A Modified Two-queen System: “Tower” Colonies Allowing For Easy Drone Brood Removal for Varroa Mite Control

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Summary

Capped drone brood removal is a varroa mite control technique that reduces the need for chemical treatments. This varroa mite control technique has not been readily accepted by many beekeepers because heavy honey supers must be removed to access the brood chamber. This study investigated a way of managing hives that makes it easier to access the brood nest and the contained drone brood, making drone brood removal a more viable option.

In this study we demonstrated that the management of honey bee colonies in a two queen tower configuration and utilizing drone brood removal reduced varroa mite population growth over the course of the summer. Colonies managed in a tower configuration contained fewer mites in early September than those that were managed normally. While this system would not likely permit beekeepers to forgo alternative mite treatment methods, it would keep mite levels below economic injury levels for a longer period of time.

Keywords: cultural control, management

Introduction

There are many ways to manage varroa mite, *Varroa destructor*, populations in honey bee, *Apis mellifera*, colonies including cultural and chemical controls. Beekeepers commonly use chemicals, but the mites have developed resistance to many of them (Elzen, *et al*. 1998, Pettis 2004, Lodesani and Costa 2005). There is also the concern that these chemicals contaminate bee products (Bogdanov et al. 1998). A more sustainable option is the use of integrated pest management (IPM), which involves using a combination of several mite reduction techniques which can include chemical and cultural controls. Drone brood removal is a cultural control technique that may be useful as part of an IPM program. This method of removing capped drone brood, and with it the reproducing varroa mites, can be very effective (Lavagnino 1995, Schmidt-Bailey *et al*. 1996, Calis *et al*. 1999, Calderone 2005). Varroa mites tend to invade drone brood more readily than worker brood so drone brood acts as an especially effective trap for the mites (e.g. Boot *et al*. 1991, Fries *et al*. 1994, Calderone and Kuenen 2001). Thus, removing the capped drone brood can greatly reduce the number of mites in infested colonies (Calderone 2005). However, drone brood removal requires the beekeeper to remove honey supers regularly to access the brood chamber. If there were a way of managing hives so it is easier to access the brood nest, drone brood removal would be a much more feasible option.

Some beekeepers use a two-queen system (Cale 1963, Hogg 1983) where colonies are maintained with two laying queens in one hive, with the two queens kept in different brood boxes by placing queen excluders between them. This management technique is thought to increase the honey bee population and, subsequently, the honey yield (Winston and Mitchell 1986). In addition, if one queen dies, the colony survives without an interruption in the addition of young bees.

In this study, we used a new hive configuration that took advantage of a two-queen system and permitted easy drone brood removal. We were able to keep the daily varroa mite drop from dramatically increasing over the summer without using chemicals and with very little effort.

Figure 1. *Hives in a tower configuration.*

Figure 2. *One side of a tower with the lid removed showing the drone frame, which is a green compared to the remaining frames, which are black.*

Materials and Methods

We started with 16 colonies in an apiary located at Betterbee Inc. in Greenwich, NY. Colonies were randomly assigned to one of two treatments: 1) normal management with a double brood chamber, queen excluder, and honey supers or 2) management in a "tower" arrangement. The tower arrangement consisted of two colonies in double brood chambers side-by-side with a queen excluder and honey supers over the center of the two brood chambers (Fig. 1). The exposed half of each brood chamber was covered by a half-size migratory cover. This setup allowed easy access to half of the frames in the upper brood nest of each colony (Fig. 2). This essentially created a two-queen system and enabled us to add and remove drone comb for mite trapping without having to remove honey supers. In addition, part of the brood nest could easily be inspected.

A one-piece plastic drone frame was added to each tower colony and the first honey supers were added to all colonies on 10 June 2005. Sticky boards were put in place in all of the hives that day as well, and were replaced every seven days until 12 August 2005. Each hive was considered separately, whether paired in a tower configuration or whether in the control group.

On 5 and 28 July, drone brood frames containing capped drone brood were removed and replaced with drone foundation. On 23 August 2005, drone brood frames were removed and replaced with drone comb that had been frozen from the previous replacement period. When possible, brood of the proper age from the removed frame was examined for varroa mites. The goal was to examine 50 capped drone brood cells per frame for the presence of varroa mites to quantify how many mites were being removed. The total amount of drone brood present on the frame was also estimated. A final sticky board was in place for three days from 9 to 12 September 2005. On 31 October, the honey was harvested from all of the colonies and the removed supers were weighed. The presence of the queen was also observed and the readiness of the colony for winter assessed.

Mite drop data from the three-day sticky board samples taken at beginning and end of the experiment, as well as during the 11 sampling periods, were analyzed using a split-plot analysis of variance design (PROC GLM; SAS Institute Inc. 1999). Treatment was the main plot factor and time was the subplot factor. Fisher's exact test was used to determine whether treatment affected queen or colony survival using contingency tables set up with three columns (treatment, status, and count).

Results

In the normal colonies (without having drone comb removed), average daily varroa mite drop increased from 3.2 ± 0.8 mites per day at the beginning of the study to 25.8 ± 6.7 mites per day over the course of the experiment (Fig. 3). In contrast, mite drop in the tower colonies, which had drone comb removed, increased from 1.9 ± 0.5 to 8.0 ± 2.9 mites per day. Thus, the change in mite drop over time was affected by treatment ($F = 5.09$; $df = 1, 28$; $P = 0.0320$). The course of the increase in mite drop over the duration of the experiment is presented in figure 4. The number of mites falling onto sticky boards was affected by treatment in five of the 11 time periods as indicated by a significant treatment x time effect (Fig. 4; $F = 4.21$; $df = 10, 154$; $P < 0.0001$).

In addition, the colonies from the two treatments produced equivalent amounts of honey with the normal colonies producing an average of 17.2 ± 4.9 kg and the tower colonies producing 15.2 ± 4.2 kg each or 30.3 ± 8.4 kg per pair ($F = 0.07$; $df = 1, 10$; $P = 0.7965$). On average, each drone frame removed from a tower colony contained 1,650 capped drone cells. Between 0 and 9 % of the drone cells that were opened contained varroa mites.

Overall, two colonies in the tower treatment and one in the control died before the end of the experiment. In addition, one queen was lost in the tower treatment. No differences between treatments were found ($P > 0.05$).

Discussion

Management of honey bee colonies in a tower configuration utilizing drone brood removal and a two-queen system reduced varroa mite population growth over the course of the summer. Colonies managed in a tower configuration contained fewer mites in early September than those that were managed normally. While this system would not likely permit beekeepers to forgo alternative mite treatment methods, it would keep mite levels below economic injury levels for a longer period of time.

The tower colonies went into the fall with much lower varroa mite populations than the control colonies. These findings are similar to those reported by Calderone (2005) who removed drone brood four times in a single summer. In this study, mite populations increased throughout the summer, as expected. This increase was significantly reduced when drone brood removal was employed. If mite population growth is slowed, beekeepers can confidently delay treatment until the end of the honey flow without compromising the health of the bees.

This management technique was easy to use and allowed bees to collect an equivalent amount of honey as compared to normally-managed colonies. In general, 2005 was a bad year for honey in New York and these colonies were started from packages, possibly contributing to the low yields in colonies from both treatments. In addition, the packages were started on frames of foundation and so the bees had to draw out comb, an activity that reduces honey production (Hepburn *et al*. 1984). If drawn comb is used for trapping, instead of foundation as was used in this study, the bees will not have to expend energy on wax production. In addition, previous work showed that the removal of drone comb increases honey production, likely due to the elimination of the need to care for costly drone adults (Seeley 2002).

The two-queen system did not increase or decrease the honey yield. In contrast, Gutierrez and Rebolledo (2000) were able to increase honey production using a two-queen system in Chile. In addition, Winston and Mitchell (1986) found that colonies managed with two queens contained more brood and bees than those managed

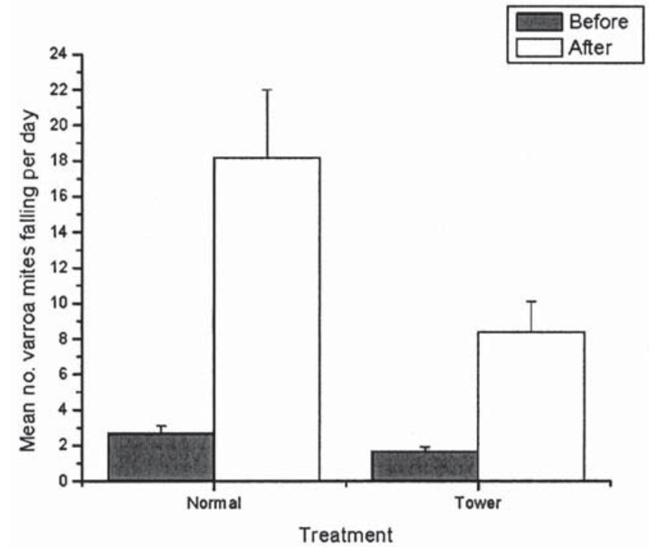

Figure 3. *Mite drop (mean ± s.e.) onto sticky boards at the beginning (Before) and end (After) of the experimental period. The change in mite drop from the beginning to the end of the experiment in the normally-managed (Normal) colonies was significantly different from that in the tower treatment (Tower) (P < 0.05).*

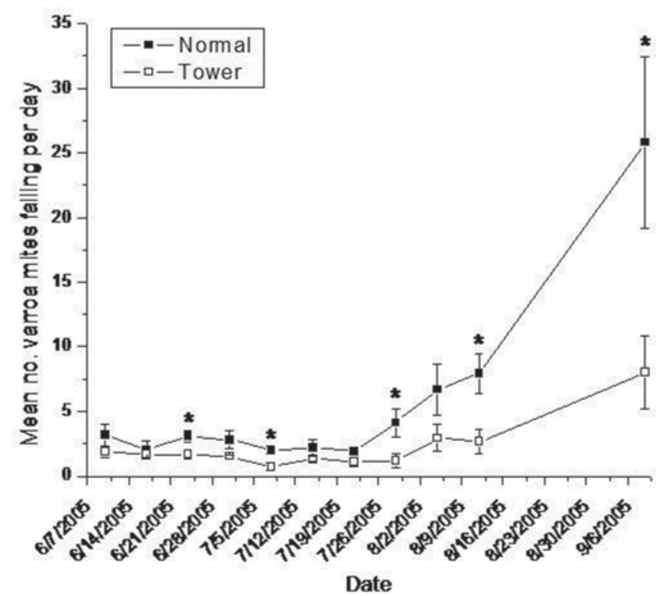

Figure 4. *Mite drop (mean ± s.e.) throughout the summer of 2005 in normally-managed (Normal) colonies where drone brood was not removed or in colonies in a tower configuration (Tower) where drone brood was removed. An asterisk (*) indicates a time when mite drop differed between treatments (SNK; P < 0.05).*

with one queen, but found that the labor involved in the system negated these positive outcomes. Using the tower configuration, labor was greatly decreased, allowing the two-queen system to be profitable.

Conclusion and Recommendations

We feel that the addition of drone brood removal to an IPM program using a tower configuration will be advantageous. The use of chemical acaricides will be reduced and can be delayed due to decreased mite reproduction. The tower configuration allowed for easy removal of drone brood, allowing this cultural control method to be used without added labor. We recommend the use of this system as part of an integrated varroa mite control program.

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