VARROA JACOBSONI CONTROL WITH FORMIC ACID USED IN DIFFERENT APPLICATION WAYS IN SUBTROPICAL AND TEMPERATE CLIMATES

M. EGUARAS[1], M. LABATTAGLIA[2], C. FAVERIN[1], M. DEL HOYO[2], M.A. PALACIO[3], M. CARRIN[2], G. RODRIGUEZ[4], S. RUFFINENGO[3], E.L. BEDASCARRASBURE[2]

[1]Facultad de Ciencias Exactas y Naturales. UNMdP. PROAPI. Funes 3350. (7600) Mar del Plata, Argentina
[2]Facultad de Ciencias Veterinarias. UNCPBA. PROAPI. Pintos 339, (7000) Tandil Argentina
[3]Unidad Integrada INTA-Facultad de Ciencias Agrarias. UNMdP. PROAPI C.C. 276, (7620), Balcarce, Argentina
[4]INTA Ascasubi. PROAPI. Hilario Ascasubi. ARGENTINA

Summary

The objective of this work was to evaluate the relation between the place where formic acid dispensers are located and falling efficacy against Varroa jacobsoni *in subtropical (Tucumán) and temperate (Buenos Aires) climates. In each location forty colonies received four treatments (two or four formic acid dispensers located over brood chambers or over colony bottom). Mite counting recovered from the bottoms was done after three days intervals. Then, two PVC strips with fluvalinate were introduced to obtain the total number of mites in the colony. Formic acid falling efficacy was calculated. Falling efficacy differed significantly between both locations being 34% higher in subtropical climate. No significant difference was detected between dispenser position in the colony.*

Introduction

Varroa jacobsoni is a honeybee *(Apis mellifera)* parasitic mite. It first parasited *Apis cerana* in a limited area on the Asian continent and since the '60, this mite begun to spread all over the world. Though many intents have been made to control this mite, it have caused and actually causes massive colonies mortality.

At first, substances to control this mite were administrated in fumigation strips, chemical dusts, evaporation and many other forms. Later, trophalaxis was used to administer systemic products. Recently, in the '80, long time treatments by contact methods using plastic PVC strips appeared as the most commonly used (KOENIGER & FUCHS, 1989).

Though many of these products were highly effective, a lower effectiveness have been registered in last years because of the indiscriminately use and inadequate application (LOGLIO & PLEBANI, 1992; LODESANI et al., 1995). This was caused, basically by mite resistance to main components (MILANI, 1995).

This situation have led to direct actual researches on *Varroa* control, to the use of natural and non-contaminating substances. In this sense lactic, formic and oxalic acid have been studied with different results (BUHLMANN, 1991; KRAUS, 1991, 1992; ARCUELO et al., 1993; KRAMER, 1993; MUTINELLI et al., 1994; EGUARAS et al., 1996; BARBERO et al., 1997).

The objective of this work was evaluate the relation between the place where formic acid dispensers are located and falling efficacy against *Varroa jacobsoni* in tropical and tempered climates.

Materials and methods

This work was carried out in two apiaries located in Aguilares, Tucumán Province (subtropical area in the country situated at 26°49'49" South latitude and 66°12' West longitude), and in Hilario Ascasubi, Buenos Aires Province, (temperate area in the country, situated at 39° 23' South latitude and 62° 37' West longitude).

1. Formic acid application

Forty Langstroth colonies were used, which were selected by similar initial honey bee population, brood area and honey and pollen stores. In each location colonies received four treatments with the same number of colonies which were assigned at random. Each treatment varied in the number and size of formic acid dispensers and in their location in the colony (Table I).

Table I

Treatments description in relation to number, size and position of formic acid dispensers

Treatment	Number of dispensers per hive	Dispensers size	Dispensers position in the hive
1	4	5 cm x 7 cm x 0,4 cm	Over brood chamber
2	2	10 cm x 7 cm x 0,4 cm	Over brood chamber
3	4	5 cm x 7 cm x 0,4 cm	Over the bottom
4	2	10 cm x 7 cm x 0,4 cm	Over the bottom

Dispenser consisted in a surface of rubber which was covered by a plastic sheet with two holes of 2,5 cm diameter. In this way, an evaporation camera was created that allowed a slow liberation of formic acid. Mobile bottoms with white sheets covered by butter were located in each hive, in order to retain falling mites. Mite counting was done after three days intervals. Formic acid was applied with a 240 ml doses in water solution 85%.

2. Final mites counting and efficacy

In order to estimate the total mite number in each colony, after formic acid treatment, two PVC strips with fluvalinate in the trade formulation Apistan^R were introduced between brood combs N^{o}2 and N^{o}7. These strips remained inside the colonies during six weeks. Falling mites after Apistan application were counted and were summed to the number of falling mites counted during formic acid administration, this number was Total Number of mites in the colony. Then formic acid falling efficacy (EFIACU) was calculated for each colony as follows:

EFIACU = N^o of mites dead by formic acid x 100/Total number of dead mites.

3. Data Analyses

General model for variance analyses for EFIACU included location, treatment and interaction effects. For media comparison Duncan Test was used. Signification level was 5%. GLM SAS (1989) was used as statistic procedure.

Results

Falling efficacy differed significantly between both locations ($p<0.05$), but only a tendency was detected for dispenser position in the hive ($p=0.09$). Location and treatment interaction was not significant. Determination coefficient was 0.641.

Average values for falling efficacy in each location are presented in Table II. EFIACU was 34% higher in Aguilares when compared to Ascasubi.

Table II

Average values and standard error (S.E.) for percentage of falling efficacy accumulated (EFIACU) in each location

Location	Colony number	EFIACU (%) ± E.S.
Aguilares	20	92,81 ± 1,13 a
H. Ascasubi	20	58,93 ± 5,63 b

(*) Different letters indicate significant differences

Though significant differences were not detected between treatments, results show a positive tendency in those cases where dispensers were located uniformly over brood chamber (Table III).

Table III

Average values and standard error (S.E.) for percentage of falling efficacy cummulated (EFIACU) for each treatment

Treatment	Colony	EFIACU (%) ± E.S.
1	10	84,26 ± 6,91
2	10	73,89 ± 8,27
3	10	79,69 ± 5,43
4	10	65,63 ± 9,98

Efficacy levels were very variable specially in temperate climates.

Discussion

Results presented in this work showed that formic acid have a strong effect against mites and than can be used for *Varroa jacobsoni* control. Formic acid efficacy is high because it acts in both phases of mite life cycle, in the phoretic phase when the mite is on adult honeybees and on mites that are inside cells on honeybee brood in the reproductive phase.

However, with an uniform dose of formic acid (240 ml) significant differences between efficacy in different locations were found with best results in subtropical climates. Existent information on this topic is variable. FRIES (1995) recommended formic acid treatment with average temperatures between 12 °C and 25 °C and with optimal results between 18 and 25 °C.

WILSON & COLLINS (1993) demonstrated that formic acid is not effective for *Varroa* control in hot climates (between 20 °C and 32 °C). Though temperatures within this range were registered in Aguilares during part of sampling period a high percentage of efficacy accumulated was registered (average 92%). A similar situation was observed in previous studies of these authors (EGUARAS et al., submitted).

Though significant differences were not detected between dispenser position in the colony, those treatments that considered an homogeneous distribution of formic acid dispensers showed a greater effectiveness. This agrees with FRIES (1989) who said that one of the principal causes of formic acid low efficacy was related to distance from dispenser to brood area. In this sense, ROSENKRANZ (personal communication) observed that mite mortality inside the cells depended on dispenser position. In this way, when dispenser was put over the combs a great proportion of dead mites was found in the upper half of brood comb; the other way, a high proportion of mites inside cells located in the inferior half of the comb survived. It is probable that this fact could explain variability between colonies in formic acid treatments, and a homogeneous distribution of formic acid in the colony does not take place because of partial location of dispenser.

Conclusions

Results showed a) significant differences in formic acid efficacy in different environments, with a better performance in subtropical climates; b) for both locations there no difference was detected in dispenser position inside the colonies, however a tendency was detected when four dispensers were used. Results in this work lead to new researches to obtain a practical way to apply formic acid for varroa control.

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