Longitudinal Evaluation of Honey Bee Colonies on Different Foraging Regimes

Project No.: **17-POLL20-Niño (COC)**

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Objectives:

- Determine the short-term and long-term effects of two different forage mixes on honey bee colony growth, health, and annual survival.
- Determine honey bee foraging preferences by collecting and identifying pollen brought to the colony.

Interpretive Summary:

This is a continuation of the project completed in 2017 of which the main goal was to evaluate supplemental forage plantings and their potential benefits on immediate and long-term honey bee colony health, growth and survival in California almond orchards. During the 2018 almond bloom we placed 32 colonies at 16 different sites. These sites constituted four groups: almond orchards with mustard plantings or wildflower plantings and accompanying control sites without supplemental forage plantings.

Unlike the year prior, coarse-scale analysis was not able to detect a significant immediate effect of supplemental forage on honey bee colony size (adult population, brood area, pollen and nectar/honey storage). Due to unpredictable and unusually cold weather patterns there were several parameters that have undoubtedly influenced our findings. Wildflower plantings, similarly, to 2017, did not bloom during almond bloom not providing expected supplemental nutrition to the experimental colonies. No significant differences were determined for adult population or brood area between any of the groups. However, while survival between the groups was not significantly different, there was a higher survival trend for mustard group. Our preliminary data combined with prior year's results suggest that presence of mustard plantings in almond orchards increases colony strength suggesting potentially increased number of foragers and therefore improved pollination efficiency, as well as higher survivorship for mustard group. Further studies would be necessary to confirm this relationship on a large scale. We are currently conducting a fine-scale analysis of pollen collected by experimental colonies at various times during bloom. This data will allow for a more direct correlation of forage resources and colony health, growth and survival.

As expected, there were no significant differences in varroa mite infestation between all four groups. The more important and more appropriate measurement of bee health in this case is the pathogen load (particularly viruses which are transmitted by varroa mites) and immune robustness of bees. The analysis of 2017 samples are still underway and additional samples were collected for 2018. Combined two-year data indicate a potential long –term benefit of mustard plantings to long term colony survival. In addition, based on the results from prior year and to test whether the prolonged placement in forage rich environment would benefit the colonies we moved one half of the colonies to Oregon and left one half of the colonies in Davis, California. The colonies continue to be monitored and will be tracked for overwintering survival. Further experiments will increase replication and will evaluate additional landscape-level effects.

Materials and Methods:

Laboratory experiments (Alaux et al. 2010; Schmehl et al. 2014) show that honey bees benefit from access to robust nutrition. Efforts to provide supplemental forage to colonies prior, during and after almond bloom are underway. However, there is a great need for recording how these efforts translate into both short-term and long-term colony health, productivity, and survival. Our project evaluates short- and long-term value of supplemental forage to honey bee colonies within the context of almond pollination.

For this project, we utilized forage plots already established in the northern growing regions (Arbuckle-Chico) by Williams lab (UCD) and other sites established by growers in collaboration with Project Apis m. Our sites consisted of four California native wildflower sites, four mustard sites and eight matching control sits. Almond orchards with no supplemental forage in riparian areas served as control sites for wildflower group and non-riparian areas with no supplemental forage served as controls for the mustard group. Each of the sites had two honey bee colonies for a total of 32 experimental colonies. Prior to moving the colonies into experimental orchards, they were overwintered at UC Davis apiaries and were managed as per standard management practices.

Before being moved into the experimental orchards, colonies in standard Langstroth hives were evaluated for weight, food stores, adult population, queen presence and brood production. Samples of adult bees were also collected at this time for future molecular (with collaborator McFrederick) and physiological (hypopharyngeal gland size in nurse bees, Niño lab) analyses. Bees were allowed to forage freely at the experimental sites and data were collected pre-bloom (once placed in experimental locations), twice during bloom, and once post-bloom while still at the experimental location. Once the almond bloom ended, colonies were moved back to UC Davis apiaries and are being monitored continuously. We have completed three additional evaluations and bee sample collections and will continue monitoring until the almond bloom 2018. Colonies are being evaluated every four weeks.

Colony strength parameters (weight, food stores area, brood area, adult population size) are evaluated as per Kanga et al. (2013), as well as alcohol washes for varroa mite infestation. For measuring the size of the hypopharyngeal glands, nurse bees are collected from the brood box and will be processed as per Hatjina et al. (2013).

We have also collected pollen from all colonies by placing pollen traps at the front entrance in order to determine target forage of experimental colonies (analysis is still in progress by collaborator Williams). Once the pollen is identified we will use this data to conduct fine-scale analysis and more directly correlate nutritional availability with colony growth, health and survival.

Results and Discussion:

The US national colony loss survey still reports average annual losses in the US of close to 45% (e.g., Seitz et al. 2015). Beekeepers are reporting an array of suspected causes including varroa mites, pathogens and exposure to pesticides. Research thus far demonstrated that some of these conditions could be alleviated by providing honey bees with access to plentiful and diverse pollen sources (e.g., Alaux et al. 2010; Schmehl et al. 2014). Efforts to provide supplemental forage to colonies prior, during and after almond bloom are underway, however, there is a great need for recording how these efforts translate into both short-term and long-term colony health, productivity, and survival. Analysis of combined two-year data indicate that, within the context of almond pollination, honey bees seemingly experience immediate benefits in terms of increased population size and possibly long-term survival.

When the groups were compared, there were no significant differences for various colony parameters measured (adult population, brood area, pollen and nectar/honey stores) and for any of the evaluation and sample collection dates (ANOVA on transformed data, $p<0.05$). However, due to unpredictably wet and cold season, wildflower plantings did not bloom at the expected time. This likely means that the colonies in this group were not exposed to supplemental forage as planned, effectively making this group more similar to the controls. Our fine-scale analysis will be able to correlate these various colony parameters with the actual pollen source brought into the colonies by foragers. Pollen analysis is currently underway (Williams lab).

We did not find any significant differences between any groups at any data points for varroa mite infestation (ANOVA on transformed data, $p<0.05$). This is not surprising since thus far there has not been any recorded interaction of varroa mite infestation levels and honey bee nutrition. The better assessment of the impact of nutrition on honey bee health and physiology will be the analysis of pathogen loads, hypopharyngeal glands, and immunity (analyses currently underway in McFrederick and Niño labs). Lastly, the true value for beekeepers would be reduced colony losses. While we did not see significant differences in colony survival (**Figure 1**) between the groups, at the last data collection point in September 100% of the colonies in the mustard group have survived while all other groups exhibited some mortality. The colonies continue to be monitored.

Our preliminary data analysis highlights the potential immediate value of mustard forage to honey bee colony growth within the almond pollination context. We predict that our physiological and molecular analyses and overwintering survival will reveal further long-term benefits of supplemental forage to colony health and survival. Future work will focus on exploring additional forage options such as wildflower plantings with the ultimate goal of providing planting recommendations to interested stakeholders.

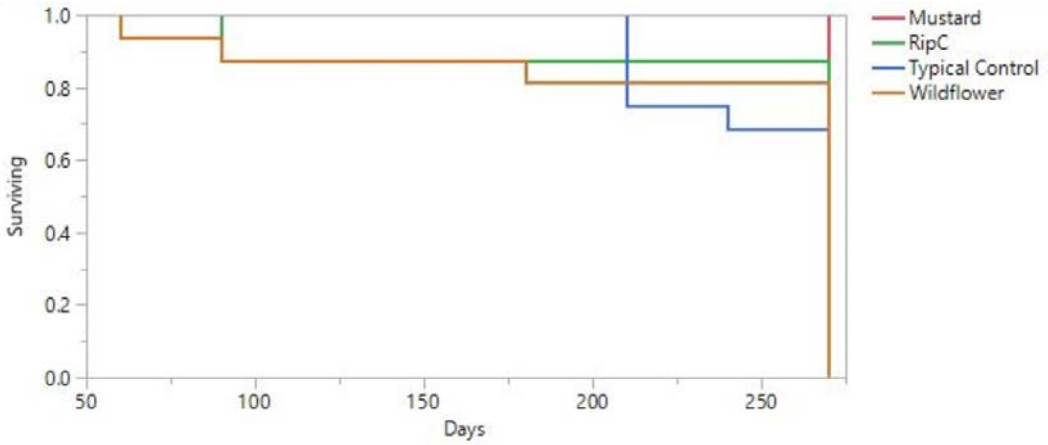

Figure 1: While survival was not significantly different there was a trend for higher survival of mustard group colonies as compared to all others (Survival statistics test: p=0.1681).

Research Effort Recent Publications:

Poster presentation at the Entomological Society of America Annual Meeting (November 8, 2017). Talk at the California State Beekeepers Association meeting in November 2107 and at the American Honey Producers Association in January 2018. Multiple presentations at the local California beekeeper associations.

Niño, E. L., and B. Niño (2018) Longitudinal evaluation of supplemental forage on honey bee colonies in California almond orchards. In the Proceedings of the 2018 American Bee Research Conference, Bee World

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Kanga, Lambert Houssou Ble, Walker A. Jones, and Rosalind R. James. "Field trials using the fungal pathogen, *Metarhizium anisopliae* (Deuteromycetes: Hyphomycetes) to control the ectoparasitic mite, *Varroa destructor* (Acari: Varroidae) in honey bee, *Apis mellifera* (Hymenoptera: Apidae) colonies." *Journal of Economic Entomology* 96.4 (2003): 1091-1099.

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