COOPERATIVE EXTENSION UNIVERSITY OF CALIFORNIA

from the U.C. APIARIES University of California

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When to Leave Almond Orchards

Let's start with when to bring honey bee colonies into the almond orchards. The recommendations suggest moving the hives into or around the orchards at about 10 percent bloom. This is supposed to be enough bloom to hold the bees and keep them out of any competing bloom However, until bloom from at least one additional compatible variety is available, not much cross-pollination will be accomplished.

References go on to state that when temperatures reach about 55 degrees Fahrenheit, the anthers in the open blossoms dehisce (crack open), exposing the pollen. There is a progression in this release of pollen, with about one-third of the anthers releasing pollen over three consecutive days.

The pollen-receiving structure, the stigmatal surface, is receptive from the first day the blossom opens until about the fifth day. However, if adequate pollen is deposited on the stigma daily, fertilization is best with the earliest timing. Day One and Day Two are really good. Day Three is not so good. Day Four is relatively poor and Day Five accounts for practically none of the set.

The petals open on Day One as normally do the first third of the anthers. The petals remain on the blossoms for more than five days; well after the stigma is no longer receptive. Nectar is secreted for a couple days after the flower isn't capable of being pollinated. Thus, nectar collectors may still be in the trees beyond the time that any pollination is taking place. Strong winds and rain may knock the petals off the blossoms before they normally fall, but by watching the bees it is easy to determine whether any pollination is being accomplished. If the foraging bees are not collecting and carrying pollen on their legs, there is little to no pollination going on.

When should the colonies be allowed to leave the orchards? When pollination no longer is happening. That does not mean that the bees should remain in place until the last petal falls from the last blossom.

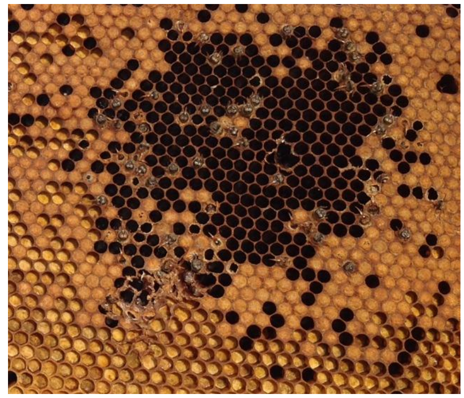
Why might beekeepers desire to move their hives out of the orchards "early?" Once the almonds no longer provide nectar and pollen for the bees, the bees find replacement sources of food. Unfortunately, those sources may be contaminated with pesticides that almond growers would never use when the bees are present. Some common pests that surge right near the end of almond bloom include Egyptian alfalfa weevil larvae and aphids in alfalfa, and grape cutworms in vineyards. Delayed dormant sprays sometimes are being applied in other deciduous fruit orchards, even when the trees are in bloom. Often blooming weeds in the crops are attracting honey bees. If the year is really dry, the bees may be attracted to sugary secretions of aphids and other sucking bugs. So, it is not difficult to see that accidental bee poisonings often happen. Despite our California regulations requiring beekeepers to be notified of applications of bee-toxic chemicals within a mile of the apiaries, bees fly up to four miles from their hives to find food and water. That is an area of 50 square miles in which they may find clean or contaminated food sources. Thus, growers whose fields are "nowhere near" any known apiary locations may accidentally kill many bees with chemical applications.

Beekeepers also may wish to move their colonies from almonds before the last petal falls because of their other pollination contracts to which to move their bees. Beekeepers may wish to move their colonies to locations where they can increase colony numbers by splitting the strongest colonies into two or three smaller colonies in hopes that they will develop quickly enough to be used for honey production later in the year. Beekeepers cannot make those splits unless the colonies are highly populated with adult bees and have many combs of healthy brood.

This season a very significant number of colonies rented for almond pollination suffered severe losses of adult bees and immature, developing bees (brood). Adult bee populations suddenly declined from ten or more frames of bees to four or five frames. The colonies had lost their total foraging populations. Samples were taken and perhaps the chemical(s) that caused those losses will be determined.

Coincidentally with those losses, beekeepers coming to remove their colonies from the orchards found comb after comb of dead larvae, dead pupae, or newly formed adult bees that had not developed normal coloration in their exoskeletons and were not able to emerge from their cells as adult bees. Often their heads were poking out of their cells and their tongues were stuck out, perhaps to recruit food or as a sign of insecticide poisoning. Abnormal immature development, especially mortality during a molt, is a common sign of exposure to an insect growth regulator. Although some fungicides have been implicated in such poisonings for years, the beekeepers are seeing more and more of this problem as applicators tank-mix fungicides and insect growth regulators (IGRs) and apply them during bloom.

Experiments conducted on the fungicides alone and in many cases the IGRs alone do not appear to elicit the damage that is seen when they are combined, perhaps including a newer adjuvant. This season the losses were of such magnitude (an unofficially estimated 80,000 colonies) that representatives of EPA visited to observe the damage. Below are images from Dr. Gordon Wardell of Para-mount Farming, of layers of dead bees on the ground, newly emerged, wingless bees pulled from the combs by other bees, and bees that failed in their attempts to emerge as adults.



It seems that a combination of exposures of colonies to truly bee-toxic insecticides, followed by delayed effects of exposure to fungicide/IGR mixes during bloom, really set the bees way behind. The problem proved so severe that a number of beekeepers stated that they were never returning to California for almond pollination. That is not a good thing, since we really don’t have too many colonies coming to almonds as it is.

The take-home message is that our honey bees cannot continue to be exposed to as many toxic agricultural products as they are, or we will not have enough bees to fill the pollination demand for our nuts, fruits, vegetable, forage and seed crops. Too many colonies are dying or being knocked back to nearly nothing for the industry to survive financially. Growers who do not require honey bees for pollination should still be concerned about bee health. Their neighbors are relying on those bees. The bees must be up and alive when they are needed.

It is fairly easy to suggest what can be done to protect the bees, but everybody must listen. First, when using insecticides in particular, choose the ones that can adequately get the job done without damaging the colonies. A very nice, new publication relating the impact of certain pesticides to honey bees can be downloaded free from an Oregon State University website:

http://extension.oregonstate.edu/catalog/details.php?search=pnw+591&submit.x=11&submit.y=4 .

Second, try not to hit flying bees, especially pollen collectors, with spray applications. Try not to contaminate pollen with spray applications. Depending upon the daily bloom cycle, many plants shed pollen early in the day. Pollen-collecting bees often remove the pollen and leave the blossoms by mid-day to early afternoon. Applications of pesticides that are not acutely toxic to bees can be used when the pollen collectors are finished for the day. Acutely toxic chemicals should not be applied when bees are in the fields or orchards. Acutely toxic materials, even night-time applications, may still be very toxic to bees on following days. Product labels seek to convey that information with RTs (residual times). Please read the labels carefully. Dry residues are much less toxic to bees than are residues that did not have enough time to dry or were re-wetted by dew. However, simply because a pesticide label does not carry a bee warning, or even states that it is "safe" to use around bees, does not mean that the use of the material will not result in loss of honey bee brood. The best exposure to pesticides for honey bees is no exposure at all.

Annual Cost of Bee Feed – CBBA, January 2013

Beekeeper	Colony Numbers in Thousands	Annual Syrup Cost in Thousands of Dollars	Syrup Cost/Col. In Dollars	Annual Protein Cost in Thousands of Dollars	Protein Cost/Col. In Dollars	Total Feed Costs in Thousands of Dollars	Total Feed Costs/Col. In Dollars
1	6.00	252	42.00	90.0	15.00	342.0	67.00
2	2.00	62	31.00	11.0	5.50	73.0	36.50
3	15.00	675	45.00	60.0	4.00	735.0	49.00
4	11.00	430	39.09	48.0	4.36	478.0	43.45
5	6.00	250	41.67	25.0	4.17	275.0	45.84
6	12.00	300	25.00	60.0	5.0	360.0	30.00
7	14.00	400	28.57	100.0	7.14	500.0	35.71
8	2.00	65	32.50	16.0	8.00	81.0	40.50
9	5.00	100	20.00	25.0	5.00	125.0.0	25.00
10	2.00	60	30.00	12.0.0	6.00	72.0	36.00
11	1.15	30	26.09	4.5.0	3.91	343.5	29.99
12	2.00	60	30.00	6.0	3.00	66.0	33.00
13	1.00	30	30.00	5.0	5.00	35.0	35.00
14	3.30	65	19.70	36.0	10.91	101.0	30.61
15	1.10	45	40.91	8.0	7.27	53.0	48.18
Totals	83.55	2,824	481.53	506.5	94.26	3,330.5	585.78
Averages	5.57	188.27	32.10	33.77	6.28	222.0	39.05

Figures may not match exactly due to rounding errors.

Annual Colony Feed Costs

For years we've wanted to generate a cost-of-production data package for maintaining a colony of honey bees for 12 months in California. However, requests for voluntary completion of survey forms have never generated enough responses to complete the task. Thus, best guess estimates by a number of commercial beekeepers in 2012 pegged the costs to at least $220 to maintain colony populations of eight frames or better to meet almond pollination demands.

At the January 2014 meeting of the California Bee Breeders' Association, Inc., I had a captive audience of nearly 20 commercial operators. I sent around a data sheet asking each beekeeper to anonymously fill in the number of colonies operated in 2013 and the total costs for sugar syrup and protein feed, fed only to their full-sized colonies, but not including the feed that was fed to their queen mating nucs. With total anonymity, the response was pretty good.

Fifteen beekeepers supplied data that can be reviewed in the table below. The substantial variations in the per-colony costs of purchasing feed exemplify the difficulty we have had in trying to generate an average cost of production for California beekeeping operations. Very few of them are "average." Keep in mind that feed costs represent only the costs of the raw ingredients, not the labor and travel expenses involved with placing the feed in the hives. Prices for raw ingredients vary according to feed type (*i.e.*, sucrose *versus* high fructose corn syrup blends) and whether the feeds are premixed or self-formulated.

The fifteen bee breeders reported operating a total of 83,550 colonies. They spent over $42.8 million on sugar syrups and $506,500 on protein substances. They averaged $32 in syrup and a little over $6 per colony on protein, for a total of nearly $39 for bee feed. However, the range in the per-colony expenses varied from a high of $45 for syrup to a low of $19.70, and for protein feed, a high of $8 to a low of $3. Most of the variation is related to the amount of natural nectar and pollen resources the bees were able to find during the year.

The bee breeders are located in the Sacramento Valley in northern California. Beekeepers based in the San Joaquin Valley, in southern California, or in other states are likely to have very different requirements for bee feed.

<u>ELAP Revived</u>

Beginning on "tax day" of this year, funds became available to reopen the USDA Disaster Assistance Programs that had been in limbo since the last Farm Bill expired in 2011. Fortunately, "Honeybees" were reinserted into the new Farm Bill at the last moment and are still covered for losses, under the "Emergency Assistance for Live-stock, Honeybees, and Farm-Raised Fish Program" (ELAP). A beekeeper can apply for colony losses that occurred during calendar years 2012, 2013, and 2014. Originally, ELAP was expanded to honey bees to cover losses caused by CCD. That likely will remain the case, but this year's droughts and other weather-related problems may be considered. If your losses can be traced back to poor beekeeping decisions, then there may not be much help available. If your losses can be attributed to CCD or other things over which you had no control, then some help could become available.

If I remember correctly, for claims based on CCD, someone in a position of authority must have examined your operation and signed a statement that he or she observed definitive signs of CCD in order for the paperwork to be accepted.

All these matters are handled through your regional Farm Service Agency office. You used to be able to find them in the Yellow Pages under Government Offices, but now you won't even find Yellow Pages. So, using your browser, type in something like "FSA office – USDA Service Center ((your state's two-letter abbreviation))." When I did that for California, one of the links was: FSA office – USDA Service Center. From there you follow the links to your state, then to your county. The offices list contact information.

<u>Help Combining Colonies</u>

At various times, and for various reasons, beekeepers sometimes wish to combine two colonies, hoping that they will settle down into one good colony. Experience suggests that sometimes such combining goes smoothly, but sometimes the colonies do not blend well.

There can be significant fighting and loss of many bees.

It is likely that combining goes more smoothly when forage is still relatively abundant. The foragers are busy and not at home most of the day. Food is abundant enough to prevent the neighboring colonies from issuing robber bees. But all that changes when the "flow" ceases. And isn't that when many beekeepers wish to combine colonies that are not adequately strong to make it through winter, or are too numerous to maintain in a small apiary so combining in late summer is a way to reduce colony numbers? At that time of the season, the colonies don't tolerate foreign intruders, and we are trying to add a lot of them.

Dr. Michael Breed and colleagues at the University of Colorado, Boulder, knew that honey bees can recognize their kin by odors on the exoskeleton and that they match some of the odors of the bees-wax in the colonies. The differential odors of the hives probably help the bees orient and return to the proper hives after foraging. So, what would happen if a beekeeper could introduce a substance into the hives or apply it to the bees that would reduce hive and kin recognition? The literature and Dr. Breed's previous work demonstrated that non-related bees, treated with 16- or 18-carbon fatty acids, were much less apt to fight when placed in an arena, than if they were not treated. In the previous studies, fatty acids like oleic, linoleic, or linolenic acid were the test substances. Dr. Breed determined that flax seed oil contains many of the same fatty acids as beeswax, so it might confuse the bees a bit. Another less purified form of flaxseed oil, linseed oil, is used as a wood preservative but is not safe for food products, so don't use it in beehives.

Nest mates placed in plastic-bag arenas showed no aggression toward each other, unless one of the bees was treated with 0.01 milliliters of flax seed oil, which is equivalent to one-fifth of a drop of water. Then recognition was masked and the bees did not get along. On the other hand, if two bees from different colonies were both treated, they got along fine. The authors conclude by suggesting that using flax seed oil before combining colonies, and treating one colony of the two obtained by making a split to prevent foragers from returning to the original hive, might have field value when working with honey bees. They did not pursue those studies.

For further details, please see: Breed, M. et al., 2012. "Use of Flax Oil to Influence Honey Bee Nestmate Recognition." J. Econ. Ent. 105(4): 1145-1148; doi: http://dx.doi.org/10.1603/EC12009.

<u>Honey Classification by Electronic Tongue</u>

We know some beekeepers or honey-attuned individuals who can stick a toothpick into a jar of unlabeled honey and guess what variety it is most of the time. That means that there are some distinct aspects of honey taste that should be measurable. It also suggests that the efforts of some European groups, and a similar effort that is underway under the auspices of the Robert Mondavi Institute for Wine and Food Science's Honey and Pollination Center, may lead to some interesting results. As an aside, the Honey Center recently hosted a mead-making workshop at UC Davis conducted by our wine and beer brewing experts. I believe that DVD(s?) of that conference will become available before long.

Back to tasting honey. We have five major "tastes" that we use to distinguish between foods: sourness, saltiness, sweetness, bitterness, and savory. That last one is a bit difficult to describe – perhaps pleasing to the sense of taste. So not surprisingly, companies have tried to develop instrumentation that can tell us how food tastes, based on our taste buds and a bit more. The Alpha MOS company in France provided seven potentiometric chemical sensors for its α-Astree electronic tongue that were used to taste eight kinds of floral honeys from China. The sensors have names reminiscent of a Dr. Seuss book: ZZ, BA, BB, CA, GA, HA, and JB. However, the probes were tested against citric acid, salt, glucose, caffeine and MSG representing the five human tastes and were able to detect them at one ten-thousandth to one ten-millionth mole (molecular weight in grams) per liter in water solution.

Researchers dissolved 60 grams of eight distinctly different, local floral honeys in 400 milliliters (ml) of deionized water, then moved

80 ml of each into clean 150 ml, sealable jars and took readings using the various probes. They graphed the changes in electrical voltage (mv) between the sample and the Ag/AgCl reference electrode. Most of the probes had stabilized in about 10 seconds. However, BA (the salt tongue) usually took about 40-90 seconds to level off.

The next step was analysis of the results. I am not going into all of this, but suffice it to say that the researchers compared results of these tests using three different approaches: 1) Principal component analysis (PCA) which determines groupings within a data set. 2) Cluster analysis (CA) which allows determining similarity of relationships using chosen criteria. When charted, the distances between the locations on the plot demonstrate degrees of similarity. 3) Artificial neural networks (ANN) which are commonly used for pattern recognition.

PCA proved least able to differentiate the samples (87.58 percent of the variance). CA, which described 92 percent of the variance, was bested only slightly by ANN which discriminated 93.75 percent of the variance. The authors went on to state that in their attempts to "classify honey samples from different floral and geographical origins by electric tongue," they felt that PCA was best for differentiating honeys, but that all three approaches would work well. PCA had a bit of a problem differentiating between samples of *Acacia* honey from five different geographical locations, but its floral source was obvious. The authors concluded that the electronic tongue approach to identifying honey was quicker than, and as accurate as, trying to identify pollen grains in honey samples.

This is not new research, but we haven't heard much about it: Wei, Z., *et al*., 2009. "Technique potential for classification of honey by electronic tongue," Journal of Food Engineering 94: 260-266. Doi.10.1016/j.foodeng.2009.03.016.

Local Honey for Allergies

Beekeepers, medical professionals, and many other people ask, "Does eating local honey really cure hay fever?" My answer has been, and probably will continue to be, "It seems to work well for some individuals, and, if you don't eat too much it shouldn't hurt you." When pressed, I would say that I was not familiar with a clinical study that demonstrated such an effect, but there were limitless testimonials.

Recently a clinical study demonstrated some success in consuming local honey for relief of "allergic rhinitis." Zamzil Asha'ari and a team of hospital research collaborators in Malaysia took a group of 40 hay fever sufferers and divided them into two equal groups by symptoms. All patients received a daily dose of 10 mg loratadine (Claritin® 12-hour has 5 mg) for a month. Half the patients concurrently received an additional 1g/kg serving of honey, daily, split into four equal doses. That is close to feeding 1/6 pound of honey per day to a 200-pound person. The control group was fed 1/6 pound of honey-flavored corn syrup. Symptoms of rhinitis were scored on Day 1, Week 4, and Week 8, to conclude the study. However, the patients were followed longer after honey consumption terminated at eight weeks.

At the beginning of the study, things were equal. Interestingly, by Week 4 both groups of patients exhibited progressive improvements in rhinitis symptoms (placebo effect or reduction in antigens?). During the next 4 weeks, only the group fed honey continued to demonstrate even more progressive improvements. After treatments ended, the improved state of health persisted for another month.

If you wish to review the article, please find: Asha'ari, Z., *et al.*, 2013. "Ingestion of honey improves the symptoms of allergic rhinitis: evidence from a randomized placebo-controlled trial in the East Coast of Peninsular Malaysia," DOI: 10.5144/0256-4947.2013.469.

Fumigillin Problematic?

A team of researchers at the University of Illinois and the Noyes Laboratory in Urbana, Ill, took an in-depth look at the implications of exposing honey bees and the two *Nosema* species to fumagillin. They concluded that for colonies with heavy infections, treatment might be advisable. But they also found that as the concentration of the chemical fell, both *Nosema apis*, a little, and *Nosema ceranae*, a lot, could rebound and produce even more spores than untreated honey bees. Digging more deeply than field observations, the team moni-tored the effects of fumagillin on the enzyme methionine aminopeptidase-2. We share that enzyme with the bees. The enzyme is important in protein maturation and post-translational processes. Exposure to fumagillin has reduced the life expectancies of honey bee workers and queens and has negatively affected wax moths.

At the labeled dose, fumagillin suppresses midgut spore production in both *Nosema* species. By 12 days post treatment at 0.01X field dosage level, only *Nosema apis* was still suppressed. *N. ceranae* spore counts were back up to the controls. At 0.001X, *N. ceranae* produce 40 percent more spores that *N. apis* and 24 percent more spores than the controls. Hindgut spore counts were even higher: 80 percent more spores than *N. apis* and 150 per cent more spores than the controls.

Field studies in Spain demonstrated that fumagillin broke down to 0.001X in about three months. These authors suggest that the normal six month break between field treatments would allow a large increase in nosema infection levels between treatments. Thus, they suggest that we develop a new treatment for nosemas that will not have these rebound effects. Doi: 10.1371/journal.ppat.1003185.

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