Apicultural Research

Survey of Miticide Use in Georgia Honey Bee Hives

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ABSTRACT

In 1990, an estimated 32,007 Georgia bee hives were treated with menthol to control tracheal mites, and 20,771 hives were treated with Apistan® to control *Varroa* mites. In 1990, Georgia beekeepers spent at least $122,343 on miticides. If Georgia beekeepers had to rely solely on non-chemical controls against mites, they predict state-wide losses of hives and hive products of at least $5,748,091. Survey respondents represented 51,608 bee hives which are 46.5% of the hives in Georgia at the end of 1990.

KEY WORDS *Apis mellifera, Acarapis woodi, Varroa jacobsoni,* menthol, Apistan®

INTRODUCTION

Tracheal mites and *Varroa* mites have prompted increased use of pesticides in U. S. beekeeping. Menthol in 50-gram packets is the only approved miticide in the U. S. for controlling tracheal mites, and Apistan®, a fluvalinate-impregnated plastic strip, is the only approved miticide for controlling *Varroa*. Neither miticide controls both mites. Some bees resist tracheal mites (Gary & Page, 1987; Milne *et al.*, 1991), but there is almost (Morse *et al.*, 1991) no evidence that North American populations of honey bees resist *Varroa* mites.

Certain pesticides have been available to beekeepers for years (Nowogrodzki, 1990). However, the arrival of menthol and Apistan® has historic implications. First, unlike other pesticides, these are used inside hives of living bees for prolonged periods. Secondly, mites are serious parasites that must be controlled, and there are no nationwide legal alternatives to menthol and Apistan®. For the first time, U. S. beekeepers depend on pesticides inside living bee hives to maintain profitable operations.

Because the role of pesticides in U. S. beekeeping is growing, I surveyed Georgia beekeepers to learn their miticide use habits, alternative controls they use, and their estimates of yield changes from alternative controls.

METHODS

I designed an anonymous mail questionnaire to determine: 1) the number of Georgia hives treated in 1990 with menthol or Apistan®, 2) frequency of treatments, 3) rates of treatment (amount of menthol per hive or number of Apistan® strips per hive body), 4) costs of treatment per hive, 5) methods of application, 6) times of application, 7) alternative non-chemical controls used, 8) estimated productivity changes from non-chemical controls, and 9) respondents' personal data, experiences in beekeeping, and opinions of problems facing the industry.

The survey mail list came from Georgia Department of Agriculture registration records and membership lists of the Georgia and Southeast Georgia Beekeepers Associations. 1,813 questionnaires were mailed on 8 February 1991, and 31 were given out at beekeeper meetings during the next two weeks, so altogether 1,844 questionnaires were distributed. Reminder post cards were mailed 27 February. Returning questionnaires were accepted up to 8 April; 226 questionnaires were disqualified because they were not deliverable or respondents were not Georgia residents.

Data were stored on permanent tape at The University of Georgia Computing and Networking Service facility. Data were machine-edited to purge answers that were disqualified based on earlier responses, search for keying errors, and check ranges of values for suspicious extremes. SAS (SAS Institute, 1988) was used to generate descriptive statistics and frequency tables. I calculated 95% confidence intervals (Scheaffer *et al.*, 1986) around certain sample percentages. Because the number of sampled hives was very high and the confidence intervals were consistently narrow, I used survey percentages to estimate state-wide conditions for several variables (see Table 1, footnote 1).

RESULTS AND DISCUSSION

378 qualified questionnaires were returned for a response rate of only 23.4% (378/1,618 qualified questionnaires). However, the 378 respondents owned 51,608 bee hives which are 46.5% of the bee hives in Georgia at the end of 1990 (111,000

Table 1. Number of Georgia bee hives treated with menthol or Apistan® in 1990

Menthol			Apistan®		
no. hives in survey	% ± CI[1]	no. hives state-wide	no. hives in survey	% ± CI[1]	no. hives state-wide
15,217	28.2 ± 0.3	32,007	9,864	18.3 ± 0.2	20,771

[1]survey percentage ± 95% CI, where n = 53,868 bee hives sampled from midpoint of 1990 season (51,608 hives sampled in early 1991 [no. hives in survey] + known hive deaths in 1990 from respondent pool [4,520 hives] and assuming that 50% of deaths occurred by midpoint of 1990 season [2,260 hives]) and N = 113,500 hives in Georgia at midpoint of 1990 season (midpoint of 1989 and 1990 hive estimates [USDA-NASS, 1990; USDA-NASS, 1991]).

hives; USDA-NASS, 1991). This is a good sample size of the population of interest, that is, bee hives in which miticides are potentially used.

Objective 1. Number of hives treated with menthol or Apistan®. Table 1 gives the number of survey hives treated with menthol or Apistan®, percentage of survey hives that were treated, and estimated number of hives treated state-wide. In 1990, an estimated 32,007 hives were treated with menthol, and 20,771 hives were treated with Apistan®.

Objective 2. Frequency of menthol or Apistan® treatments. Survey hives that were treated with menthol received, on average, 1.5 ± 0.7 treatments per hive in 1990, and hives treated with Apistan® received 1.1 ± 0.5 treatments. Table 2 gives treatment frequencies, number of survey hives in each category, percentage of survey hives in each category, and estimated number of hives state-wide in each category. With menthol, most hives received two treatments, but with Apistan® most hives received one treatment.

Objective 3. Rates of treatment. Table 3 lists rates of treatment, number of survey hives in each category, percentage of survey hives in each category, and estimated number of hives State-wide in each category. With menthol, most hives received one 50-g packet per treatment application, but cough drops and vegetable oil were popular alternatives. With Apistan®, most hives received two strips per hive body.

Objective 4. Costs of treatment. In 1990, respondents spent, on average, $2.2 ± 1.4 per hive to treat with menthol and $2.5 ± 1.5 per hive to treat with Apistan®. Using data from Table 1, estimated state-wide cost for treating hives with miticides in 1990 is $122,343.

Objective 5. Methods of application. Table 4 gives methods of treatment application, number of survey hives in each category, percentage of survey hives in each category, and estimated number of hives state-wide in each category. Menthol was usually put on the top bars, and Apistan® strips were almost always put between hive frames.

Objective 6. Times of application. Table 5 gives times of treatment application, number of survey hives in each category, percentage of survey hives in each category, and estimated number of hives state-wide in each category. Most menthol was used in autumn followed closely by spring. Most Apistan® was used in autumn.

Objective 7. Alternative non-chemical controls. More than half the respondents said the following non-chemical controls were very important or somewhat important in controlling tracheal mites: breeding from their own resistant bees (60.1% favorable responses), using another beekeeper's resistant stock (69.5%), and "letting the fittest survive" (50.3%). Respondents generally did not favor dark-colored queens (22.5%) or vegetable oil (28.5%). Nevertheless, 8,418 hives were treated with vegetable oil in 1990 (Table 3).

More than half the respondents said that breeding from their own resistant bees (53.8%) and using another beekeeper's resistant stock (65.3%) were very important or somewhat important in controlling *Varroa*. Slightly fewer respondents (45.7%) favored "letting the fittest survive".

Objective 8. Estimated yield changes from non-chemical controls. I asked beekeepers to estimate yield changes if they had to rely solely on non-chemical controls. Table 6 gives economic characters possibly affected by non-chemical controls, respondents' estimates of the effect of non-chemical controls, and estimated state-wide changes. If no chemical miticides were available, beekeepers predicted greater loss from *Varroa* mites than from tracheal mites. Although *Varroa* mites are not as widespread and fewer hives were treated for *Varroa* (Table 1), beekeepers perceive *Varroa* as the greater threat. This reflects the concentration of *Varroa* in the major beekeeping region of the state and the general inability of honey bees to resist this mite.

Objective 9. Respondents' personal data and opinions. The average respondent was 55 years old, had kept bees for 16 years, owned 137 hives, and had 6 apiary locations. 90.7% of respondents were male, and 39.4% were college graduates. 41.3% belonged to a local bee organization, and 16.4% belonged to a national bee organization.

I asked beekeepers to indicate their best sources of help and information. These sources were "other beekeepers" (39.2% of responses), "beekeeping magazines" (28.6%), "bee meetings" and "short courses" (7.4%), "Cooperative Extension Ser-

Table 2. Number of treatments per hive in 1990

menthol				Apistan®			
frequency of treatment	no. hives in survey	% ± CI[1]	no. hives state-wide	frequency of treatment	no. hives in survey	% ± CI[2]	no. hives state-wide
1	6,515	42.8 ± 0.6	13699	1	5,821	59 ± 0.7	12255
2	7,317	48.1 ± 0.6	15395	2	4,003	40.6 ± 0.7	8433
3	1,377	9 ± 0.3	2,881	3	0	0	0

[1]Survey percentage ± 95% confidence interval, where n = 15,217 survey hives that were treated with menthol and N = 32,007 hives state-wide that were treated with menthol (Table 1).

[2]Survey percentage ± 95% confidence interval, where n = 9,864 survey hives that were treated with Apistan® and N = 20,771 hives state-wide that were treated with Apistan® (Table 1).

Table 3. Number of Georgia bee hives receiving certain rates of treatment in 1990

menthol				Apistan®			
rate[1]	no. hives in survey	% ± CI[2]	no. hives state-wide	rate[3]	no. hives in survey	% ± CI[4]	no. hives state-wide
< 50g	3,057	20.1 ± 0.5	6,433	< 2 strips	3,514	35.6 ± 0.7	7,394
50g	5,378	35.3 ± 0.6	11298	2 strips	6,347	64.3 ± 0.7	13356
> 50g	200	1.3 ± 0.1	416	> 2 strips	0	0	0
cough drops	2,227	14.6 ± 0.4	4,673	.	.	.	.
menthol + oil[5]	4,000	26.3 ± 0.5	8,418	.	.	.	.

[1]Menthol is labeled for one 50-g packet per colony.

[2]see footnote 1, Table 2.

[3]Apistan® is labeled for two strips per hive body.

[4]see footnote 2, Table 2.

[5]Patties of vegetable oil and sugar may complement menthol as a control for tracheal mites (K. S. Delaplane, unpublished data).

vice" (6.6%), and "newsletters" (3.7%).

When asked, "Which of the following statements about money and beekeeping best describes your situation?", respondents answered "I lose money" (46.6%), "I break even" (29.1%), "I get extra spending money" (11.6%), "beekeeping is my livelihood" (5.8%), and "beekeeping is an important income supplement" (2.6%).

Respondents were asked, "What is the most serious bee affliction you must deal with?". Wax moths were the most serious affliction (52.1%), followed by tracheal mites (12.7%), pesticide kill (8.2%), American foulbrood (7.9%), *Varroa* mites (3.4%), European foulbrood (1.3%), nosema (1.1%), and chalkbrood (0.8%).

Respondents were asked, "What is the one biggest problem facing Georgia beekeepers today?". Tracheal mites were the biggest state-wide problem (18%), followed by Africanized bees (14%), public misconceptions about the bee industry (10.6%), *Varroa* mites (7.1%), non-supportive legislation (6.6%), consumer ignorance about honey (6.1%), American foulbrood (2.9%), and state quarantines (1.6%).

Table 4. Number of Georgia bee hives receiving certain methods of treatment in 1990

menthol				Apistan®			
method[1]	no. hives in survey	% ± CI[2]	no. hives state-wide	method[3]	no. hives in survey	% ± CI[4]	no. hives state-wide
top bars	11328	74.4 ± 0.5	23813	top bars	4	0.04 ± .03	8
bottom board	3,471	22.8 ± 0.5	7,298	bottom board	0	0	0
between frames	418	2.7 ± 0.2	864	between frames	9857	99.9 ± .04	20750

[1]Menthol label calls for packet on top bars or bottom board depending on ambient temperature.

[2]see footnote 1, Table 2.

[3]Apistan® label calls for one plastic strip between frames 3 and 4 and one strip between frames 7 and 8.

[4]see footnote 2, Table 2.

Table 5. Times of colony treatment in 1990

menthol				Apistan®			
time	no. hives in survey	% ± CI[1]	no. hives state-wide	time	no. hives in survey	% ± CI[2]	no. hives state-wide
spring	7,177	47.2 ± 0.6	15107	spring	3,034	30.8 ± 0.7	6,397
summer	211	1.4 ± 0.1	448	summer	4	0.04 ± .03	8
autumn	7,450	49 ± 0.6	15683	autumn	6,783	68.8 ± 0.7	14290
winter	366	2.4 ± 0.2	768	winter	0	0	0

[1]see footnote 1, Table 2.

[2]see footnote 2, Table 2.

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REFERENCES

Gary, N.E. & R.E. Page, Jr. 1987. Phenotypic variation in susceptibility of honey bees, *Apis mellifera*, to infestation by tracheal mites, *Acarapis woodi*. Exp. Appl. Acarol. 3:291–305

Milne, C.P., Jr., G.W. Otis, F.A. Eischen, & J.M. Dormaier. 1991. A comparison of tracheal mite resistance in two commercially available stocks of honey bees. Am. Bee J. 131:713–718

Morse, R.A., D. Miksa, & J.A. Masenheimer. 1991. Varroa resistance in U.S. honey bees. Am. Bee J. 131:433–434

Nowogrodzki, R. 1990. Pesticides registered by the U.S. Environmental Protection Agency, *In* Honey bee pests, predators, and diseases 2nd ed. (R.A. Morse & R. Nowogrodzki, eds.). Cornell Univ. Press, Ithaca, New York

SAS. 1988. Version 5.18. SAS Institute, Inc., Cary, North Carolina

Scheaffer, R.L., Mendenhall, W., & L. Ott. 1986. Elementary survey sampling 3d ed. PWS Publishers, Boston, Massachusetts

USDA-NASS. 1990. Honey. National Agricultural Statistics Service release

USDA-NASS. 1991. Honey. National Agricultural Statistics Service release

Table 6. If you had to rely solely on non-chemical controls against mites, how would the following production areas change?

tracheal mites			*Varroa* mites		
area	% change[1]	estimated state-wide change[2]	area	% change[1]	estimated state-wide change[2]
hive survival	-19.3	-21,423 hives	hive survival	-23.3	-25,863 hives
honey	-23.3	-1293150 lb	honey	-23.3	-1293150 lb
package bees	-25.7	-8,522 packages	package bees	-26.1	-8,655 packages
queens	-23.5	-31,776 queens	queens	-21.9	-29,612 queens
pollination fees	-25.1		pollination fees	-26.9	
TOTAL LOSS[3] = -$2,712,774			TOTAL LOSS[3] = -$3,035,317		
TOTAL STATE-WIDE LOSS[3] = -$5,748,091					

[1]Weighted mean of respondents' estimated changes

[2]Based on USDA-NASS data for 1990 and respondents' estimated changes. There are no data for pollination income in Georgia.

[3]Conservatively based on USDA-NASS data for 1990, assuming lost hives valued at $50 each, including costs for replacing 50% of hives, assuming package bees valued at $19.33 each, assuming queens valued at $6.02 each (average 1990 prices of seven commercial Georgia beekeepers) and excluding lost income from pollination