Timing of Apistan® treatments for *Varroa jacobsoni* control

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ABSTRACT

We compared the development of *Varroa jacobsoni* infestations in colonies that were treated according to label instructions with Apistan®, either from Dec. 1, 1994 to Jan. 9, 1995, from Feb. 22, 1995 to March 27, 1995 or not treated. Infestations rose quickly in colonies following treatment in Dec.-Jan. and exceeded infestation levels in untreated colonies by June. In June, infestations in colonies treated in Dec. and Jan. were greater than 50% and further treatment was indicated to assure colony survival. Colonies treated in Feb.-March remained comparatively free of varroa to the end of the experiment in late July. The majority of colonies treated in Dec.-Jan. died before the end of the honey flow. Treatment in Feb.-March permitted colonies to survive without treatment throughout the local honey flow period.

KEY WORDS

Varroa jacobsoni, varroosis, *Apis mellifera*, mite control, Apistan®, fluvalinate.

Received for publication: 8 April 1996
Accepted for publication: 21 June 1996

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INTRODUCTION

Varroa jacobsoni is a deadly parasite of honey bee (*Apis mellifera*) colonies. Typically untreated infestations result in the death of colonies. The only available product registered in the U. S. for the control of varroa in honey bee colonies is Apistan®, a product containing the acaracide fluvalinate. Label directions permit treating colonies for a period of 42-56 days, but these treatment periods must not extend into nectar flows that will be used to produce surplus honey. Although Apistan® remains an effective treatment in Louisiana to kill varroa mites in hives, mite population dynamics require that colonies be treated twice each year if they are to survive.

Weather conditions in Louisiana are favorable throughout the year for treating colonies with Apistan®. Even through winter, colonies can be opened on most days for treatment application or removal without harming the colony. The nectar-flow period in south-central Louisiana typically extends from the end of March to the end of July (Oertel *et al.* 1980). Hence, a four-month period comprises the yearly honey production period.

Previous experience indicated that colonies treated only in the autumn would die before the end of the honey flow the following summer. We sought to determine the optimum timing of annual treatments for varroa which would not interfere with harvesting the entire surplus honey crop. Two pre-honey-flow treatment periods were considered. A mid-December period was hypothesized to be favorable, since a short broodless period causes all varroa mites to be on adult worker bees for 1 to 2 weeks. Such conditions may enhance the effectiveness of treatment and extend the survival of colonies through the honey flow period. Also, a December treatment period was considered convenient. Alternatively, a less convenient treatment in late-February and March, just before the honey-flow period would provide the latest possible treatment and perhaps the best colony protection.

MATERIALS AND METHODS

All experimental apiaries were comprised of colonies that were treated the previous August-September with Apistan® according to label instructions. All colonies began the experiment with commercially available nominally Italian queens and 25,000 to 35,000 worker bees in three 6 5/8 inch depth 10-frame Langstroth hive bodies. Since the experiment began in December, very little to no brood (100 cells or less) was present in the colonies. All colonies had sufficient honey and pollen reserves to survive and develop during the winter dearth. Also, all colonies were given Terramycin extender patties (Wilson *et al.* 1971) on January 26, 1995. The proportion of mite infested brood for each colony in the 4 apiaries was determined and analyzed prior to the start of the experiment. No statistically significant differences were found.

Four apiaries (separated by at least 2 miles from the nearest apiary) were randomly assigned one of three treatment periods. Two apiaries (15 and 13 colonies) were treated with Apistan® from Dec. 1, 1994 to Jan. 9,

Table 1

Comparisions of the treatment by apiary least squares means for the proportions of infested brood. Capital letters preceding numbers compare values between time periods within apiaries. Lower case letters following numbers compare values between apiaries within time periods. In both cases, numbers not associated with a common letter significantly differ (P = 0.05).

Date (Julian)	Apiary Number (Treatment Period)			
	1 (Dec. 1, 1994-Jan. 9. 1995)	2 (Dec. 1, 1994-Jan. 9, 1995)	3 (Feb. 22,1995-March 27, 1995)	4 (No Treatment)
Feb. 15 (46)	A 0.01 ± 0.01 a	A 0.01 ± 0.01 a	A 0.06 ± 0.01 b	A 0.04 ± 0.01 b
March 27 (86)	A 0.03 ± 0.01 a,b	B 0.06 ± 0.01b,c	B 0.01 ± 0.02 a	B 0.09 ± 0.01 c
April 27 (117)	B 0.22 ± 0.04 b	C 0.25 ± 0.04 b,c	A, B 0.04 ± 0.04 a	C 0.35 ± 0.04 c
May 24 (144)	B 0.26 ± 0.04 b	C 0.34 ± 0.04 b,c	A, B 0.06 ± 0.04 a	C 0.39 ± 0.04 c
June 26 (177)	C 0.59 ± 0.05 b,c	D 0.71 ± 0.06 c	C 0.19 ± 0.06 a	D 0.50 ± 0.05 b
July 24 (205)	D 0.80 ± 0.06 b,c	E 0.88 ± 0.06 c	D 0.37 ± 0.06 a	E 0.70 ±0.05 b

Table 2

The number of dead colonies in the 4 apiaries at the end of the experiment.

Date (Julian)	Apiary Number (Treatment Period)							
	1 (Dec. 1, 1994-Jan. 9, 1995		2 (Dec l, 1994-Jan. 9, 1995)		3 (Feb. 22, 1995-March 27, 1995)		4 (No Treatment)	
	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive
July 24 (205)	9	6	10	3	0	13	5	9

$X^2 = 17.9$, df= 3, P = 0.001

1995, which included the winter broodless period. A third apiary (13 colonies) was treated with Apistan® from February 22, 1995 to March 27, 1995, just prior to the year's honey flow. A fourth apiary (14 colonies) served as an untreated control. Colonies were chosen for treatment in groups since the movement of mites between colonies having different treatments would tend to cause all colonies to quickly harbor large populations of mites. This design causes apiary and treatment to be confounded in the analysis. This is partially resolved by having replication for one of the treatments.

Each month after the initial treatment, all colonies were evaluated for colony survival. The brood of all living colonies was evaluated to determine the number of infested cells. The proportion of brood infested with *Varroa jacobsoni* was determined by examining 100 cells containing dark-eyed pupae with yellowish

abdomens (approximately 16-17 days old) (Ifantidis 1984). Sampling was done every month. Colonies killed by varroa infestations were assumed to have 100% infestation on dates following the death of the colonies.

The analyses were done in SAS using the MIXED and FREQ procedures (SAS Institute, Inc. 1990). The numbers of infested brood were analyzed as a randomized block design with a repeated measure treatment structure. Least squares estimates were used because of unequal numbers in the various apiary by time combinations. The number of dead colonies in the four apiaries at the end of the experiment was analyzed using X^2.

RESULTS

In the analysis of rates of infestation, treatments were significantly different ($P = 0.001$) and there was a significant treatment by time interaction ($P = 0.001$). Hence, a full evaluation of the data requires an inspection of differences among treatments within periods and within treatments among periods.

Comparing time periods within treatments, in each apiary there was a general increase in infestation through time (Table 1). However, apiary 3 was treated after the data collection period began rather than before data collection, as was the case for apiaries 1 and 2. The reduction in infestation during the data collection period resulting from the treatment data for apiary 3 undoubtedly contributed to the treatment by date interaction. Also, the rate of increase appears to be greater in the control apiary receiving no treatment (apiary 4) and the two apiaries treated in Dec.-Jan. which provide similar results. This both supports the view that treatment effects were usefully measured in the experiment and may account for some of the significant treatment by time interaction in the overall analysis. In all apiaries, increases in rates of infestation between April and May were small and not statistically significant.

On February 15, all colonies were producing the first cycle of brood of the year. They were inspected and the numbers of infested cells were determined. The two apiaries (apiaries 1 and 2) which had been treated in Dec.-Jan. had statistically lower rates of infestation (1.0 ± 1.0%, $P<0.05$). However, the rates of infestation in the colonies in apiary 3, which had yet to be treated, and the rates in apiary 4, the control apiary, were also low (6 and 4 % respectively) (Table 1). On March 27, all infestations had risen between 2 and 5% except in the colonies that had been treated from February 22, to March 27. In these colonies, the infestation rate was 1.0 ± 2.0%, statistically similar to the rate of infestation in apiary 1 (Table 1). Thereafter, infestation rates rose sharply in apiaries 1, 2 and 4. On April 27, near the beginning of the nectar flow, average infestations in these three apiaries were greater than 23%. These rates were significantly higher than the average 5% infestation of the colonies in apiary 3 (Table 1). This trend persisted through the remainder of the experiment (Table1).

By the end of May the number of bees in many colonies was dwindling in apiaries 1, 2 and 4. By the end of June, near the peak of the honeyflow, colonies were dying in these three apiaries. On July 24, at the end of the experiment, more of the colonies in apiaries 1 and 2 were dead than were alive (19 dead, 9 alive) (Table 2). Five of the 14 untreated colonies in apiary 4 died by July 24 as well. However, none of the 13 colonies of apiary 3, treated in Feb.-March, had died. The overall X^2 of 17.9 indicated significant differences between apiaries ($P=0.001$).

DISCUSSION

In the conditions of south-central Louisiana, the February-March treatment period produced superior results. Mite populations were sufficiently suppressed by treatment in February-March that colonies were thriving during the honey flow. By the end of the honey flow mite populations in the colonies treated in February-March were about 2 months behind the levels found in the untreated control colonies and the colonies treated in December-January. This difference in mite population development was sufficient to permit the delay of a second treatment of the colonies until August, a period of nectar dearth for the area. In order to assure the survival of the untreated colonies and the colonies treated in January-February, treatment would have had to start in the honey flow, near the end of May.

No apparent advantage was gained by treating colonies during the December broodless period. The similarity of mite population development in control colonies and those treated in December-January is remarkable. Although the treatment did significantly reduce mite populations, the mite populations in untreated colonies were also low (Table 1). Presumably, mite populations reach a natural low point during winter due to natural mortality and reduced reproduction occasioned by lack of brood, especially drone brood, in the colonies. Hence, mite populations grew in both untreated and December-January treated colonies and reached harmful levels in May and June, regardless of the December-January treatment.

Other beekeeping areas are likely to have different limitations of winter and nectar seasons on the timing of treatments. However, three general themes in these results are likely to be true in other conditions as well. First, springtime treatments timed to end just prior to the honeyflow will permit the longest possible honey harvests. Second, honeyflow conditions promote ample brood rearing in colonies, including drone brood. These conditions favor the development of large varroa populations. Hence, nectar flows longer than 4 or 5 months will have coincident development of large varroa populations that will, third, require treatment and perhaps the sacrifice of the last portion of the nectar flow to ensure the survival of colonies. This last conclusion supports that of Hoopingarner (1995). Timing of the springtime treatment is essential to maximizing the time available for honey production between treatments. Colonies treated with Apistan® in February-March of 1996 remained vigorous through the 1996 honey production season, providing additional evidence supporting this treatment timing strategy.

ACKNOWLEDGMENTS

This research was completed in cooperation with the Louisiana Agricultural Experiment Station. We thank H. Shimanuki, H. Sylvester, and W. Wilson who made several suggestions about early manuscript drafts.

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