

VARROA CONTROL USING CELLULOSE STRIPS SOAKED IN OXALIC ACID WATER SOLUTION

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Abstract

Oxalic acid used for the control varroa mites is widely practiced in central Italy. The oxalic acid sugar solution typically is applied by trickling it between the bee space of the frames. During the past years beekeeping associations suggested this acaricide to be administrated with cellulose strips soaked in a solution of oxalic acid and water. In field trials carried out during the spring and autumn, we tested the effectiveness of this method. In different experimental apiaries located in the Latium region, the trials were carried out with two treatments of the prepared strips. The efficacy of cellulose strips was evaluated in comparison with other oxalic acid treatments: trickling and vaporisation methods. In spring trials the effectiveness of the cellulose strips was not statistically different from the varroa natural fall. Similarly the autumn trials gave the same results to confirm the low efficacy of this method. However when spraying, trickling and vaporising oxalic acid, varroa mite control was good under central Italian conditions. The unsatisfactory efficacy of cellulose strips versus the good control results of trickling and vaporization suggests the possibility that the high acidity of oxalic acid water solutions (pH around 1) may be responsible for the best oxalic acid activity against the mites.

Keywords: varroa control, oxalic acid

Introduction

Over twenty years after the arrival of varroa in the Latium region, the control of this parasite continues to be the prime focus in controlling beehive diseases. Since it is impossible to definitively eradicate this parasite from all apiaries, it is necessary to adopt methods of therapeutic actions aiming to control the pest within reasonable limits during the development and the production of colonies. Over the past several years, research on varroa control has been oriented toward methods having low environmental impact. Oxalic acid (O.A.), in particular, has been widely used for varroa control because of its high effectiveness in killing the mite, its low cost, and its ease of application. The low risk of honey contamination characterized by this acid has allowed it to be included in the products used in organic beekeeping (Reg CE N. 1804/99). Recently (Reg. CE N. 546 of 24 March 2004), oxalic



acid has also been included in EU attachment II of Reg. CE N. 2377/90 -veterinary drugs for which no maximum residual limit (MRL) has been set.

Many methods of administering oxalic acid have been used in colonies. Various studies demonstrate the most effective methods are trickling (Arculeo, 1999; Brødsgaard et al, 1999; Charriere and Imdorf, 1999; Colombo, 1998; Ferrero et al, 2004; Imdorf et al, 1997; Mutinelli et al, 1997; Nanetti and Stradi, 1997; Radetzki, 1994) and evaporation using the appropriate electrical device (Radetzki, 2001) . In addition, some trials carried out in the experimental apiaries of Istituto Sperimentale per la Zoologia Agraria Sezione di Apicoltura di Roma demonstrated that a trickling method using a sugar solution of 4.2% O.A. and distributed in the colony by a syringe with a dosage of 5 ml/DB, maintains an 80% efficacy against varroa in combs partially or fully occupied by the bees under broodless conditions. (Marinelli et al, 2000). The evaporation of 1 or 2 grams of O.A. inside the beehive through the Varrox® device has demonstrated an efficacy of over 80% (Marinelli et al, 2004). Recently, administering O.A. by means cellulose strips has been proposed by the Association Beekeepers 3A of Pisa (Ciabini et al, 2003a; Ciabini et al, 2003b). In order to evaluate the effectiveness of this method, and considering its already widespread application among beekeepers, field trials were conducted over the past year by ARSIAL, ASL Roma D, Istituto Sperimentale per la Zoologia Agraria Sezione di Apicoltura di Roma and Istituto Zooprofilattico Sperimentale delle Regioni Lazio e Toscana.



Materials and methods

Seven apiaries were chosen, in six different areas of the Latium region and one in the Tuscany region. Each of the seven, consisting of 20 colonies, were divided into two groups of the same strength: One group (T) received the O.A. treatment, while the other, control group (C), received only a cellulose strip (without O.A.). The treatments were carried out during the spring of 2004 (April-May) and during the winter of 2005 (December-January-February). They followed a nationally agreed upon protocol determined by the Istituto Nazionale di Apicoltura. The cellulose strips (3 cm x 25 cm) were impregnated with 9 g of O.A. solution achieving a concentration of 14.2% (20 g of dihydrate O.A. in 100 ml of distilled water). In order to



achieve such a high concentration, the solution was prepared at the temperature of approximately 40°C. The final content of every strip was 1.3 g of O.A.. The content of the formulation was verified by Chemicals Laif of Vigonza (Padova). Two cellulose strips impregnated with O.A. were inserted between the combs of each colony in the T group. Two cellulose strips not impregnated with O.A. were inserted between the combs of each colony in the C group. On the fourteenth day the strips were removed and a second set of strips was administered following the same procedure. After another

fourteen days, the strips were removed and an evaluation of the remaining mite infestation was carried out using O.A. trickled with Perizin® (coumaphos). To determine the treatment's effectiveness, a daily count was also made of the varroa falling on adhesive sheets placed in the diagnostic drawers of the beehives during the experimental period.

The effectiveness of the treatment has been calculated with the following formula:

$$\text{efficacia \%} = \frac{\text{Sum of number of mites fallen as a result of the treatment with OA strips}}{\text{Sum of fallen number total of mites (OA strips + OA trickle d + perizin)}} \times 100$$

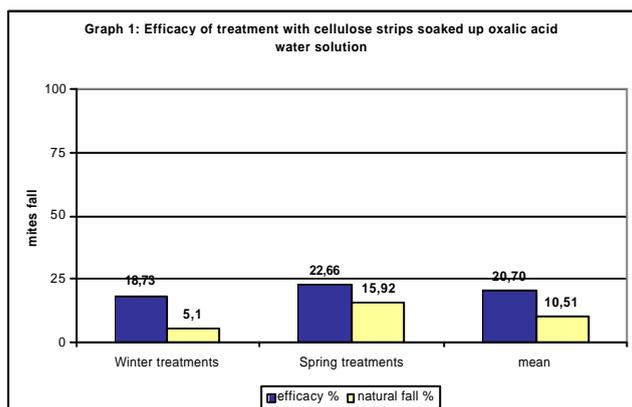
The individual colony efficacies were analyzed with an Analysis of Variance (ANOVA). The average efficacies by apiary were analyzed with Student-t tests, even though this method has a greater risk of reporting false positives.

Results and discussion

Table 1 – Spring treatments results

Spring treatment	efficacy %	natural fall %	P-value
Castelporziano (Rm)	7,6	8,6	0,98
Mentana (Rm)	30,8	35,7	0,88
Artena (Rm)	19,3	2,9	<0,02*
Titignano (Pi)	37,7	2,5	<0,01*
Latina	17,9	29,9	<0,04*
Mean	22,7	15,9	0,4

* The difference between the averages is statistically meaningful for p<0,05



As observed in Table I and Graph 1, spring treatments using cellulose strips with O.A. showed a very low effectiveness in varroa control. In fact, even if there had been found a significant difference between the fall of varroa in the T groups (due to the treatment), compared with that in the C group (natural fall), it was of such a low values that it could not be considered a valid treatment for the control of the varroa. The average

effectiveness in the T group was 22,7% as compared to the average natural fall of 15,9% to the C group. One of the factors that could have produced the low effectiveness of the treatments could be due to the season of the treatment. In fact, during the spring season the colonies are normally very strong and their activity can quickly destroy the cellulose strips. This destruction would, of course, reduce the presence of O.A. in the beehives and diminish the effectiveness of the treatment.

The winter trials carried out in the three apiaries of Tormancina (Rome), Ciampino (Rome) and Titignano (Pisa), with broodless colonies, also showed the effectiveness of cellulose strips with O.A. was unsatisfactory, with an average fallen of 18.7% for the T group compared to a natural fall of 5.1% (Table 2 and Graph 2).

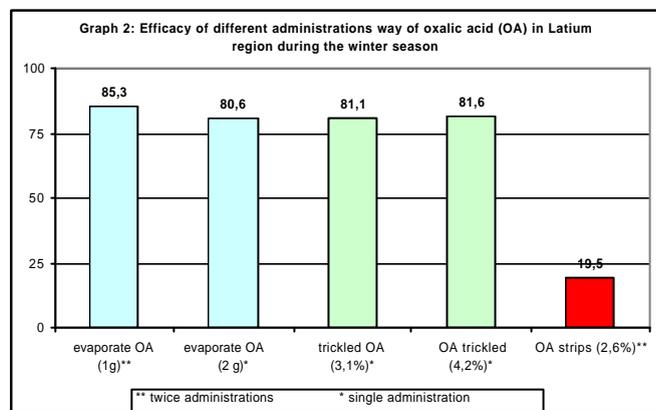
Table 2 – Winter treatments results

Winter treatment	efficacy %	natural fall %	P-value
Tormancina (Rm)	25,1	8,4	<0,01*
Titignano (Pi)	17,2	3,5	<0,01*
Ciampino (Rm)	13,9	3,4	<0,01*
Mean	18,7	5,1	<0,01*

* The difference between the averages is statistically meaningful for $p < 0,05$

During the winter treatment, the cellulose strips were removed from the nest much more slowly than during the spring season. The t-tests showed consistent significant differences between the mite fall in colonies treated with O.A. cellulose strips compared to the natural mite fall in control colonies.

The O.A. molecule is characterized by an extremely elevated constant of dissociation ($pK_{a1}=1,19$ - $pK_{a2}=4,21$), which gives an elevated acidity to the solutions, even at low levels of O.A. concentration. The acidity level of the solutions is probably the main factor in the effectiveness of O.A., but it is achieved only when the O.A. is placed in a water solution. Dispensing O.A. in cellulose strips, without water presence but only with crystals of organic acid gives unsatisfactory results especially when the level of humidity inside the nest is not sufficient to moisten the O.A. crystals.



Conclusions

Oxalic acid soaked in cellulose strips did not give acceptable varroa control under spring conditions in central Italy. Control was better for winter treatments under broodless conditions. The reason for its poor efficacy is possibly due to the modality action of O.A. This paper also has shown the trickling and the evaporation of O.A. are the most effective ways of it to control varroa (Graph 2).

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