Effects of Hive Color and Heat on Tracheal Mites

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I recently published a study that measured the effect of heat on tracheal mite populations (Field and laboratory tests that associate heat with mortality of tracheal mites, *Journal of Apicultural Research,* 32: 159-165, 1993). From inquiries that I received, I learned that many people had read or heard about only parts of the study and had incomplete and in some cases incorect information. The major finding in the study was that heat can kill tracheal mites in live bees without killing bees. The major misunderstanding was that dark colored hives should be used to control tracheal mites. I do not recommend dark hives. Therefore, I decided to describe what I did, what the results were, and how I interpreted the results.

First Observations

In August, 1991, I noticed that a group of dark colored hives had very low populations of bees. During the summer dearth period in Louisiana, it is normal for a colony to decline in population, but these colonies were weaker than usual. Since tracheal mites were relatively new to the Baton Rouge area in 1991, I thought that perhaps tracheal mites had caused the ruin of these colonies. However, no mites were found in any of the colonies, even though 48% of the bees in those hives had been infested with tracheal mites in May. On sunny days, the dark colored hives were noticeably hot to the touch, so I considered that heat absorbed by the dark hives may have caused the decline in productivity of the bees and the demise of the tracheal mites. Work during the following year tested those ideas.

The Field Test

The following year, I set up an experiment consisting of 12 "cool" and 12 "hot" colonies. White paint was chosen as the color for the "cool" hives because among the finishes tested (aluminum paint, a radiant barrier, and various colors of paint), white paint provided the coolest interior temperature in empty hives. The hot hives consisted of the dark hives used the previous year; cool hives were produced by painting 12 of those hives with two coats of oil-based, white paint. I measured a variety of characteristics that reflected colony productivity and health

Table - Comparing 12 colonies in unpainted (dark) hives with 12 colonies in white hives. 38% of the bees were infested with tracheal mites on May 7, 1992. Data are mean ± standard deviation.

Characteristic measured	White colonies	Dark colonies	Prob.[2]
Initial adult bee pop. (May 8)	5014 ± 171	5075 ± 131	ns
Wt gain, 8 May - 28 May (grams)[1]	1483 ± 276	1674 ± 430	ns
Wt gain, 8 May - 5 Aug (grams)[1]	975 ± 631	30 ± 456	*
Capped brood, 28 May (cells)	5046 ± 559	4848 ± 687	ns
Capped brood, 10 July (cells)	3668 ± 672	2972 ± 831	*
Capped brood, 27 July (cells)	2753 ± 613	1601 ± 492	*
Capped brood, 5 Aug (cells)	3445 ± 1002	1741 ± 961	*
Adult bee population, 5 Aug	6495 + 1207	5410 ± 1295	*
Adult bee life span (days)	24.5 ± 4.6	28.8 ± 8.0	*
Bees with tracheal mites, 5 Aug	8.6% (31/360)	0.6% (2/360)	*
Bees with tracheal mites, 26 Oct	25.2% (83/330)	2.1% (7/330)	*

[1] This weight included pollen, honey, brood, and bees.

[2] Statistical probabilities. A "*" in this column indicates that the two numbers in the row (the means) are statistically different. An "ns" (not significant) indicates that the two means in the row, though not exactly equal, should not be regarded as different.

(results are listed in the table).

On sunny days in summer, temperatures in the brood area were often 5-6ºC (9-11ºF) warmer in dark than in white hives. Temperatures in dark hives often exceeded 40ºC (104ºF) with a maximum temperature of 45ºC (113ºF). The maximum temperature recorded in the brood area of white hives was 38ºC (100ºF). Temperatures in dark and white hives were not different during rainy days and at night.

Conclusions From Field Test

Although hive color had no effect in May, bees in white hives were more productive during June and July. Dark hives had fewer tracheal mites at the end of the test, but they also had fewer bees, less honey, and less brood. Three things are important to note: (1) these differences occurred in June and July in Louisiana where weather is hotter and more humid than most other places in the U.S.A, (2) mite populations were measured only at the beginning and end of the experiment (I do not know when the mite populations declined), and (3) an association between heat and mite populations does not prove that heat caused the mite populations to decline in the dark colonies.

Direct information was needed about the effect of heat on tracheal mites. Therefore, I conducted laboratory tests to measure the effects of time and temperature on the survival of tracheal mites.

Conclusions From Laboratory Tests

Laboratory experiments showed that temperatures that are not lethal to bees can kill tracheal mites inside live bees. Three temperatures were tested (42, 39, and 34.5ºC [the normal temperature of the broodnest of honey bees]; equal to 108, 102 and 94ºF). Temperatures as low as 39ºC were lethal to adult and immature tracheal mites, and 39ºC did no apparent harm to adult bees. Higher temperature (42ºC) killed mites sooner, but adult bees showed high mortality in the days after being exposed to this temperature; six hours at 42ºC did not seem to harm populations of 50 bees, but 42º killed larger populations of bees (such as 2 pounds of bees [*ca* 1 KG] in a standard package) in only a few hours.

Immature mites may provide the weak link in the life cycle of tracheal mites. Egg and larval stages of the tracheal mite were more susceptible to 39º than were adult mites. During the 48-hour period when bees were kept at 39ºC, existing eggs did not develop and female mites did not lay eggs. Adult mites did not show signs of mortality until they had been at 39º for 3 days.

A Possible Mechanism for Mite Control

I speculate that any stimulus that generates excessive heat in a bee is a potential control measure for tracheal mites. Tracheal mites live in tracheal tubes near the wing muscles, and these muscles are probably the hottest place within a bee and the major source of heat for a colony. When the temperature surrounding the bee high, the temperature inside the bee is probably higher, especially when the bee is active (flying or fanning the air to cool the hive). Thus any irritant (as menthol probably is) may help kill mites because of heat generated by treated bees as the bees respond to the irritant.

There seems to be a seasonal and geographic pattern to population change in tracheal mites, and these patterns may be related to temperature. Data from the field test (see table) show that dark colonies had fewer tracheal mites than white colonies, but both groups experienced a major decline in mite populations in the summer and an increase in the fall. In Louisiana it is difficult to study tracheal mites in summer because populations of tracheal mites are so low. I noted no concern about tracheal mites at a beekeeper's meeting in Florida, but Minnesota beekeepers considered tracheal mites to be a major cause of colony loss. Beekeepers in cooler climates tend to agree with the Minnesota beekeepers; those in warmer climates agree more with the Florida beekeepers.

These opposite conclusions from beekeepers in different parts of the country suggest that normal bee activities may kill tracheal mites when the outside temperature is high. Perhaps some locations do not provide enough hot weather to provide adequate seasonal control of tracheal mites.

Unfortunately, I do not know how high temperatures need to be to control mites, nor do I know how long it needs to remain hot. Neither the field test nor the laboratory tests defined the exact limits of temperatures that are effective in controlling tracheal mites. There are innumerable combinations of time, temperature, and possibly humidity (always 60 ± 10% RH in my laboratory tests) that could be tried. Since white and dark hives were the same temperature at night, it seems that constant heat is not essential when controlling tracheal mites. Laboratory tests showed that higher temperatures killed mites in a shorter time, but high temperatures also kill bees. Time and temperature need to be adjusted so as to enhance the survival of honey bees and the death of tracheal mites.

Should Beekeepers Use Dark Hives to Control Tracheal Mites?

No. Heat may provide an effective way to control tracheal mites, but a treatment lasting all summer strongly reduces the production of bees and honey during hot weather in Louisiana. In cooler climates, dark hives may not reduce colony productivity, but they also may not affect tracheal mites.

I recommend white or light colored hives. This is especially important for lids on small hives or nucleus colonies during hot weather. The field test clearly showed that bees were much more productive in white hives during summer months (see table). Moreover, when selecting for genetic resistance to tracheal mites, bees should be kept in white colonies. Otherwise, environmental effects such as dark hives in sunny locations could reduce mite populations in some or all of the colonies and thereby prevent the detection of colonies that are resistant to mites because of genetic characteristics.

* Reprinted from Volume 134, No. 11, November, 1994 American Bee Journal