Bee tolerance of different winter Varroa treatments

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Introduction

A suitable anti-Varroa treatment applied in winter plays a central role in the integrated Varroa control strategy. For the time being, this strategy seems to be the most successful one for keeping Varroa populations under control. A non-breeding period occurs in many regions during the winter due to the geographical location and climate conditions. During this time all surviving mites will be found on the bees. Beekeepers can take advantage of this to control Varroa with acaricides, which are highly effective against mites. This post-season treatment takes place too late to assure the development of healthy winter-bees and represents therefore only a complement to the treatment during late summer. However, an efficient therapy during the winter can significantly reduce the Varroa kick-off population for the coming season. Thanks to this treatment, further control measures will not be needed until the summer treatment of the coming season [15].

Many scientific publications put the effectiveness of winter therapy during the non-breeding period at between 89 and 99% depending on the chosen active agent and its application (Table 1).

Table 1: Effectiveness of winter therapy

Product / application	Effectiveness against Varroa	Source
Perizin (Coumaphos) / Trickle treatment	89 – 98%	Alonso et al. (1990) [1] Barbattini et al. (1989) [3] Ritter et al. (1986) [24]
Oxalic acid / spray treatment	95 – 98%	Imdorf et al. (1997) [13] Radetzki (1994) [23]
Oxalic acid / trickle treatment	95 – 98%	Charrière et al. (2001) [8] Liebig (1998) [19] Nanetti et al. (2003) [20]
Oxalic acid / evaporation	95 – 98%	Radedzki et al. (2001) [22] Imdorf et al. (2002) [14]
Lactic acid / 2 spray treatments	94 – 99%	Assmann et al. (1990) [2] Imdorf (1990) [16] Kraus et al. (1994) [17]

Many beekeepers regard winter treatment as an infringement of the old rule of allowing bee colonies complete rest during the cold season. Moreover, past experience has shown that certain winter treatments can lead to harmful effects on the honey bees, when dosages are too high [5, 7, 18]. However, recent trials show that winter therapies are well tolerated by the bees if properly dosed [6].

Test procedure

A number of tests have been carried out within the framework of the European working group for integrated Varroa-control in order to quantify potentially harmful effects of winter treatment on bee colonies. Special attention has been given to its impact on bees during the winter season and on their development in springtime.

Tested methods of treatment

The experiment ran for two seasons at two apiaries with a total number of 72 bee colonies in Dadant boxes with 12 frames. During August and September all colonies were treated with formic acid using "FAM Liebefeld"-dispensers each of which contained 130 ml of 70% acid. [9] Table 2 reviews the details of the winter treatments tested. The treatments were carried out on 13 November 2000 and 29 November 2001 at a temperature of between 6 and 11°C. Both apiaries were located in the Swiss Plateau.

Table 2: Tested alternatives and number of colonies per group

Treatment	Application	Number of colonies per group Wohlei 2000/01	Wohlei 2001/02	Bellechasse 2001/02
- Control	no winter treatment	6	6	6
- Perizin	1 application of 50 ml dilution	6		
- OA-spray treatment	Mixture of 30 g OA dih. in 1 l water 3 – 4 ml per comb side[13]	6	6	6
- OA-trickle treatment	Mixture of 35 g OA dih. in 1 l sugar-syrup 1:1; 30 - 50 ml in between the combs, depending on the strength [8]	6	6	6
- OA-evaporation	2 g OA dih. evaporation using the Varrox® device[22]		6	6

OA dih.: oxalic acid dihydrates

Formic acid was applied to all the colonies, including the control colony, but the latter was not given the winter therapy. Perizin is an accredited acaricide in Switzerland and contains Coumaphos (a phosphoric acid ester). It was used in the recommended dose but only once instead of twice as prescribed.

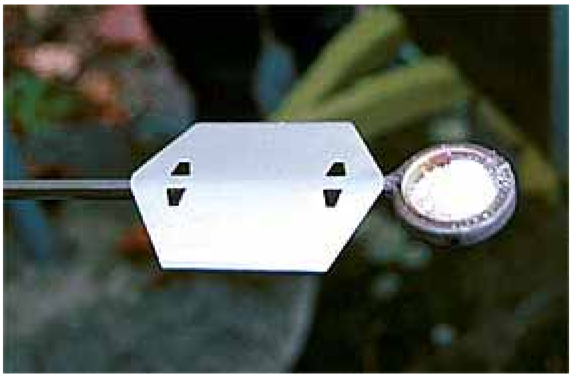
Criteria for the bee tolerance level

In order to analyse the possible effects of winter treatment on the development of the bee colony, the actual strength of the colony was measured in autumn and between March and May of the following year. The evaluation method used was the "Liebefelder"-method.[12] The strength of the colony was estimated during the bees' flying time. The values are therefore relative but allow comparison between the different groups.

One of the criteria to be assessed was the change in the strength of the colony before and after the cold season (wintering losses); the other was the development during springtime.

The counting of dead bees at the entrance or in the beehive is not pertinent, because bees which die as a result of an overdose of oxalic acid are not found in the beehive nor close by [7]. It is likely that these individuals leave the beehive and do not return. The population measurements taken in autumn served as basis for the formation of homogeneous groups of bee colonies. All colonies were managed in the same way.

The statistical computation of the bee losses during the winter and the development during spring was carried out using an analysis of variance, or an ANOVA-test following a square root conversion. The mites were counted on the grid-protected trays for 6 weeks in order to determine the death rate of the mites after treatment.



The three possible ways of treating with oxalic acid: trickling (left above), evaporation (left down) and spraying (right)

Results 2000/01

At the apiary in Wohlei, wintering was good and the bee losses were generally low (graph 1). The lowest losses were recorded in the untreated control group. The groups treated with Perizin showed the second lowest losses followed by the groups sprayed or trickled with oxalic acid. The differences between the groups are not significant.

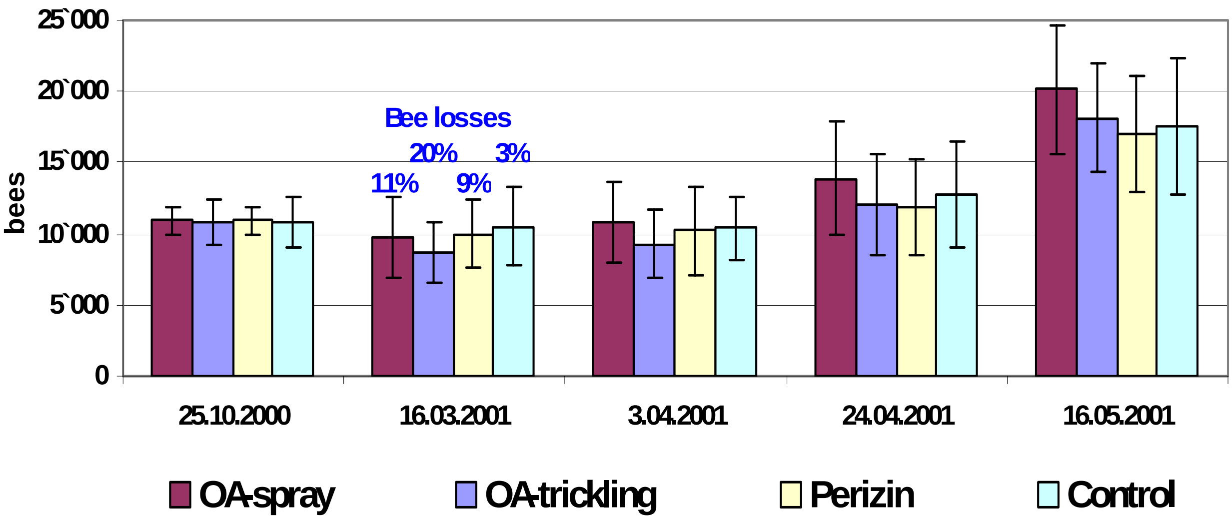


Figure 1: Average strength of the bee colony (with standard deviation) for the different treatment groups before the winter (in autumn 2000) and the groups' development in spring 2001. (The longer the standard deviation bar, the bigger the spread between the bee colonies of one group.)

In spring the treated colonies (Figure 1, Table 3) developed just as well as the control colonies. No essential differences were noted between the four groups with regard to the development of the honey-bee colonies. From the beginning of April until May, when dandelions and rapes are in bloom, the strength of the treated bee colonies compared with that of the non-treated colonies was not adversely affected. The group sprayed with oxalic acid was even a little stronger than the control group. There was only a minimal difference when the other two groups were compared. Such differences do not normally affect the amount of spring honey harvested.

Measurements of the brood surface show that winter treatment does not have a negative effect on brood rearing. The climatic conditions are much more decisive for the brood. After the cold and rainy April of 2001 a decline in the brood could be seen for all treatment variants (Table 3).

Table 3: Average number of bees and occupied brood cells as registered during the population estimations in autumn 2000 and spring 2001.

	OA-spraying		**OA-trickling**		**Perizin**		**control**	
No. of bee colonies	6		6		6		6	
Date	bees	brood	bees	brood	bees	brood	Bees	brood
25.10.2000	10917	147	10850	93	10950	0	10883	413
16.03.2001	9750	7333	8733	4867	9983	5333	10533	6833
03.04.2001	10833	12867	9267	10833	10217	10933	10417	12533
24.04.2001	13833	9433	12100	8233	11883	7747	12783	6960
16.05.2001	20183	32033	18117	28867	16983	24467	17617	28933

Results 2001/02

Greater bee losses were registered during the winter of 2001/02 than in the year before (Figure 2 and 3). This is mainly due to the fact that there were on average 2000 to 3000 more bees in the honey-bee colonies in autumn 2001 than in the previous autumn. However, towards the end of both winters the bee colonies showed the same strength. It is possible that numerous summer bees were still being counted when the population measurements were carried out in autumn 2001.

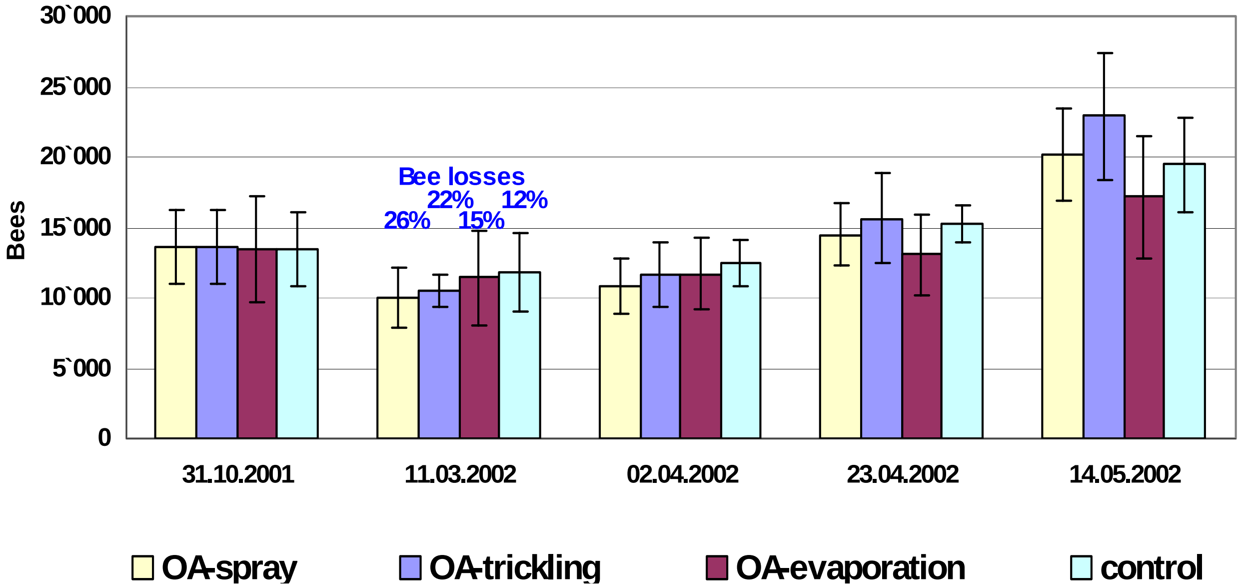


Figure 2: Average strength of the bee colony (with standard deviation) for the different treatment groups at the Wohlei apiary before the winter (in autumn 2001) and development in spring 2002.

At both apiaries, there were no significant differences between the different treatment groups in terms of wintering and development during spring.

As noted the year before, the control groups tended to winter better. None of the treated groups was out of the ordinary. Spraying oxalic acid for example led to the highest bee losses in the Wohlei and to the smallest losses in Bellechasse. The differences noted between the groups are therefore not due to the winter therapy but to other factors.

None of the winter treatments had a negative impact on development in spring in Wohlei or in Bellechasse (Figure 2 and 3, Table 4). The slight deficit of bees at the end of the winter found in the treated colonies compared with the control group is made up or even exceeded by the time of the harvest at the end of April. The treated bee colonies are therefore as strong as the control colonies and consequently have the same potential to produce honey. With reference to the size of the breeding-area (Table 4), there are no major, significant differences between the groups. This criterion too has not been negatively affected by the winter therapy.

Similar experiments were conducted in Germany between 2000 and 2002. In these the Centre for Bee Research in Kirchhain applied lactic acid instead of spraying oxalic acid. In most instances the results are in line with the observations made here [6]. In Kirchhain no significant differences were observed with respect to wintering and development during springtime.

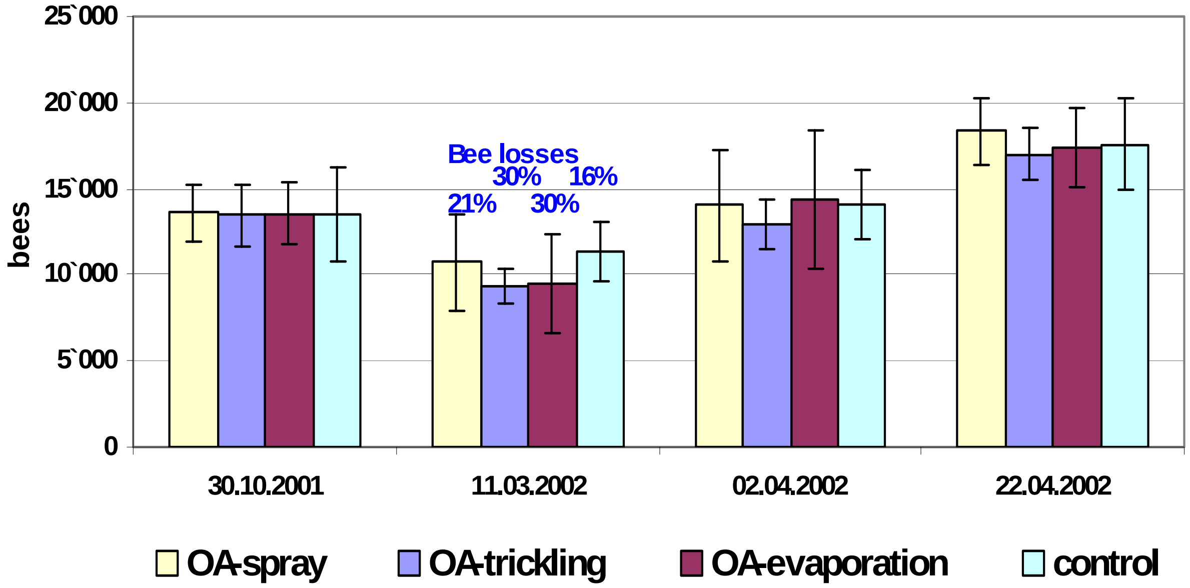


Figure 3: Average strength of the bee colony (with standard deviation) for the different treatment groups at the apiary in Bellechasse before the winter (in autumn 2001) and in spring 2002.

Table 4: Average number of bees and occupied brood cells as registered during the population estimation in autumn 2001 and spring 2002

		OA-spray		OA-trickling		OA-evaporation		control	
	No. of colonies	6		6		6		6	
	Date	bees	brood	bees	brood	bees	brood	bees	brood
Wohlei	31.10.2001	13550	447	13567	407	13417	147	13417	313
	11.03.2002	10000	6433	10533	5933	11417	6600	11800	7733
	02.04.2002	10783	11536	11660	13560	11717	10920	12467	14333
	23.04.2002	14480	23712	15600	27160	13060	23040	15283	25407
	14.05.2002	20200	26000	22900	33800	17160	27760	19450	30333
Bellechasse	30.10.2001	13583	720	13450	1360	13550	1120	13483	1987
	11.03.2002	10750	8933	9383	7400	9533	7267	11317	8567
	02.04.2002	14033	17533	12917	16333	14400	18800	14066	17967
	22.04.2002	18333	29900	17017	29300	17360	29536	17600	33833

Dynamic of the Varroa mite falls after the winter treatments

According to our observations, Perizin works the fastest. One day after treatment with Perizin more than 50% of the mites were already dead, whereas only 10% were counted after one day of treatment with oxalic acid. However, after one week of treatment the same result was achieved with all four methods, namely almost 80% of the mites lay dead at the bottom of the beehive (Figure 4). The evaporation method is slower than the other OA-treatments. The comparatively rapid losses of Varroa-mites when using Perizin can be explained by the different mode of action of this product. It follows from these figures that mite losses must be measured for three weeks in order to achieve a detailed quantification.

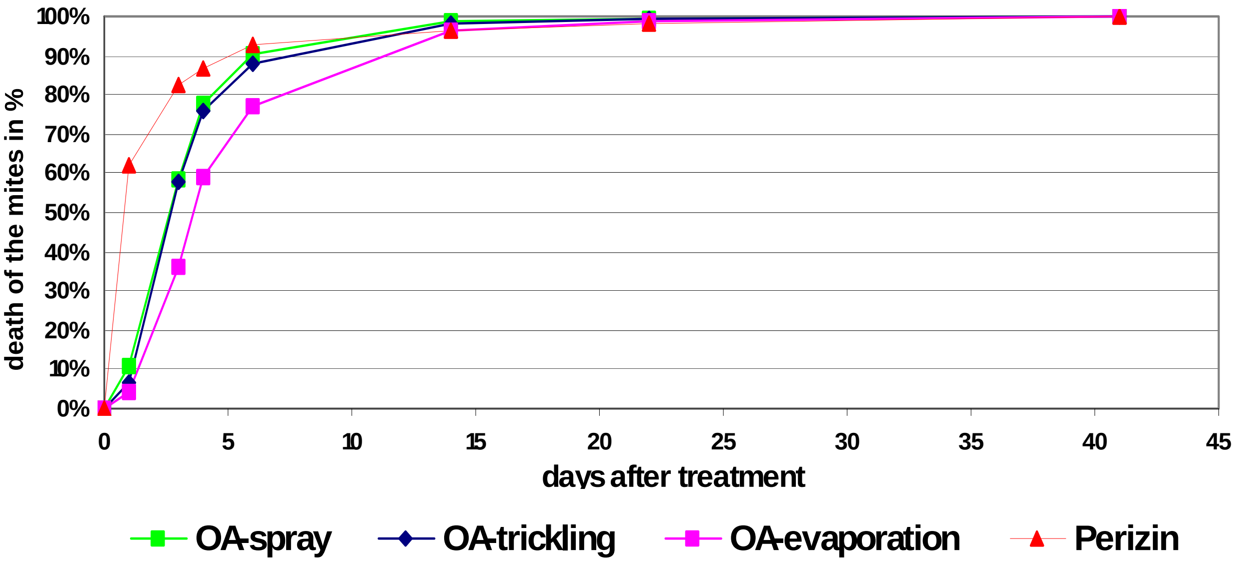


Figure 4: The rate of mite losses after different winter treatments. It is assumed that after 41 days all mites killed by the treatment have fallen (=100%).

Conclusion for practical application

- A correctly dosed once-only treatment with oxalic acid (spraying, trickling or evaporation method) or with Perizin is well tolerated by the bees.
- In terms of wintering and development in spring, no significant differences can be seen between the 3 different applications of oxalic acid and Perizin. Please note that Coumaphos, which is the active substance in Perizin, can lead to residues in wax[4, 21] and resistant mites have been found in Italy[25] and in the USA[10, 21].
- Untreated bee colonies tended to winter better, but not significantly so. The slight difference disappeared completely during the spring.
- The type of winter treatment does not affect the development of the bee colony during the spring.
- Trickling oxalic acid requires the least amount of time and is easiest to apply.
- The products for the control of Varroa-mites in summer which are available today are not sufficiently effective[15] unless combined with biotechnical methods. Therefore, winter treatment is absolutely essential. We must adapt to this and be prepared to give up formerly accepted customs such as not disturbing the colony during the winter rest period from October to April.
- To determine the exact number of dead Varroa-mites, which occur due to treatment with oxalic acid, the dead mites have to be counted for a period of three weeks.
- When applying the different products, beekeepers must consider all user protection measures.[11]

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After: Charrière J.D., Imdorf A., Kuhn R. (2004) Bienenverträglichkeit von Varroabehandlungen im Winter, Schweizerische Bienen-Zeitung 127, 19-23.

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