Oxalic Acid in Varroa Management

Randy Oliver
Revised 14 Jan 2016

(see notes under the slides)
Oxalic has a long history in Europe
Why Oxalic Acid?
Acids are much more toxic to mites than to bees.
Oxalic is the strongest organic acid.
There are speculative hypotheses as to why acids kill varroa, but no definitive study. Beekeeper Gerhard Bruning suspects that OA crystals are absorbed through varroa’s sticky tarsal pads.
Safety to Humans
Oxalis
Table I: Oxalic acid content in selected vegetables. These are ballpark numbers, actual content depends on many variables. See note at the end of the article.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Oxalic acid (g/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asparagus</td>
<td>0.13</td>
</tr>
<tr>
<td>Broccoli</td>
<td>0.19</td>
</tr>
<tr>
<td>Lettuce</td>
<td>0.33</td>
</tr>
<tr>
<td>Brussels sprouts</td>
<td>0.36</td>
</tr>
<tr>
<td>Collards</td>
<td>0.45</td>
</tr>
<tr>
<td>Beet leaves</td>
<td>0.61</td>
</tr>
<tr>
<td>Spinach</td>
<td>0.97 (0.32-1.26)</td>
</tr>
<tr>
<td>Purslane</td>
<td>1.31</td>
</tr>
<tr>
<td>Parsley</td>
<td>1.70</td>
</tr>
<tr>
<td>Rhubarb leaf</td>
<td>0.3-1.5</td>
</tr>
<tr>
<td>Rhubarb stalk</td>
<td>0.39 - 0.54</td>
</tr>
</tbody>
</table>
Typical treatment = 1 serving per hive
Purchasing Oxalic Acid
Sold as oxalic acid dihydrate

“Wood Bleach”
This is the only registered and legal oxalic product!
Mixing Oxalic Syrup
Need to weigh
HARD WATER LEVELS THROUGHOUT THE U.S.

LEGEND
- 0 - 3.5 grains per gallon – Soft
- 3.5 - 7.0 grains per gallon – Moderately Hard
- 7.0 - 10.5 grains per gallon – Hard
- over 10.5 grains per gallon – Very Hard

Due to the nature of the water bed sub-soil structure, water hardness may vary from one source to another within a general area.

Don’t use hard water
Oxalic Acid Treatment Table

Be sure to read "Oxalic Acid - Questions and Answers" and "The Learning Curve - Part 3" before using oxalic acid. It is critical to apply it correctly, or you risk seriously harming your bees!

Important Note: the following proportions refer to common oxalic acid dihydrate (wood bleach). If you manage to get your hands on pure laboratory oxalic acid, you must reduce the amount of acid to only 7/10ths of that of the dihydrate!!!!

Also note that if you use hard water, some of the oxalic acid will precipitate out as calcium oxalate, and thus reduce the efficacy (you'll easily see the white precipitate if this is the case.

<table>
<thead>
<tr>
<th>Oxalic strength →</th>
<th>&quot;Hot&quot; 4.2% w:v</th>
<th>&quot;Medium&quot; 3.2% w:v</th>
<th>&quot;Weak&quot; 2.5% w:v</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>OA Crystals</td>
<td>1</td>
<td>0.75</td>
<td>0.6</td>
<td>Oxalic crystals must be measured by weight. Sugar and water are about the same by weight or volume (1 pint of either granulated sugar or water weight 1 lb)</td>
</tr>
<tr>
<td>Sucrose</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Dist. Water</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

OA Crystals 60g  45g  35g  Makes 1 liter

Use the exact dose!
<table>
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<td>Sucrose</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>Makes 1 liter</td>
</tr>
<tr>
<td>Dist. Water</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>Treats about 20 colonies</td>
</tr>
<tr>
<td>OA crystals</td>
<td>60g</td>
<td>45g</td>
<td>35g</td>
<td></td>
</tr>
<tr>
<td>Sucrose</td>
<td>600g</td>
<td>600g</td>
<td>600g</td>
<td>Makes 1 liter</td>
</tr>
<tr>
<td>Dist. water</td>
<td>600ml</td>
<td>600ml</td>
<td>600ml</td>
<td>Treats about 33 colonies</td>
</tr>
<tr>
<td>OA crystals</td>
<td>100g</td>
<td>75g</td>
<td>60g</td>
<td>Makes 1700ml</td>
</tr>
<tr>
<td>Sucrose</td>
<td>1 kg</td>
<td>1 kg</td>
<td>1 kg</td>
<td>Treats about 75 colonies</td>
</tr>
<tr>
<td>Dist. water</td>
<td>1 liter</td>
<td>1 liter</td>
<td>1 liter</td>
<td></td>
</tr>
<tr>
<td>OA crystals</td>
<td>232g</td>
<td>174g</td>
<td>139g</td>
<td>Makes 1+ gallon</td>
</tr>
<tr>
<td>Sucrose</td>
<td>5 lb</td>
<td>5 lb</td>
<td>5 lb</td>
<td>Treats about 75 colonies</td>
</tr>
<tr>
<td>Dist. water</td>
<td>2.5 qt</td>
<td>2.5 qt</td>
<td>2.5 qt</td>
<td></td>
</tr>
<tr>
<td>OA crystals</td>
<td>1112g (2lb 7oz)</td>
<td>834g (1lb 13.4oz)</td>
<td>667g (1lb 7.5oz)</td>
<td>Makes 5 gallons</td>
</tr>
<tr>
<td>Sucrose</td>
<td>25 lb</td>
<td>25 lb</td>
<td>25 lb</td>
<td>Treats about 375 colonies</td>
</tr>
<tr>
<td>Dist. water</td>
<td>3 gal</td>
<td>3 gal</td>
<td>3 gal</td>
<td></td>
</tr>
</tbody>
</table>
Oxalic acid crystals dissolve more readily in hot water than in sugar solution.

Tip: dissolve the oxalic crystals in the indicated amount of hot (150°F) water before adding the sugar.

After the oxalic crystals are fully dissolved, only then stir in the sugar.
Storage
Store in the ‘fridge

Oxalic Acid 5.2% 8/17 POISON
Safety
Protect your eyes
Tastes like strong lemonade
Carry baking soda in water to neutralize.
Application
Must be applied directly to bees' bodies.
~5 mL per “seam” of bees
1 tsp = 5 mL
Dribble, not spray
Calibrate pump output
Hit both boxes
Tips:

Fill the garden sprayer only about $\frac{1}{4}$ full of solution. This leaves a large air space, which minimizes the fluctuation in pressure.

After you’ve dribbled a yard of hives, measure how much syrup you’ve applied in total, and divide by the number of hives. This will tell you if you’re applying the correct amount.
Timing of Treatment
Oxalic won’t kill mites in the brood.
Note the difference in efficacy, dependent upon how much brood is present.

Oxalic gives poor efficacy if there is much brood present, especially if drone brood is present.
Age Class Distribution of Workers Over the Year
Manitoba, Shed Wintered

- Spring turnover (die-off of "summer bees")
- Fall turnover (shift to "winter bee" physiology)

Best treatment windows
Oxalic acid is, by far, most effective when colonies are broodless.
We use our fall oxalic dribble as a last check on our colonies before winter. I took a step back from swapping frames of honey from heavy to lightweight hives to show Eric and Ian dribbling oxalic in the background.
We use our fall oxalic dribble as a last check on our colonies before winter.
Oxalic drops mites for about 4 days.
Benefit against nosema
Accepted Manuscript

Effect of oxalic acid on *Nosema ceranae* infection

Antonio Nanetti, Cristina Rodriguez-Garcia, Aránzazu Meana, Raquel Martin-Hernández, Mariano Higes

PII: S0034-5288(15)30033-3
DOI: doi: 10.1016/j.rvsc.2015.08.003
Nosema infection after fall dribble of weak OA, 50mL/hive
Summer Treatment

- *Can be used on severely mite-stressed colonies to buy time.*
- *Must be repeated at weekly intervals.*
Colony about to collapse
Formic or thymol may be too strong a treatment.
Summer treatment—3 weekly applications.

Around 50% mite reduction.
Induced Brood Break
Understand the timing!
Beekeepers in Italy create an induced brood break during late summer by temporarily caging the queen.
Creating an induced brood break for oxalic treatment by caging the queen for two weeks.

- Cage Queen:
  - Day 0: Eggs
  - Day 1-2: Induced brood break
  - Day 3-4: Open brood
  - Day 5-6: Sealed brood

- Release Queen:
  - Day 14: Eggs
  - Day 15-16: Induced brood break
  - Day 17-18: Last day of old sealed brood
  - Day 19-20: Window for oxalic dribble

- Treat with oxalic:
  - Day 21: First new sealed brood
  - Day 22: First day of new sealed brood

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Cage the queen for 12 days minimum. Then release her. Treat 4-5 days later.
Treat walkaway splits at 20 days.

http://eberthoney.com/
Combine OA with requeening
Kill the old queen, insert a queen cell, treat with OA 19 days later.
Cage the old queen for 2 weeks, then remove her and introduce a new queen, treat with OA 5 days later.
Treatment of Nucs or Packages

A no brainer
Treat package bees or swarms shortly after installation for a “clean start”
Treatment window for nucs

The Biology Behind the Method

10-day queen cell inserted on Day 1

Virgin queen
Mated queen
Laying queen

First new eggs
New larvae
Pupae

Window of treatment opportunity while most mites are phoretic

Mites enter new brood

Existing eggs
Last larvae from old queen

Mites exiting old brood

Pupae

All old brood emerged

Days from nuc make up
Treatment Effect upon Normalized Mite Infestation Rates over 3 Months

- Control (10)
- Hopguard (9)
- Hive Clean (9)
- Oxalic (11)

Percent change in mite level

Day 0 | Day 37 | Day 51 | Day 87

5-fold difference!
Timeline, Trial 2
Oxalic dribble of nucs

Day -9: Grafted
Day 0: Made up nucs
Day 15: Equalized to 5 frames of bees
Day 16: First larvae being sealed; treated w/ oxalic dribble

53 days (3+ mite reproductive cycles)

Day 69: alcohol wash & grading
Trial 2: Mite Infestation Rate in Nucs
53 Days Post Treatment

- Control Colonies (n = 15)
- Oxalic dribbled colonies (n = 18)

Number of mites per ~300 bee alcohol wash

Number of colonies:
- Median, Oxalic
- Median, Control
Trial 2: Colony Strength
53 Days Post Treatment

- Control
- Oxalic dribble

Number of colonies

Seams filled with bees

Median, Control

Median, Oxalic
Doesn’t appear to harm queens
<table>
<thead>
<tr>
<th>Graft #</th>
<th>Queen(s)</th>
<th>No. cells</th>
<th>Day</th>
<th>Graft date</th>
<th>Sealed</th>
<th>Incubator</th>
<th>Nucs by</th>
<th>Early ripe</th>
<th>Typ mate</th>
<th>Typ eggs</th>
<th>Check/oxalic</th>
<th>Nuc yard(s)</th>
</tr>
</thead>
</table>

Create a spreadsheet to keep track of dates
Vaporization
(Sublimation)

A Magic Wand?

Useful where winter comes on suddenly.
Simple Varrox vaporizer.
Vaporized oxalic is dangerous!
Wear a respirator.
Other issues:
Cooked bees
Burnt wood or plastic

https://beeinformed.org/2014/02/03/oxalic-acid-fogger-demostration/
Sublimation may be easier on the bees.
ORIGINAL RESEARCH ARTICLE

Towards integrated control of varroa: 2) comparing application methods and doses of oxalic acid on the mortality of phoretic Varroa destructor mites and their honey bee hosts

Hasan Al Toufailia*, Luciano Scandian and Francis L W Ratnieks
## Dribble vs. Sublimation

<table>
<thead>
<tr>
<th></th>
<th>Dribble</th>
<th>Sublimation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pros:</strong></td>
<td>High efficacy</td>
<td>Perhaps higher efficacy</td>
</tr>
<tr>
<td></td>
<td>Very safe to apply</td>
<td>No opening of the hive</td>
</tr>
<tr>
<td></td>
<td>Quick</td>
<td>Can do in freezing weather</td>
</tr>
<tr>
<td></td>
<td>Little equip needed</td>
<td>Perhaps gentler to the bees</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No syrup mixing</td>
</tr>
<tr>
<td><strong>Cons:</strong></td>
<td>Requires opening hive</td>
<td>Vapor fog is hazardous</td>
</tr>
<tr>
<td></td>
<td>May be problematic in freezing weather</td>
<td>Requires specialized vaporizer and energy source</td>
</tr>
<tr>
<td></td>
<td>Easier with helper</td>
<td>Problems with hot tip</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Effect of a single treatment, no brood
Instructions: type values into for the two yellow cells and hit enter

<table>
<thead>
<tr>
<th>Percent of full broodnest present</th>
<th>100 %</th>
<th>A full broodnest with substantial bees present. If it appears there may be only 50% or less of a full broodnest present. Adjust this value to reflect the actual condition.</th>
</tr>
</thead>
</table>
| Expected weekly kill of the phoretic mites by the treatment | 90 % fill in | See Note:...
Effect of treatment once every three weeks
Instructions: type values into for the two yellow cells and hit enter

Percent of full broodnest present: 100% A full broodnest with substantial coverage may be only 50% or less of a full broodnest present. Adjust this value to your needs.

Expected weekly kill of the phoretic mites by the treatment: 90% fill in

Effect of weekly treatment:

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Another application method
A new formulation of oxalic acid for Varroa destructor control applied in Apis mellifera colonies in the presence of brood

Matías Maggi¹,², Elian Tourn³,⁴,⁵, Pedro Negri¹,², Nicolás Szawarski¹, Alfredo Marconi³,⁴,⁵, Liliana Gallez⁶, Sandra Medici¹,², Sergio Ruffinengo⁷, Constanza Brasesco¹, Leonardo De Feudis¹, Silvina Quintana⁸, Diana Sammataro⁹, Martin Eguras¹,²
Oxalic/glycerine on cardboard strips.
A Critical Closing Thought

“The only way to halt the development of resistance to a certain product is by interrupting its use in the control strategy.”

Practice some sort of rotation of treatments

Formic → Amitraz → Oxalic → Thymol → Formic
Happy beekeeping!
ScientificBeekeeping.com