Natural Comb Management of Honey Bees for Varroa Control

Final Report for FS07-221

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Principal Investigator:

Michael Wilson

Project Information

Abstract:

Project activities
At two locations, beehives were managed with wooden starter strips instead of standard 5.4mm foundation by turning the wedge of a 'wedge top' frame on its side and applying a bead of wax. Doing this provides a guide for the bees to build comb from the top of standard frames. Foundation is a sheet of wax with hexagonal cells imprinted on the sheet to create a guide, throughout the entire frame, for the honey bees to build their comb. The colonies in which foundation sheets are not used are called 'natural cell' colonies as the sizes of the cells they build are 'natural' instead of being influenced by foundation cell sizes. We intended to test the idea that a standard 5.4mm foundation cell size alters the biology of honey bee colonies in a way that is detrimental, as it relates to parasitic Varroa mite populations. As a part of this idea, some beekeepers buy 4.9mm foundation, with the idea that this size is more 'natural'. Since Varroa destructor mites only reproduce on pupating honey bees in their cells, it is reported the size of the comb cells may influence the mites' ability to reproduce.
At location 1 (Michael Wilson), in spring 2007, ten colonies were started from splits of natural cell colonies begun in 2006. Each colony split consisted of 5 medium frames of comb which included the approximate ratios of, 2 frames of brood, 1 frame of pollen, 1 frame of honey, and 1 empty frame. Each colony split also had about 4 frames of bees and a new Carniolan-Italian hybrid queen acquired from the same supplier the day before. In the five control colonies, standard 5.4mm wax foundation was provided in frames and the colony was built up to 3 medium boxes. Five natural cell colonies were established using frames with wooden starter strips instead of foundation. Once these colonies were built up to 3 medium boxes of comb, the original 5 frames of the splits were removed and replaced with frames of foundation and starter strips respectively. Therefore, by fall 2007 all combs in the hives was newly built.
In 2008, these ten colonies were observed another year, while ten new colonies were made from splits of these hives. All colonies were again given new queens from the previous supplier. While making new colonies, frames were removed from

the 2007 colonies to populate the new ones. New frames were used to replace the ones removed and thus a third year of comb was built without the influence of foundation in natural cell hives. The ten group 2008 colonies were split from their respective control and natural cell parents in the same matter as colonies started in 2007, except this time natural cell colonies were given 10 frames of 4.9mm foundation per colony in addition to starter strip frames. The ten group 2007 hives and ten group 2008 hives were again allowed to build up to 3 medium boxes. When applicable, honey supers were provided above a queen excluder with drawn comb and foundation to provide an area for harvestable honey. The strength of the hives, surplus honey, worker cell size, Varroa mite populations, and percentage of drone comb as compared to worker comb was recorded.

The strengths of the hives were measured a number of ways. In spring 2007, the rate in which the new colonies built comb was recorded. As described by natural cell beekeepers, empty frames were moved into the middle of drawn combs to encourage comb building. Every 10 days, this manipulation was done in all ten colonies and the percentage of drawn comb in each group was recorded.

Surplus honey was recorded as numbers of frames of honey removed from supers. Worker cell sizes were measured by placing a metric ruler over the cells and measuring 10 cells. Dividing this measurement by ten made one observation of cell size. One to four cell size observations were made for most worker bee frames built in 2007 and 2008 for both natural cell and control colonies.

Varroa mite populations in the beehives were recorded as 24hr natural mite fall averaged over 3 days. Natural mite fall is used as a method to record Varroa mite populations. A wood frame with screen on the top and a sticky, plastic shelf liner underneath is slid into the entrance of the hives. Any mites that fall off bees or from the comb go through the screen and become stuck to the shelf liner material. After three days, the screens are removed and mites counted. This was done roughly once every 4-5 weeks with longer intervals during winter months.

Percentage of drone comb per colony was also measured. Combs in which honey bees raise drones (males) are visually larger then cells built for raising workers (females). It is understood that exclusively providing 5.4mm foundation in each frame suppresses the amount of drone comb built by colonies.

At another location (Larry Chadwell), 10 hives were started in 2007 from standard foundation hives. Five colonies were again developed on starter strips, while the other five were on 5.4mm plastic foundation. These hives were kept for 2 years and allowed to build up to two deep box hives, instead of the three smaller medium boxes used at Michael Wilson’s location. At this location, the deeper frames of the hive boxes seemed to cause problems. Larry Chadwell took the project in a different direction at this point. Learning from the comb building activities of hives without foundation, a method called “drone comb trapping” was used in a way to take advantage of the bees desire to build drone sized cells when not given foundation. This technique is well proven to reduce Varroa mite populations. Varroa mites are highly attracted to drone pupae over worker cells and honey bees like to have a certain amount of drone comb in their hives. When a beekeeper provides empty frames in colonies with only combs built from standard worker size (5.4mm) foundation, they will build drone cells. These drone combs are then removed when the drone pupae are capped and the combs, with Varroa mites inside, are destroyed.

Drone comb trapping is often described as a labor intensive technique primarily suited for hobby beekeepers. Larry Chadwell keeps about 100 hives, which is considered large scale for our area. He decided to try out the feasibility of drone comb trapping on the large scale of 100 hives.

Data collection was initially conducted on his natural cell trial hives, but it was halted after the initial poor performance of natural cell colonies. Data collection on the 75 hives in which drone comb trapping was being used was not possible in this study. However, Larry Chadwell's experience and opinion of the feasibility of large scale drone comb trapping and the usefulness of natural cell beekeeping was recorded during an interview by Michael Wilson.

Results

The results are separated between Michael Wilson and Larry Chadwell's location. At Michael Wilson's location, hives were grouped as 2007 hives and 2008 hives depending on when the colony was started. Five control and five test hives were in each group. During the first year of both groups, mite levels did not significantly differ. However, during the second year of group 2007 colonies, mite levels were significantly lower in natural cell hives (60 ± 11, mean ± s.e.) than in control hives (114 ± 22; P = 0.0004). Despite these lower numbers, hives in both groups surpassed economic thresholds and experienced colony death. The mean peak mite levels in natural cell colonies reached 162/day, while in control colonies they reached 278/day. The economic threshold is considered to be between 59-187 (Delaplane 1999 Apidologie 30:383-395). By the end of the study, across both group 2007 and group 2008 hives, 5 out of 10 control hives and 5 out of 10 natural cell hives died, likely to Varossis.

The reason for the lower mite levels in the 2nd year of group 2007 hives appears unrelated to worker cell size. Control colonies in both year groups had a worker cell size of 5.3mm ± .003 (mean ± s.e., n = 531) while natural cell colonies had a worker cell size of 5.4mm ± .007 (n = 437, P ? 0.0001). Cells of natural cell colonies did not decrease in size between 2 years (2007) and 3 years (2008) of management without foundation. The worker cell size of comb on small cell (4.9mm) foundation placed in group 2008 hives was 5.5mm ± .02 (n=96). The bees ignored the cell imprints on the small cell foundation and built either drone cell sizes, or worker cell sizes close to 5.5mm.

It is difficult to say if the strength of 2nd year, group 2007 control colonies could account for the higher mite counts. Colonies with higher bee populations will have more mites. The average strength of group 2007 colonies did not significantly differ when measuring the rate of comb building in spring 2007, the hive weight in summer 2007, and the area of bees, brood, pollen and honey in the brood chambers during spring, summer, and fall 2008. However, significantly more comb was built by control colonies (100% ± 0, mean ± s. e.) as opposed to natural cell (87% ± 5.78; P = 0.0492). This trend is also seen in honey production. Significantly more surplus honey was produced by control colonies (25.4 frames ± 3.9, mean ± s.e.) over natural cell colonies (5.4 frames ± 3.5; P = 0.0052). This difference may be related to the greater amount of drones produced by natural cell colonies. Due to the timing of data collection, a difference in the amount of drones between the two groups was not measured, however a difference in drone comb was measured in natural cell colonies (33% ± 3.5%, mean ± s.e.) as opposed to control colonies (1% ± 0.2; P ? 0.0001). Plentiful drone production was observed in the second year of group 2007 natural cell colonies, as opposed to controls. In first year natural cell colonies, drone production was not as evident. In a previous study, (Seeley, 2002 Apidologie 33:75-86) colonies with 20% drone comb were found to gain half the weight of control colonies and produced more drones.

At Larry Chadwell's location, Varroa mite levels did not differ significantly between control (27± 22.46; mean ± s.d.) and natural cell hives (24 ± 20.29; P = 0.5463) in the first year. Control colonies were stronger by weight in kilograms (49.1 ± 4.54; mean ± s.d.) as compared to natural cell (35.78 ± 4.21; P = 0.0026). The weight of control colonies was adjusted to account for the additional plastic foundation. The bees in the natural cell colonies did not move up well into the second deep, while the hives with foundation moved up and completed the combs in the upper box.

Combs that were built in the upper boxes of natural cell colonies was mostly drone comb, some of which was not straight in the frames. The combs in the first box of natural cell colonies were built well. This was also observed at Michael Wilson's location. The combs in the first box without foundation was mostly worker comb, but as they moved up into more boxes, and the season progressed, mostly drone comb was constructed.

The drone comb trapping trial was added in spring 2008. In his opinion, he found it to be economically feasible and a good fit in his management of 50-75 colonies out of 100. He plans to expand it to all his hives in the coming season. To use drone comb trapping, he put a 2 inch strip of wax foundation across the top of a deep frame and left the rest of the frame empty. One to three frames were provided per hive. Then, during his normal spring inspection routine, he would cut out the drone cells on an every other brood cycle basis. This allowed some drone production for mating queens. Larry makes splits of his colonies for resale, so he is in them about once a week during the spring before queens are shipped to make splits with. During these inspections he is doing swarm control and making splits from colonies with queen cells. Drone cells were consistently built in the empty frames below the wax strips. This is due the preference for bees to build 17 ± 3% of drone comb in natural colonies (Seeley 1976 Insectes Sociaux 23:494-512).

From the results above, it is clear natural cell beekeeping is not a successful method to control Varroa mites in small scale, commercial apiculture. In addition, the increase in management and decrease in honey yield, probably due to excessive drone production, is not compatible with profitable beekeeping. However, drone comb trapping is a proven method for organic mite control and can be successfully and efficiently applied by beekeepers managing 100 colonies or less.

Future Work

This study did not produce results that show natural cell beekeeping as being a beneficial practice for beekeepers. However, it did produce results that question an accepted understanding of Varroa mite population growth. The main difference in makeup of natural cell and control colonies was the percentage of drone comb. Drone production is understood to increase Varroa mite populations in hives (Seeley, 2002 Apidologie 33:75-86). This is due to the fact that one female mite can produce more offspring in drone cells then she can in worker cells (Martin 1994 Exp Appl Acarol 18: 87-100). However in this study, the colonies with more drone comb produced fewer mites. This result only occurred in the second year of the group 2007 hives, but it is likely that this was the only situation where much larger amounts of drones were being produced by natural cell colonies. During the first year of natural cell hives, mostly worker combs were developed initially, and then as the season progressed, drone comb was built in the form of honey storage comb and filled with nectar. During the colony's second season, the bees had eaten through the honey during the winter making the drone size comb available to rear drones. So, during the period with the greatest potential for natural cell colonies to rear the most drones, fewer mites were produced. When the natural cell colonies had the least potential to rear drones, their mite levels did not significantly differ.

The natural mite fall method records total mite population per hive. The strength of the hive affects the amount of mites in the hives. Stronger hives will have more mites, since there is more brood for the mites to reproduce in. This study did not record a difference in the strengths of natural cell hives as opposed to control colonies 'per se', but a short term difference in strength may have been missed, during the peak drone rearing season. If it takes more energy to rear drones then workers, there may have been a short term reduction in hive strength in natural cell colonies. Or, the potential for worker production may have been decreased in natural cell hives due to the limited amount of worker comb, compared to control

colonies.
It would be beneficial to continue similar work to more directly ask, “What effect does drone comb have on colonies” and, “what is the optimal amount of drone comb that balances benefits and costs”. It is clear in this study that a large amount of drone comb significantly reduces honey yield. This was also observed by Seeley 2002. Understanding the effects of drone comb on colonies is important because drone comb is recommended for Africanized Honey Bee mitigation by flooding the area with European drones. Drone comb is also used for drone comb trapping, but beekeepers may wonder if they are doing more harm than good if they don’t have time to destroy the drone comb, and mites inside, before they emerge. Drone comb is also necessary for queen rearing. It is well understood that plentiful drones are necessary for proper mating of queens. However, does the perception of more Varroa mites reproducing in drone cells, due to the higher reproduction rate, limit the use of drone comb for the above benefits? And, what is the optimal amount of drone comb as it relates to cost and benefits?

Adoption

Neither Michael Wilson nor Larry Chadwell adopted natural cell beekeeping. Both are eliminating the natural cell hives from their apiaries spring 2009. Also, neither plan to use small cell foundation in their hives in the future as the bees do not readily use it correctly. And, because other studies have come out recently showing the failure of smaller comb cells to decrease Varroa populations (Berry 2009, in press; Ellis 2009 Exp Appl Acarol. 47:311-6; Taylor 2008 J App Res 47:239-242;).
It is clear that natural cell beekeeping increases labor, reduces honey yield, limits the amount of worker comb that can be used for making marketable nucleus colonies, does not prevent surpassing economic thresholds of mite populations, and does not prevent colony death from mites. However, both Michael Wilson and Larry Chadwell are adopting drone comb trapping as an organic method for mite control. The experienced gained from using starter strips instead of foundation has shown how bees easily build drone comb on their own. Drone sized foundation is advertised and sold for drone comb trapping, but this study shows plentiful drone combs can be built without having to use drone sized foundation. During spring inspections for swarm control, and when making spring splits, capped drone comb will be culled to reduce mite populations. Due to the fact that capped drones will be removed when it is convenient instead of on a strict schedule as defined in most drone comb trapping schemes, it is likely some drone production will go unchecked. However, our study shows unchecked drone production should not increase mite populations. Some concern exists for reducing honey yield, but this should be remedied by reducing the amount of drone comb to the previously recommended %10, instead of %30 at Michael Wilson’s location, and removing capped drones when possible. Removing capped drones will reduce the cost of drone production on colonies by preventing the drones from becoming adults and consuming honey through adult hood. Drones do not forage, but instead consume hive honey and take mating flights, which could explain some of the decreased honey yield in drone producing colonies.

Outreach

Outreach is ongoing due to the fact that data collection for this project continued up till its end date. Outreach has already involved presentations at national and local level apiculture meetings, publication in a nationally distributed beekeeper magazine, and dissemination on the World Wide Web. A presentation was given to the 2009 American Bee Research Conference in Gainsville, FL. This meeting was combined with the Apiary Inspectors of America annual meeting. In one meeting, results of this project were distributed to many US bee researchers, apiary inspectors, and some international apiculture specialists. After the presentation,

more detail about the results were discussed with numerous researchers, some of which had either researched similar ideas, or whom have had experience with beekeepers using the techniques in this trial. A 540 word abstract from this presentation was written and is to be published in the May 2009 issue of the American Bee Journal as part of the proceedings of the American Bee Research Conference.
At the local level, a more detailed presentation was given to the Anderson County Beekeepers Association. Dissemination on the internet is underway by the placement of this report's summary, on the Anderson County Beekeepers webpage at www.acbeekeepers.org .
A detailed article based on this report and graphs will be developed with the intention of publication in one of the larger beekeeping trade journals. In the event that this detailed article does not get published, we will post it on the acbeekeepers.org website and advertise its presence through internet discussion groups and state beekeeping associations. If publication is successful, permission to place a copy of the article on the website will be pursued. The more detailed power point presentation will be enhanced to be given at other beekeeper meetings in the future.

Summary
A trial was conducted on natural cell beekeeping, comparing colonies with wooden starter strips to colonies on standard sized foundation. Colonies without foundation are reported to have fewer problems with parasitic, Varroa mites, due to smaller cell sizes. It was found that after 3 years without the influence of foundation, natural cell colonies drew out cells slightly larger than bees on standard 5.4mm foundation. Natural cell colonies produced significantly less honey, probably due to a significant increase in drone sized comb (%30 n.c., %1 with foundation). Varroa mite populations did not differ in the first year of colonies, but in the second, significantly fewer mites where recorded in natural cell colonies. This was surprising considering foundress mites can produce more offspring on drones. No significant difference in the population of the control and test group was recorded. Natural cell and control colonies exceeded economic thresholds for Varroa and experienced colony death. At another location, 1-3 frames without foundation per colony were used in 75 out of 100 colonies to test out the feasibly of a large scale use of drone comb trapping, a proven technique to control Varroa mites. The methods used for drone comb trapping, in this case, fit very well with existing management practices in these apiaries. It was decided that drone comb trapping is economically feasible in similar beekeeping operations with about 100 colonies. Based on our results, we recommend drone comb trapping for organic Varroa mite control and do not recommend natural cell beekeeping for mite control or profitable beekeeping.

Research

Participation Summary

US Department of Agriculture

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