Evaluation of Oil Seed Cover Crops as a Pre-Bloom Alternate Food Source for Pollinator Honeybees (*Apis Mellifera*) in the San Joaquin Valley

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ABSTRACT: Almonds (*Prunus dulcis*) are almost exclusively pollinated by honeybees (*Apis mellifera*) and each year in February, over 1.5 million hives are placed in California almond orchards. Bee colonies suffer nutritional deficiencies as a result of being fed supplemental feedings of high fructose corn syrup (HFCS) in the time of dearth preceding almond bloom. This reduces colony strength. Alternate food sources, rapini (*Brassica rapa*), borage (*Borago officinalis*), and cuphea (*Cuphea* spp.), that can bloom prior to pollination, were planted and evaluated to see if they increased colony health during almond bloom. The experiment was a randomized complete block design with four treatments replicated four times, and treatments within each block were separated by a mile. Evaluations included calculation of brood area, hive weight, and pollen analysis. Corbicular pellets, were collected from honeybees (*A.mellifera*) using pollen traps placed in several sites in the San Joaquin valley of California. Data were analyzed by date using a two-way repeated measures with time and treatments as factors.

INTRODUCTION: There are currently over 312,000 hectares of almonds [*Prunus dulcis* (Mill.) D.A. Webb (Rosaceae)] under cultivation in California which is up from 256,000 ha (640,000 ac) in 2007 (USDA-CDFA, 2012). In recent years there have been shortages of pollinator bees which have consequently driving hive rental prices ($200 per colony in 2014 vs. $40-50/colony in 2003). Several factors currently affect the health of the honeybee industry such as varroa mites (*Varroa destructor*, Acari: Varroidae), the fungal affliction *Nosema* spp. (Dissociodihaplophasida: Nosematidae), American foulbrood (*Paenibacillus larvae*, Bacillales: Paenibacillaceae), colony collapse disorder (CCD), and nutritional deficiencies as a result of supplemental feedings of high fructose corn syrup (HFCS) in the time of dearth preceding almond bloom (DeGrandi-Hoffman et al. 2009).

OBJECTIVE:

To determine the effect of strategically planted oilseed cover crops that bloom prior to the almond pollination, on bee colony size and colony health.

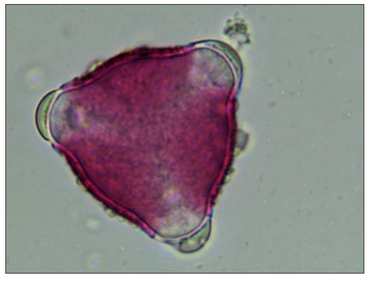

Fig. 1. A pollen grain (magnified x 1000) of almond (*Prunus dulcis*)

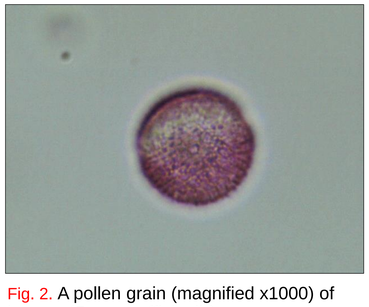

Fig. 2. A pollen grain (magnified x1000) of borage (*Borago officinalis*).

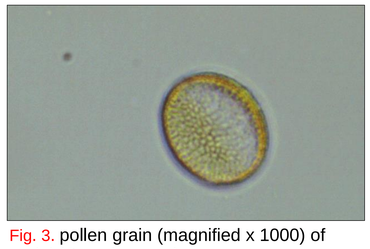

Fig. 3. pollen grain (magnified x 1000) of rapini (*Brassica rapa*)

Fig. 4. Rapini field at 100% bloom (Fresno, California).

METHODOLOGY:

Plots: single factor (RCBD) with four replicates. Fixed factor: cover crop type: a) no cover crop, b) rapini planted at 5 lb/acre, c) borage planted at 10 lb/acre, and d) cuphea at 8 lb/acre. Random factor: the orchard blocks.

Statistical analyses: on the brood area and net hive weight were performed using SPSS v. 22.0 (IBM Corp.), and pollen intake analyzed using Excel v. 2013 (Microsoft Corp.). Data for the brood area and hive weight were evaluated for their conformity to the assumptions of a general linear model (GLM) two-way repeated measures analysis of variance (ANOVA) using α=0.05 with time as a within factor and treatment (cover crop type) as a between factor.

Bees: 32 colonies supplied by Hiatt Honey (Madera, California). Hives contained identical equipment (boxes, frames, feeders, wax foundation).

In late January, 2014, two hives placed into each treatment plot at the beginning of the pre-almond cover crop bloom, which would allow the 21-day brood cycle of honey bees (Sheesley et al. 1968) to complete one full cycle before almond bloom. Hives placed in untreated no cover crop plots received high fructose corn syrup (HFCS) and Honey Bee Healthy (HBH) pollen cakes (Dadant Corporation, Fresno, California) as a supplemental feed until almond bloom.

Pollen Traps: Gross colonial intake rates of pollen were determined by placing Sundance bottom pollen traps on hives. (Ross Rounds, Inc. Albany, NY

Pollen Identification: reference slides made from flowers of almond (Figure 1), borage (Figure 2), and rapini (Figure 3) in order to aid the bee pollen identification process. Pollen sampled 2X/week, to determine pollen species composition in order to determine where bees have been foraging as well as dry weight. This pollen history is important as bees should move from pre-bloom forage to almonds when almonds begin to bloom (Gary et al. 1978).

Brood frames: photographed and cropped using a fixed camera frame holder (Figure 5), then processed (Image J version 1.48, National Institute of Health, USA) to create a 98 square grid (Figure 6) to measure brood area in cm² as a measure of colony health (Sheesley et al. 1968).

Hives: weighed at the beginning of pre-bloom staging, the beginning of almond bloom, and the end of almond bloom which allowed a general measurement of colony growth including bees, brood, pollen and honey (Figure 7).

Fig. 5. Fixed frame photograph of brood frame.

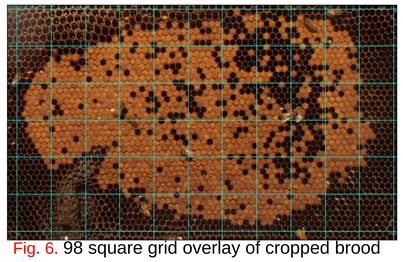

Fig. 6. 98 square grid overlay of cropped brood frame to calculate brood cm² .

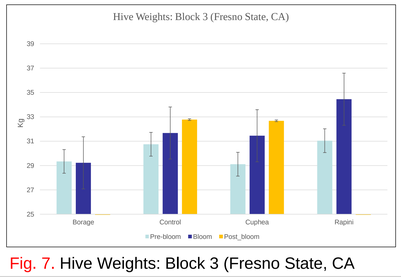

Fig. 7. Hive Weights: Block 3 (Fresno State, CA

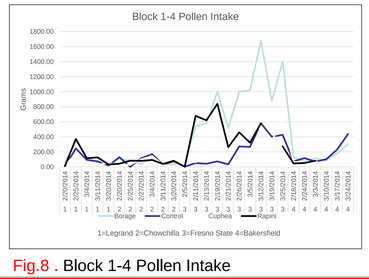

Fig.8 . Block 1-4 Pollen Intake

RESULTS AND DISCUSSION:

Cover Crops: All rapini plots began blooming in the last week of January. Almost 100% of the plants bloomed (Figure 4). Other treatments were not as prolific.

Multivariate Tests: Brood cm²: A two-way repeated measures ANOVA was conducted on the brood cm² data to look for interaction between time and cover crop treatment. However, this interaction was not significant (P = 0.963).

Multivariate Tests: Hive Weights: A two-way repeated measures ANOVA showed that there was no interaction (P = 0.681) between the cover crop treatment and time on brood cm². There was no interaction (P = 0.546) between the cover crop treatment and time on hive weights. Time and cover crop treatments also had no effect (P = 0.071 and 0.637, respectively) on hive weight.

CONCLUSION:

The experimental design of pursuing a non-irrigated field trial, coupled with the ambitious distance parameters involved in separating treatments to prevent cross foraging, proved to be quite troublesome. Because of a lack of water, some treatments in the RCBD yielded no data at all, while others were slow to grow and flower, thus depriving us of a pre-bloom set of data. Despite these shortcomings, valuable data on pollen volume versus other blocks was gathered from Block 3 (Fresno) (Figure 8), as well as floral diversity from all blocks (Figures 9-12).

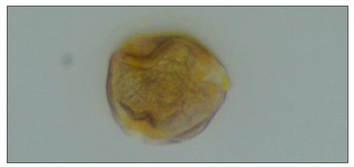

Fig. 9. Magnified (x1000) pollen grain of fiddleneck (*Amsinkia intermedia,* Boraginaceae).

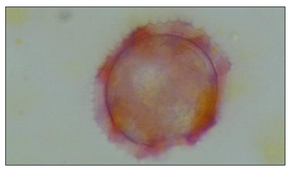

Fig. 10. Magnified (x1000) pollen grain of Asteraceae.

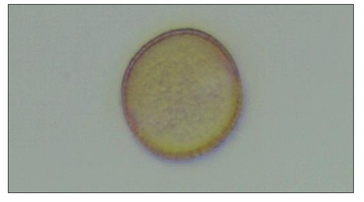

Fig. 11. Magnified (x1000) pollen grain of wild mustard (*Sinapsis arvensis*).

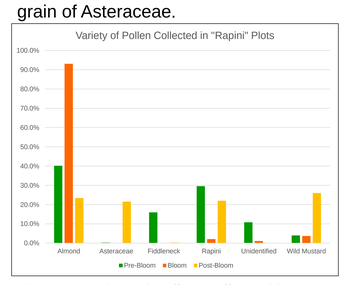

Fig. 12. Variety of Pollen Collected in "Rapini" Plots.

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