeds (P. O. Box 1275 Carpenteria CA 93014) and planted in our soil-floored glasshouse in Logan, UT in January 2007 with drip irrigation. Nectar and pollen was withdrawn from bagged flowers and measured/counted. Lifetime bloom production was tracked on select plants. 64 female and 55 male BOBs were released in the glasshouse. We observed forager's floral pollen/nectar preferences and acquisition methods. Total nests and daily cell production were monitored, and the sum of surviving progeny tallied with the aid of nest X-rays. As of this writing, surviving progeny have all spun cocoons and gone through summer diapause. In the greenhouse and outdoors in Logan and near Turlock, California, blooming dates and durations of these wildflowers were also recorded.

Results and Discussion:

California BOB trap-nesting. With our years of trap-nesting experience, we were able to obtain 1326 males and 847 females from 673 nests of BOBs in valley and foothill habitats around the Central Valley. Subsets of these were distributed to commercial entities eager to evaluate their performance, and to begin their mass-production. Their potentially superior climatic adaptation for pollinating almonds will be evaluated in 2008.

Floral pollen and nectar rewards. Nectar volume averaged 1.4 ul for *C. heterophylla,* 1.1ul for *N. maculata,* 6.4ul for *N. menziesii,* and 1.5 ul for *P. campanularia;* ug sugar per flower is being calculated for these and for *P. tanacetifolia*. Early-season flowers produced prodigious pollen: *P. campanularia* (mean 145362 SE ±11210), and *N. menziesii* (111161 SE ±6167), *C. heterophylla* (mean 93904 SE ± 5242) and *N. maculata* (mean 84004 SE ±6868). Late-season flowers produced 2-4x less pollen.

Flowering schedules. Bloom time and duration of bloom differed by species and planting location. In our greenhouse, *N. maculata* was the first to bloom (March 13), followed by *N. menziesii* (March 19), *P. campanularia* (March 20), and *C. heterophylla* / *P. tanacetifolia* (March 27). Last bloom data collected in the greenhouse was completed on May 15. Some species continued to bloom into June. Outside plants in Logan began to bloom April 20 and, in the case of *P. campanularia*, continued into August. Steve Peterson (AgPollen) reported to us the same basic order and dates of first bloom for these plants species seeded outside near Visalia, CA, beginning in mid-March as in our Logan glasshouse.

Daily and lifetime flower production and longevity per species. Flower densities at peak bloom was about 1700 flowers per sq meter for *C. heterophylla*, 1400 for *P. campanularia*, 1000 for *N. menziesii*, and 700 for *N. maculata*. For daily and lifetime flower production per plant, marked *N. maculata* plants produced 2x more flowers than *C. heterophylla* (32/day, 953 lifetime per plant), which produced 8x more flowers than *N. menziesii*.

BOB greenhouse progeny production. BOBs used four of the six species for nectar and sometimes pollen. Canola and *N. menziesii* were largely ignored by BOBs nesting in our glasshouse. BOBs strongly preferred provisioning nest cells with *C. heterophylla* pollen. They also frequented flowers of *N. maculata* and *P. tanacetifolia* for nectar, as well as *C. heterophylla* and *P. campanularia*. BOBs were seen foraging for pollen at these four species too.

The 64 California females released into the greenhouse produced 315 viable offspring on pollen and nectar provisioned from these wildflowers. At peak bloom, when all species were available and flowering abundantly, BOBs chose to provision with pollen from *C. heterophylla.* Its pollen predominated in larval provision masses. Larval provision masses consisted of 13$\pm$6 million pollen grains. Minor fractions of *N. maculata* and *P. tanacetifolia* pollen occurred in some early nest cells. All provision samples (n = 20; 10 early, 10 mid-season) were > 70% *C. heterophylla*, some being purely *C. heterophylla*. These proportions were surprising, since we also observed BOBs frequently visiting flowers of *N. maculata* too, followed by *P. tanacetifolia*, less so for *C. heterophylla* and *P. campanularia* and rarely *N. menziesii* and canola throughout bloom, sometimes obviously collecting pollen as well as nectar. These pollen visits to other species apparently represent a minority of the female bees' overall pollen foraging effort.

Overall, we expect that canola will be ignored by freely-foraging bees, or bees with foraging options. Most of the BOB progeny production in our glasshouse resulted on pollen provisions dominated by *Collinsia heterophylla*. *Nemophila maculata* and *Phacelia tanacetifolia* were avidly used for nectar and sometimes pollen, and to a lesser extent, so was *P. campanularia.* If *Collinsia* is sparse or absent, these other floral hosts may be used for pollen (our lab has regularly used *P. tanacetifolia* alone in the glasshouse for producing BOBs). In the glasshouse, we obtained excellent nest cell production from BOBs, even though growing conditions were suboptimal (plants overcrowded, limited weak daylight, aphid and thrips outbreaks). We estimate that about one BOB nest cell can be produced daily per 3-4 square meters of blooming *C. heterophylla.*