



# **Oxalic Acid in Varroa Management**

**Randy Oliver  
Revised 14 Jan 2016**

**(see notes under the slides)**



# **Oxalic acid for the control of varroosis in honey bee colonies – a review<sup>1</sup>**

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Received 17 February 2005 – revised 17 June 2005 – accepted 26 July 2005

**Abstract** – The review summarizes research results on the use of oxalic acid as an acaricide in honey bee colonies. Three different treatment techniques (i.e. trickling, evaporation and spraying) have been developed for the application of oxalic acid. Detailed information is given on the efficacy against *Varroa destructor*, tolerability by *Apis mellifera*, protective procedures for the user, residue situation and consumer safety, as well as recommendations for use.

*Oxalic has a long history in Europe*

# Why Oxalic Acid?



**Acids are much more  
toxic to mites than to bees**

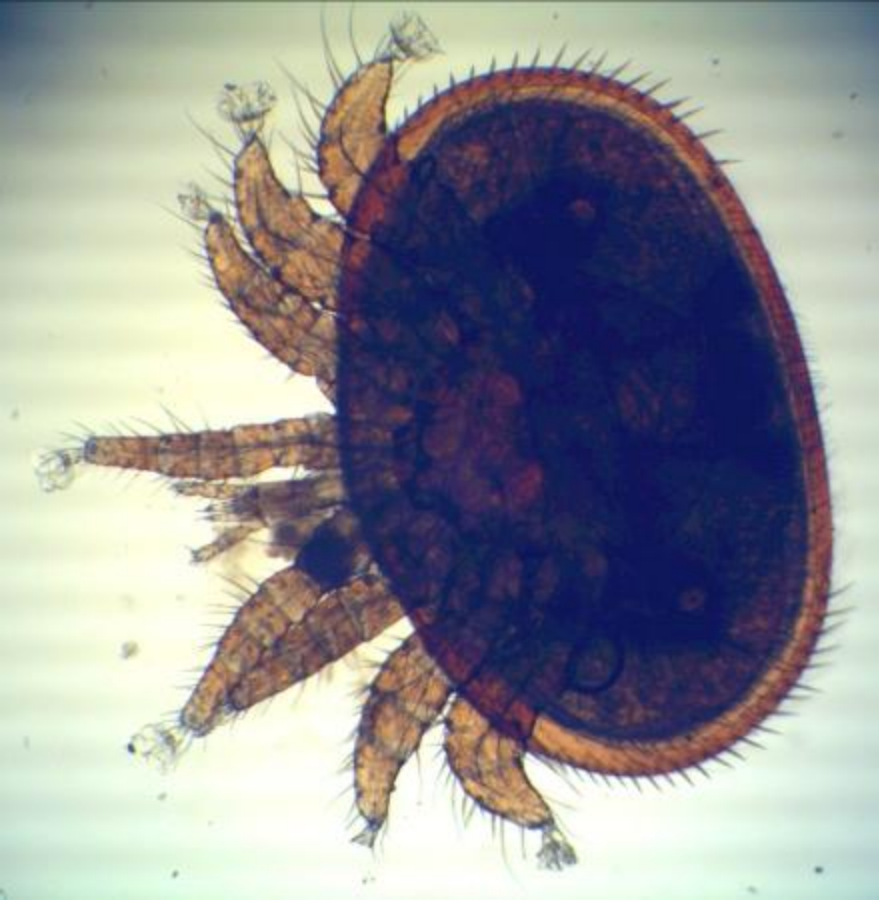
Oxalic is the strongest organic acid

## pH of Organic Acids – Sorted by increasing pH



Formula	Name	Alternative name	1 mM	10 mM	100 mM
C <sub>2</sub> H <sub>2</sub> O <sub>4</sub>	oxalic acid	ethanedioic acid	3.00	2.09	1.31
C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	maleic acid	toxic acid	3.05	2.21	1.54
C <sub>4</sub> H <sub>6</sub> O <sub>8</sub>	dihydroxytartaric acid		3.04	2.20	1.54
C <sub>6</sub> H <sub>6</sub> O <sub>6</sub>	cis-aconitic acid		3.05	2.21	1.55
C <sub>4</sub> H <sub>4</sub> O <sub>5</sub>	oxaloacetic acid	oxalacetic acid	3.05	2.29	1.68
C <sub>5</sub> H <sub>6</sub> O <sub>5</sub>	oxoglutaric acid	ketoglutaric acid	3.09	2.36	1.77
C <sub>3</sub> H <sub>4</sub> O <sub>3</sub>	pyruvic acid	acetylformic acid	3.11	2.38	1.79
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	2-oxobutanoic acid	alpha-ketobutyric acid	3.11	2.38	1.79
C <sub>6</sub> H <sub>6</sub> O <sub>6</sub>	trans-aconitic acid		3.14	2.48	1.92
C <sub>3</sub> H <sub>4</sub> O <sub>4</sub>	malonic acid	propanedioic acid	3.17	2.50	1.94
C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	phthalic acid	ortho-phthalic acid	3.20	2.55	2.00
C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	L-tartaric acid	racemic acid	3.18	2.55	2.01
C <sub>7</sub> H <sub>6</sub> O <sub>4</sub>	gentisic acid	"2,5-dihydroxybenzoic"	3.21	2.56	2.01
C <sub>7</sub> H <sub>6</sub> O <sub>3</sub>	salicylic acid	2-hydroxybenzoic acid	3.21	2.57	2.02
C <sub>4</sub> H <sub>4</sub> O <sub>4</sub>	fumaric acid	allomaleic acid	3.19	2.57	2.03
C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	DL-tartaric acid	racemic acid	3.19	2.58	2.03
C <sub>4</sub> H <sub>6</sub> O <sub>4</sub>	methylmalonic acid		3.23	2.60	2.05
C <sub>5</sub> H <sub>6</sub> O <sub>4</sub>	mesaconic acid	dimethylfumaric acid	3.23	2.61	2.06
C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	meso-tartaric acid	racemic acid	3.24	2.62	2.08
C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	citric acid		3.24	2.62	2.08
C <sub>2</sub> H <sub>2</sub> O <sub>3</sub>	glyoxilic acid	oxoacetic acid	3.27	2.65	2.11
C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	isocitric acid		3.28	2.69	2.16
C <sub>4</sub> H <sub>6</sub> O <sub>5</sub>	malic acid		3.33	2.74	2.21
C <sub>8</sub> H <sub>8</sub> O <sub>3</sub>	mandelic acid	phenylglycolic acid	3.34	2.75	2.22
C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	isophthalic acid	meta-phthalic acid	3.33	2.76	2.24
C <sub>8</sub> H <sub>6</sub> O <sub>4</sub>	terephthalic acid	para-phthalic acid	3.36	2.79	2.26
C <sub>3</sub> H <sub>6</sub> O <sub>4</sub>	glyceric acid		3.38	2.80	2.27
C <sub>4</sub> H <sub>6</sub> O <sub>3</sub>	acetoacetic acid	diacetic acid	3.40	2.83	2.30
C <sub>4</sub> H <sub>8</sub> O <sub>3</sub>	hydroxybutanoic acid		3.43	2.86	2.33
CH <sub>2</sub> O <sub>2</sub>	formic acid	methanoic acid	3.47	2.91	2.38
C <sub>2</sub> H <sub>4</sub> O <sub>3</sub>	glocolic acid	hydroxyacetic acid	3.50	2.94	2.42
C <sub>5</sub> H <sub>6</sub> O <sub>4</sub>	itaconic acid	methylenesuccinic acid	3.50	2.95	2.43
C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	lactic acid	milk acid	3.51	2.96	2.44
C <sub>8</sub> H <sub>8</sub> O <sub>2</sub>	toluic acid	ortho-toluic acid	3.53	2.98	2.46
C <sub>6</sub> H <sub>8</sub> O <sub>6</sub>	ascorbic acid	vitamin C	3.59	3.04	2.53
C <sub>5</sub> H <sub>8</sub> O <sub>4</sub>	methylsuccinic acid		3.62	3.08	2.57
C <sub>7</sub> H <sub>6</sub> O <sub>2</sub>	benzoic acid		3.66	3.12	2.60
C <sub>8</sub> H <sub>8</sub> O <sub>4</sub>	phthalic acid	ortho-phthalic acid	3.65	3.13	2.61





<http://www.varroamilbe.ch>

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*







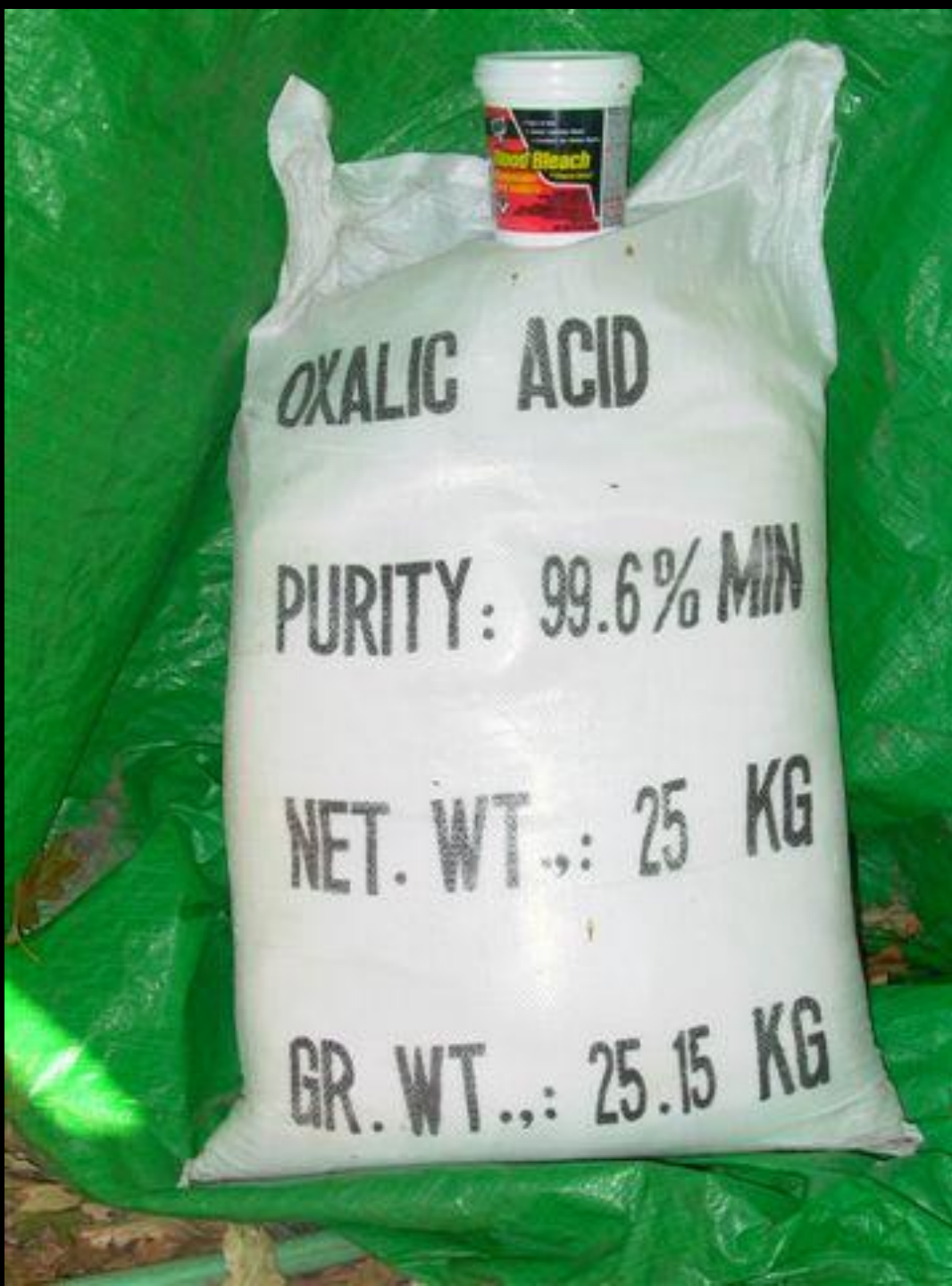
Table I: Oxalic acid content in selected vegetables. These are ballpark numbers, actual content depends on many variables. See note at the end of the article.

Vegetable	Oxalic acid (g/100 g)
Asparagus	0.13
Broccoli	0.19
Lettuce	0.33
Brussels sprouts	0.36
Collards	0.45
Beet leaves	0.61
Spinach	0.97 (0.32-1.26)
Purslane	1.31
Parsley	1.70
Rhubarb	0,3-1.5
leaf	0.59 - 0.72
stalk	0.39 - 0.54



Typical treatment=  
1 serving  
per hive

# Purchasing Oxalic Acid



Sold as  
oxalic acid  
dihydrate

“Wood Bleach”





Serving the industry for more than 30 years

# Brushy Mountain Bee Farm

BEST QUALITY | BEST SERVICE | BEST SUPPORT



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## Online Store

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**Free Shipping on Most Orders Over \$150\***

*Free Shipping does not apply to international orders, back ordered items shipped separately, glass jars, honey or syrup, LTL shipments will be sent out at no charge but any accessorial fees will be billed to customer's account. Other restrictions may apply.*

Search Results for : "oxalic"

Item #	Image	Description
727		Oxalic Acid Shp. Wt. 1 lb.
727K		Kit for Oxalic Acid Ship wt. 2 lbs. In Stock
727OAV		Varrocleaner Ship wt. 3 lbs. In Stock

**This is the only registered and legal oxalic product!**

# Mixing Oxalic Syrup

American Weigh Scale

0.1 G

by American Weigh Scale



**\$9.89** ~~\$20.95~~ Prime

Get it by **Monday, Nov 30**

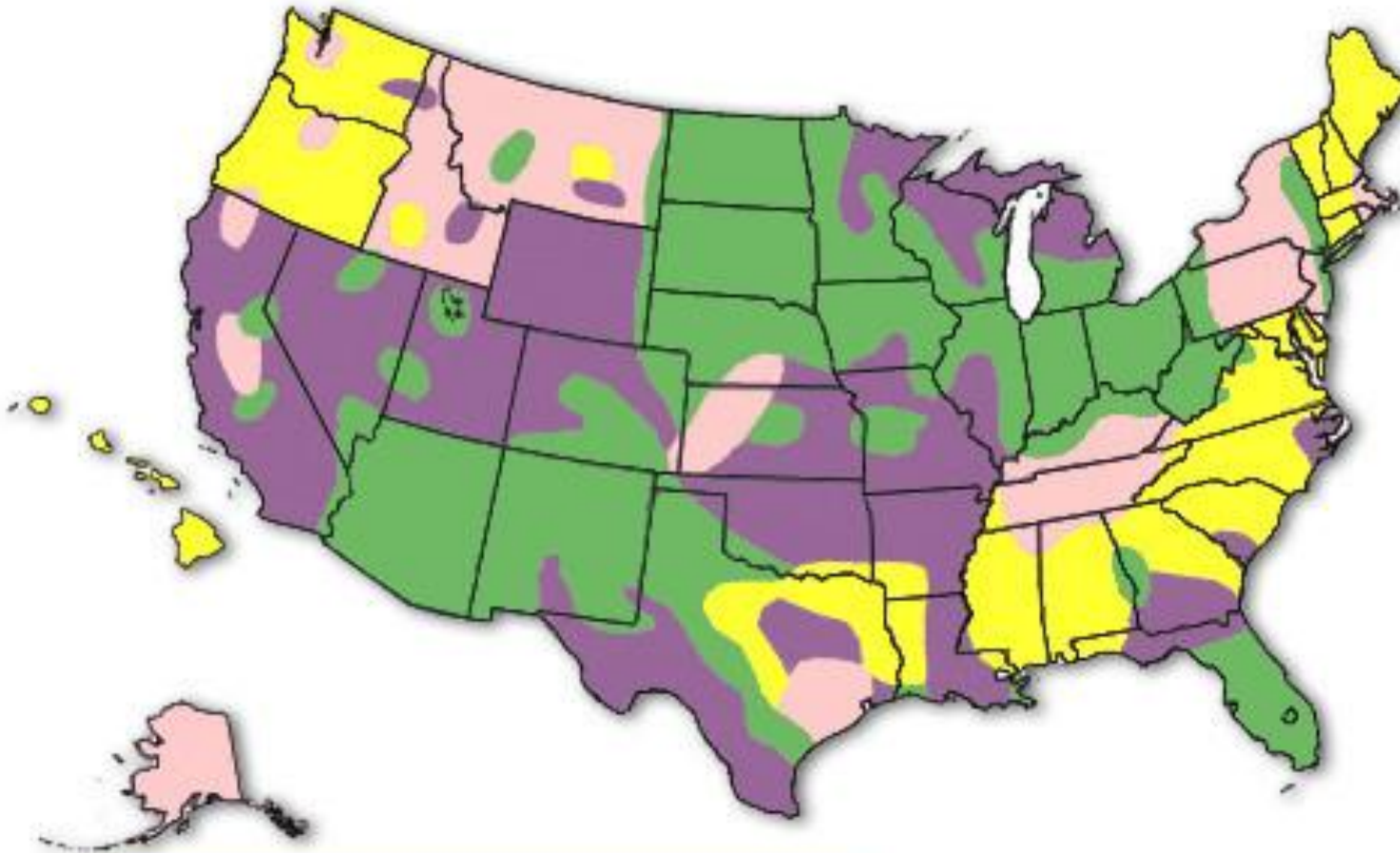
More Buying Choices

**\$6.00** new (8 offers)



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

Save PDF Email Print

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).

Oxalic strength →	"Hot" 4.2% w:v	"Medium" 3.2% w:v	"Weak" 2.5% w:v	Notes
OA Crystals	1	0.75	0.6	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)
Sucrose	10	10	10	
Dist. Water	10	10	10	
OA Crystals	60g	45g	35g	Makes 1 liter:

[Articles By Publication Date](#)

[Bee Behavior and Biology](#)

[Varroa Management](#)

[Bee Nutrition](#)

[Colony Health – Diseases, Viruses, CCD](#)

[Pesticide Issues](#)

[Nosema ceranae](#)

[Almond Pollination](#)


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# Use the exact dose!

<b>Oxalic strength→</b>	<b>“Hot” 4.2% w:v</b>	<b>“Medium” 3.2% w:v</b>	<b>“Weak” 2.5% w:v</b>	Notes 
OA crystals	<b>1</b>	<b>0.75</b>	<b>0.6</b>	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 weigh 1 lb)
Sucrose	<b>10</b>	<b>10</b>	<b>10</b>	
Dist. Water	<b>10</b>	<b>10</b>	<b>10</b>	
OA crystals	<b>60g</b>	<b>45g</b>	<b>35g</b>	Makes 1 liter Treats about 20 colonies
Sucrose	<b>600g</b>	<b>600g</b>	<b>600g</b>	
Dist. water	<b>600ml</b>	<b>600ml</b>	<b>600ml</b>	
OA crystals	<b>100g</b>	<b>75g</b>	<b>60g</b>	Makes 1700ml Treats about 33 colonies
Sucrose	<b>1 kg</b>	<b>1 kg</b>	<b>1 kg</b>	
Dist. water	<b>1 liter</b>	<b>1 liter</b>	<b>1 liter</b>	
OA crystals	<b>232g</b>	<b>174g</b>	<b>139g</b>	Makes 1+ gallon Treats about 75 colonies
Sucrose	<b>5 lb</b>	<b>5 lb</b>	<b>5 lb</b>	
Dist. water	<b>2.5 qt</b>	<b>2.5 qt</b>	<b>2.5 qt</b>	
OA crystals	<b>1112g (2lb 7oz)</b>	<b>834g (1lb 13.4oz)</b>	<b>667g (1lb 7.5oz)</b>	Makes 5 gallons Treats about 375 colonies
Sucrose	<b>25 lb</b>	<b>25 lb</b>	<b>25 lb</b>	
Dist. water	<b>3 gal</b>	<b>3 gal</b>	<b>3 gal</b>	

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%  
POISON  
8/17

HALF & HALF

Pasteurized GRADE A

CONTAINS 100% JUICE  
Nutrition Facts

Per 100g	
Calories	100
Total Fat	10g
Sodium	100mg
Total Sugar	10g
Total Protein	10g



**Safety**



**Protect your eyes**





**Tastes like strong  
lemonade**



# DIY Alkaline Water

homeAIDmom.blogspot.com



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.**



Kill rate of phoretic mites

90

← you can change this value

Percent of full broodnest	Estimated percentage of mites in the brood	Estimated percentage of mites phoretic	Kill rate of phoretic mites	Percent kill of total mite population
100	70%	30%	90%	27%
90	63%	37%	90%	33%
80	56%	44%	90%	40%
70	49%	51%	90%	46%
60	42%	58%	90%	52%
50	35%	65%	90%	59%
40	28%	72%	90%	65%
30	21%	79%	90%	71%
20	14%	86%	90%	77%
10	7%	93%	90%	84%
0	0%	100%	90%	90%

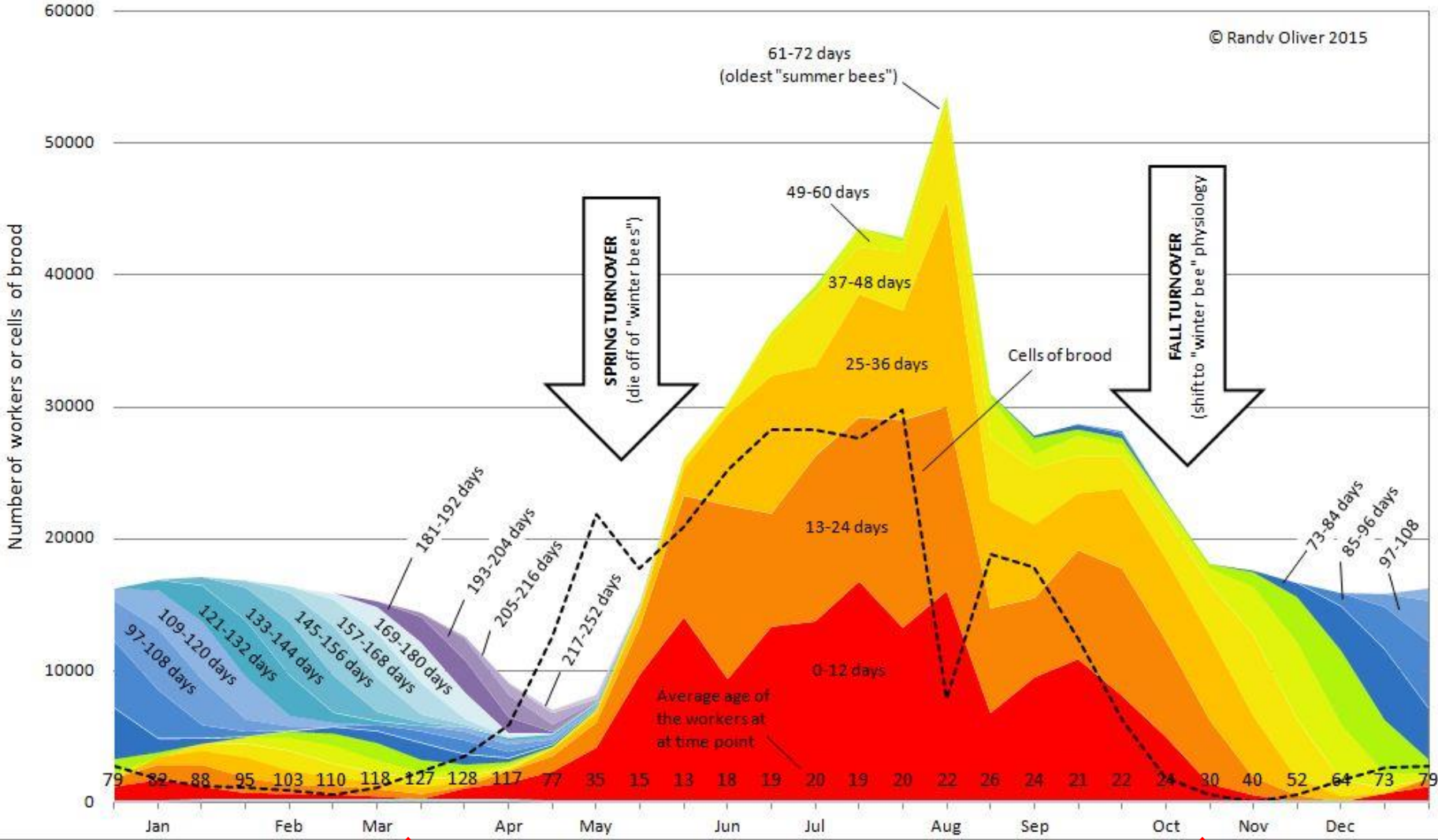
Note the difference in efficacy, dependent upon how much brood is present.

**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



© Randy Oliver 2015



**Best treatment windows**





# Fall treatment



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.**





**Oxalic drops mites  
for about 4 days.**



# **Benefit against nosema**



# Accepted Manuscript

Effect of oxalic acid on *Nosema ceranae* infection

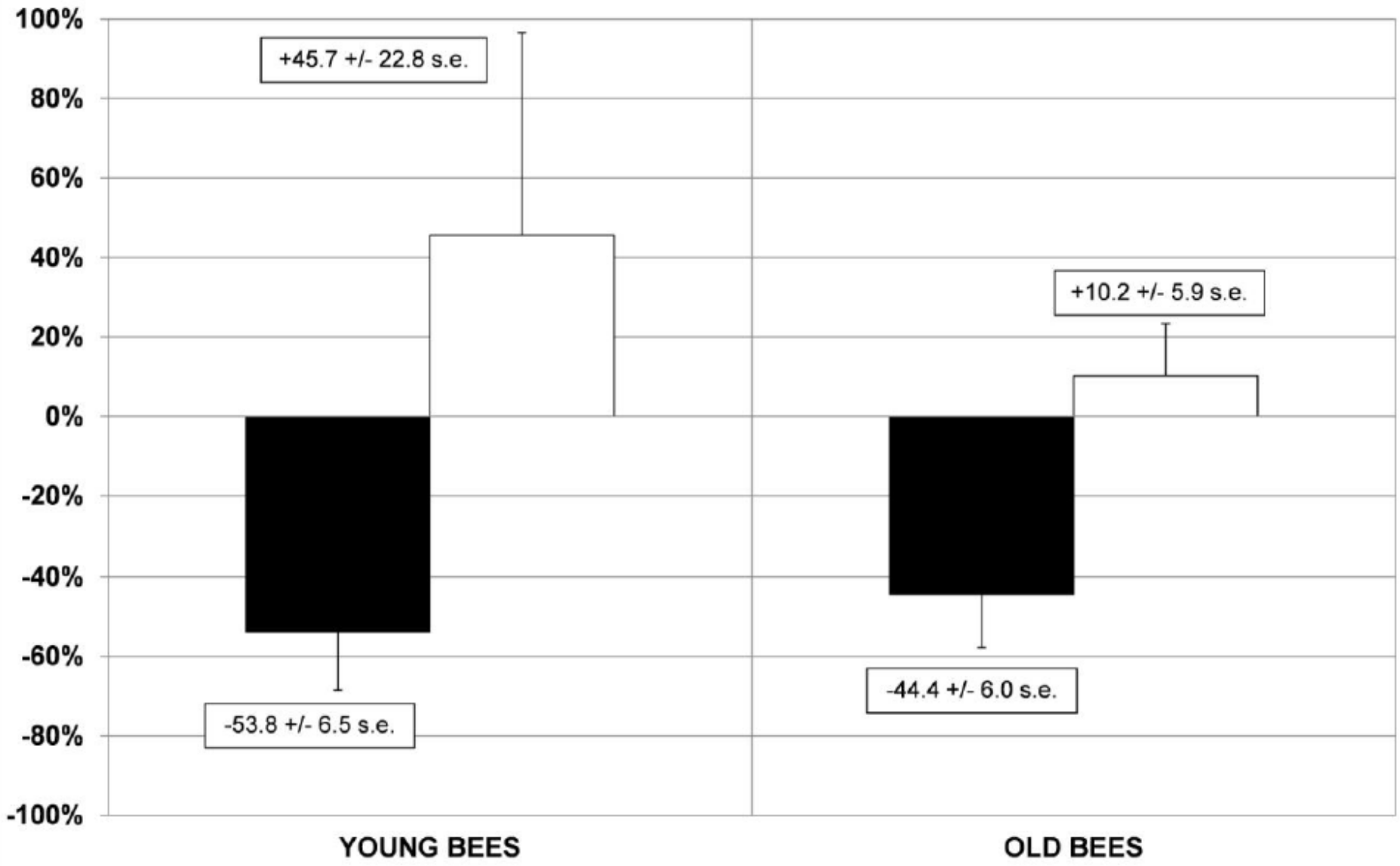
Antonio Nanetti, Cristina Rodriguez-García, Aránzazu Meana, Raquel Martín-Hernández, Mariano Higes

PII: S0034-5288(15)30033-3

DOI: [doi: 10.1016/j.rvsc.2015.08.003](https://doi.org/10.1016/j.rvsc.2015.08.003)



■ Treated □ Control



**Nosema infection after fall dribble of weak OA, 50mL/hive**

# Summer Treatment

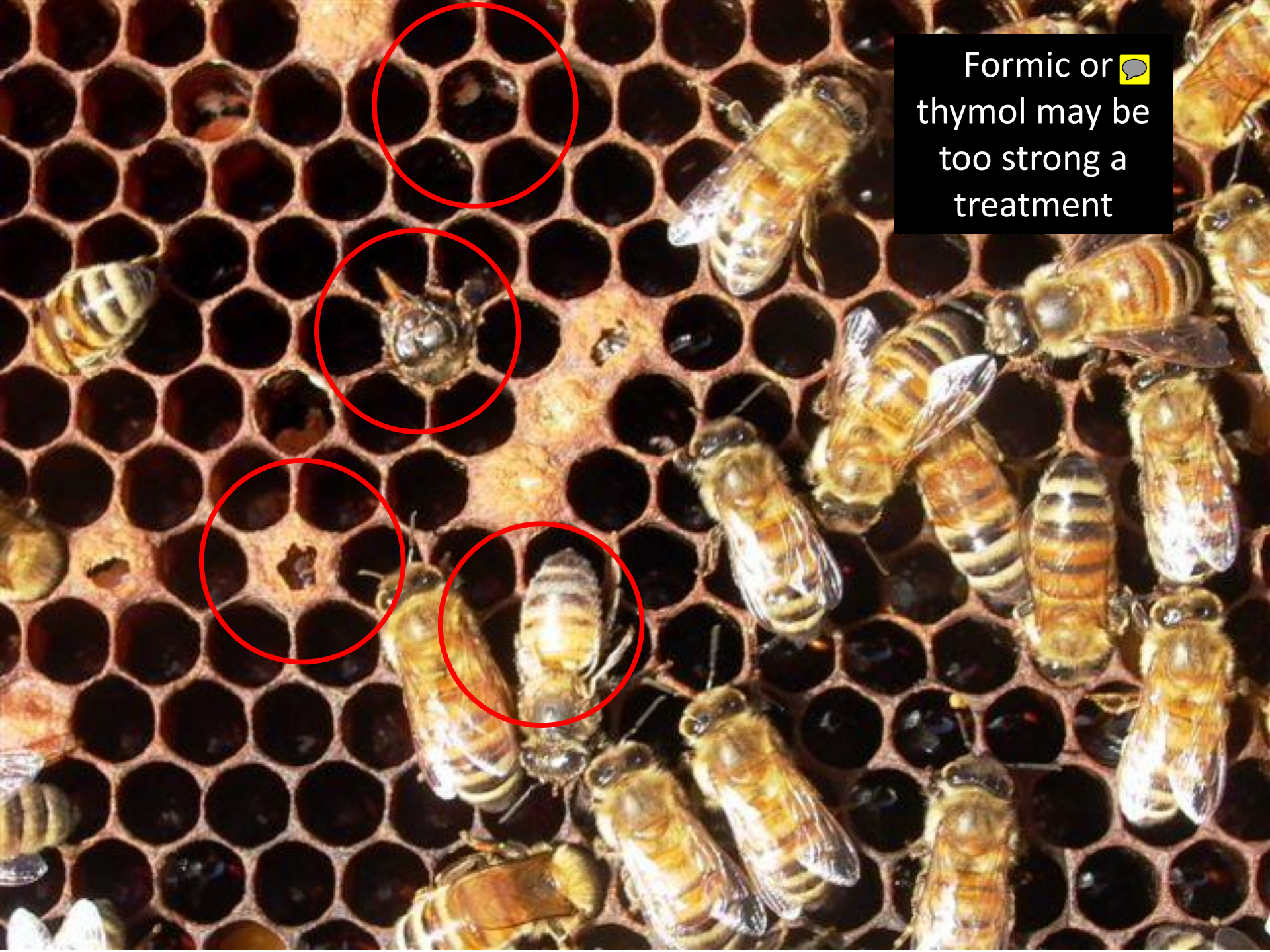
- *Can be used on severely mite-stressed colonies to buy time.*
- *Must be repeated at weekly intervals.*




**Colony about to collapse**







Formic or  thymol may be too strong a treatment



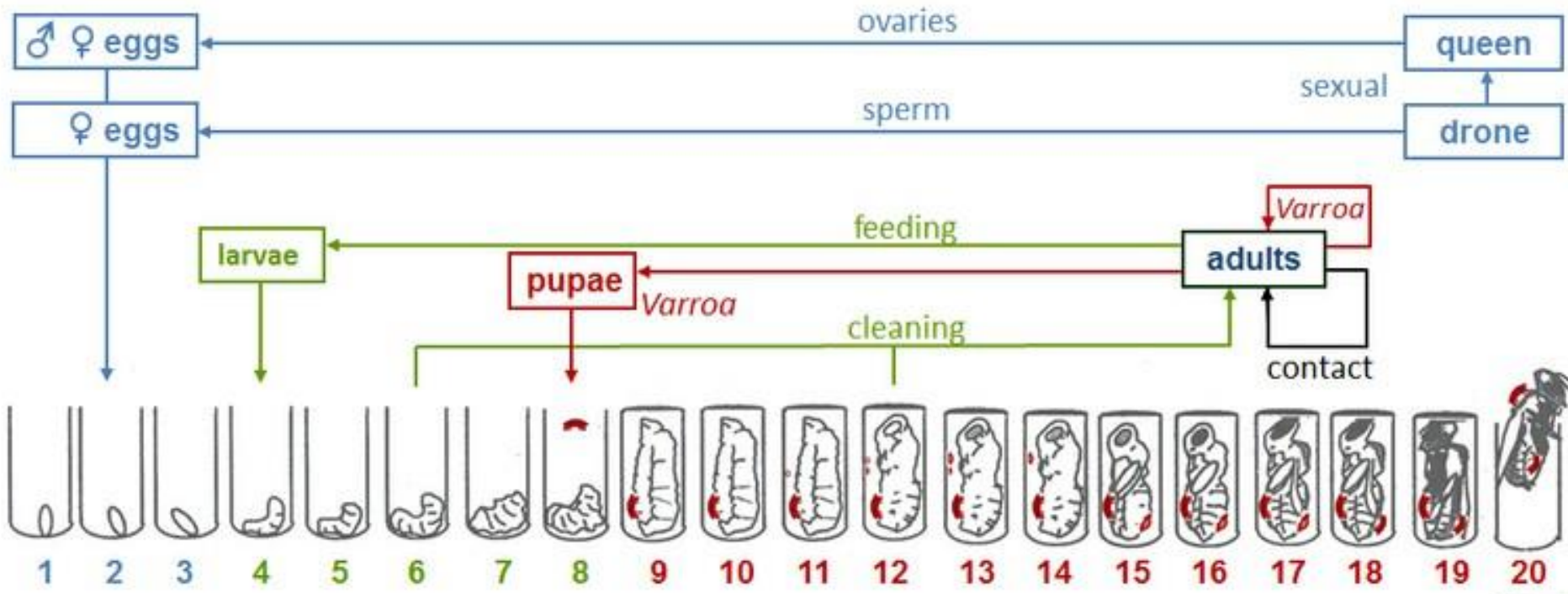


**Summer  
treatment—  
3 weekly  
applications.**

**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**



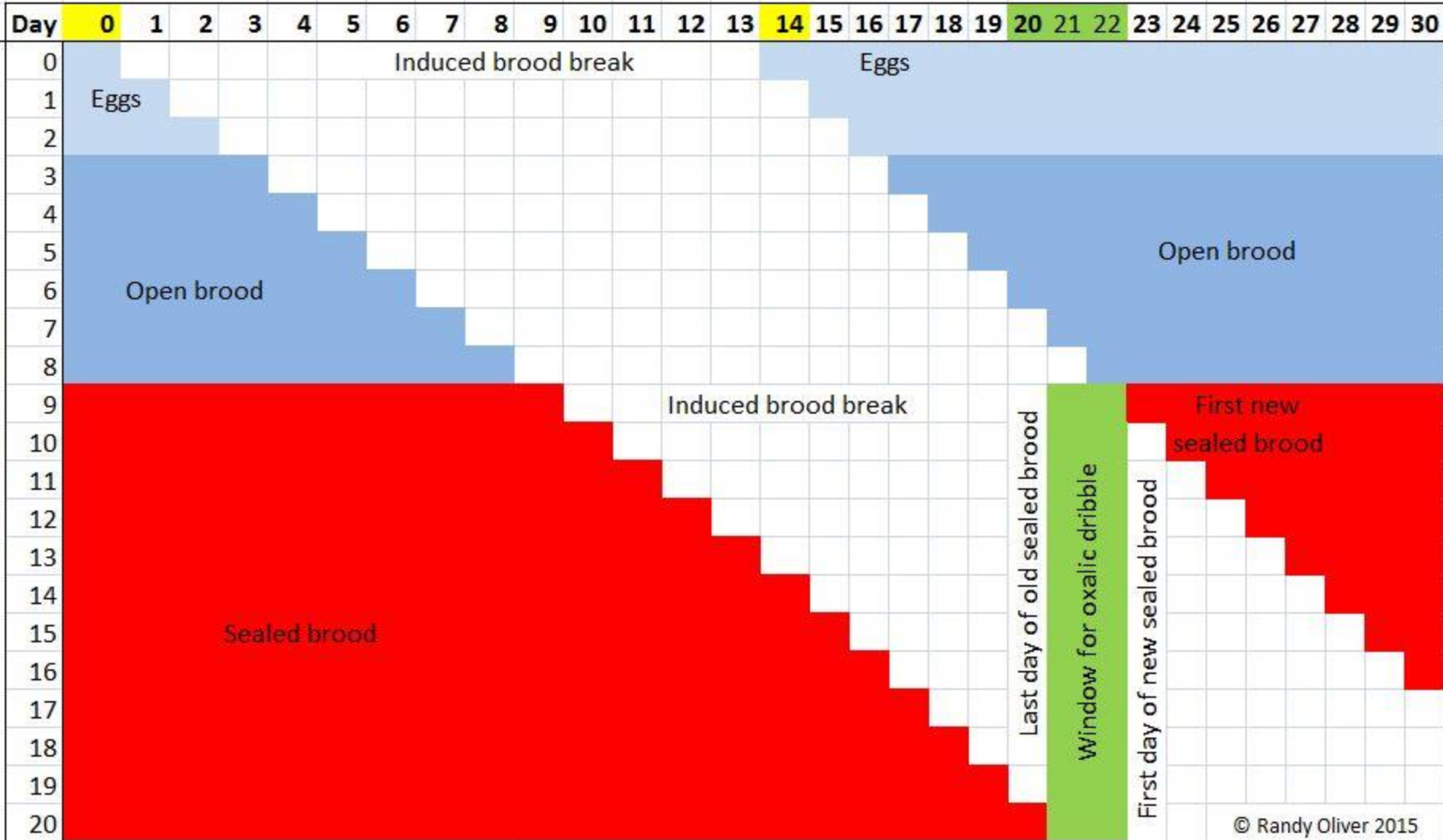
# Creating an induced brood break for oxalic treatment by caging the queen for two weeks.



Cage Queen

Release Queen

Treat with oxalic



Brood development

Induced brood break

Eggs

Open brood

Open brood

Induced brood break

Last day of old sealed brood

Window for oxalic dribble

First day of new sealed brood

Sealed brood

First new sealed brood



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





<http://eberthoney.com/>

**Treat walkaway splits at 20 days.**

**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*



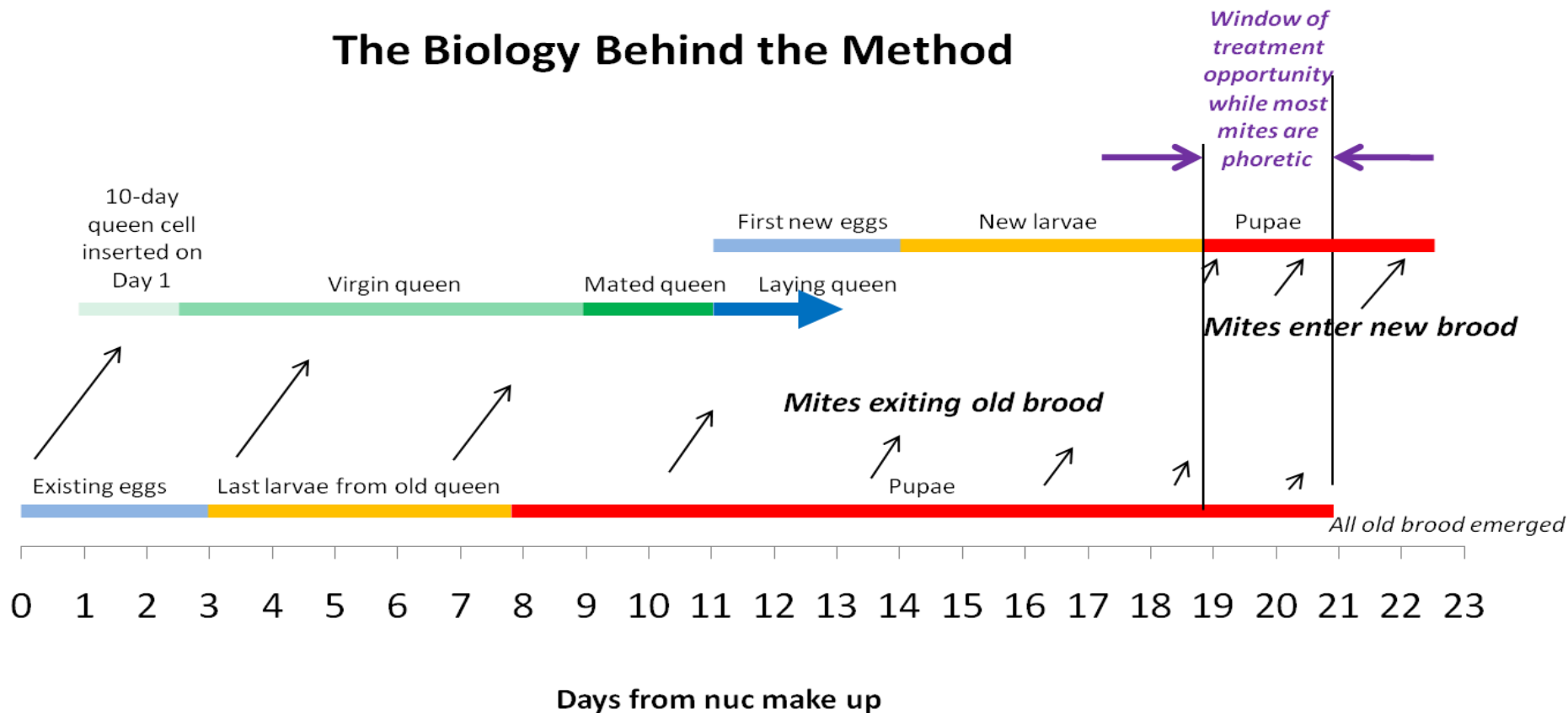


Treat package bees or swarms shortly after installation for a "clean start"

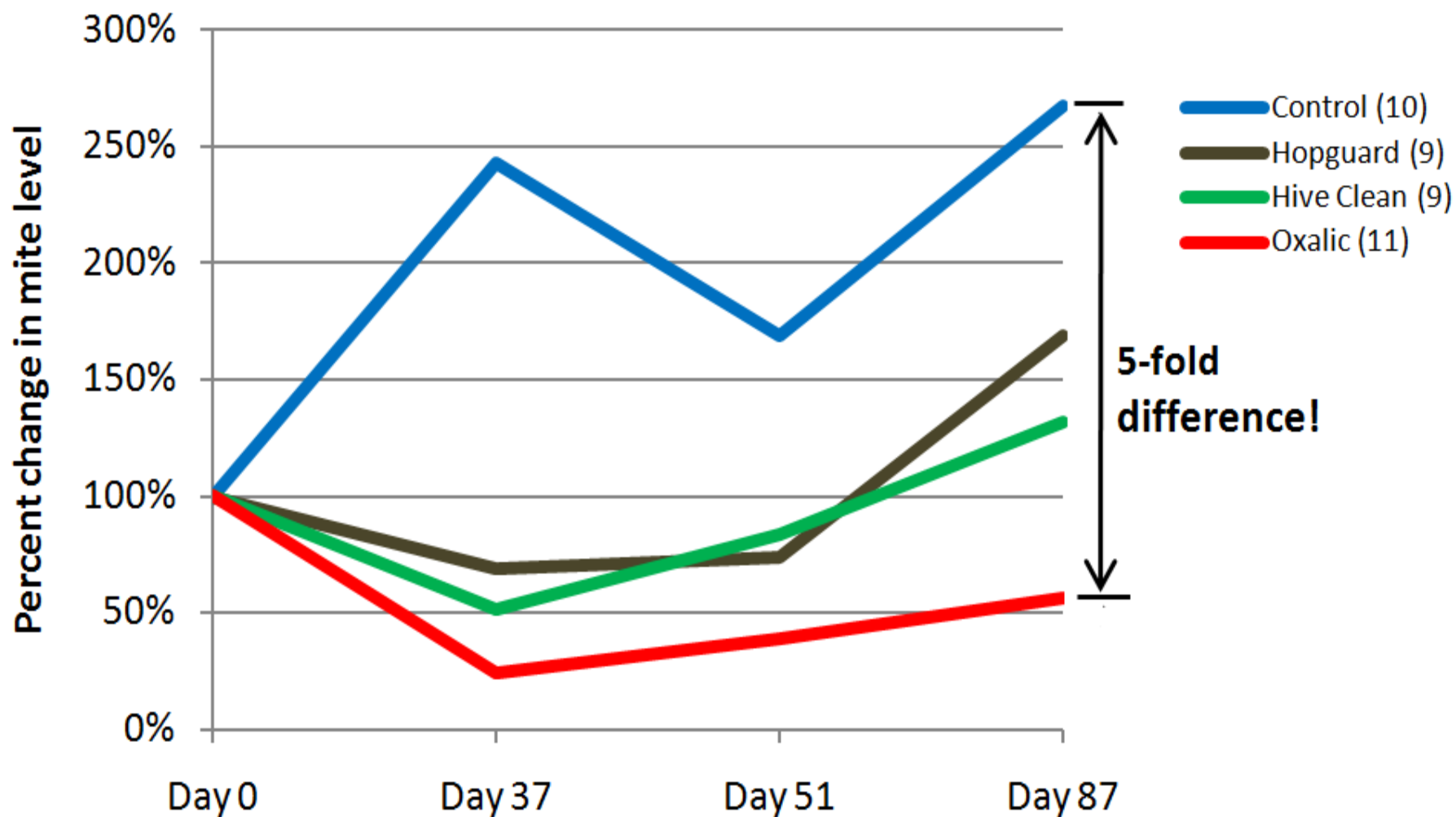


# Treatment window for nucs

## The Biology Behind the Method



## Treatment Effect upon Normalized Mite Infestation Rates over 3 Months

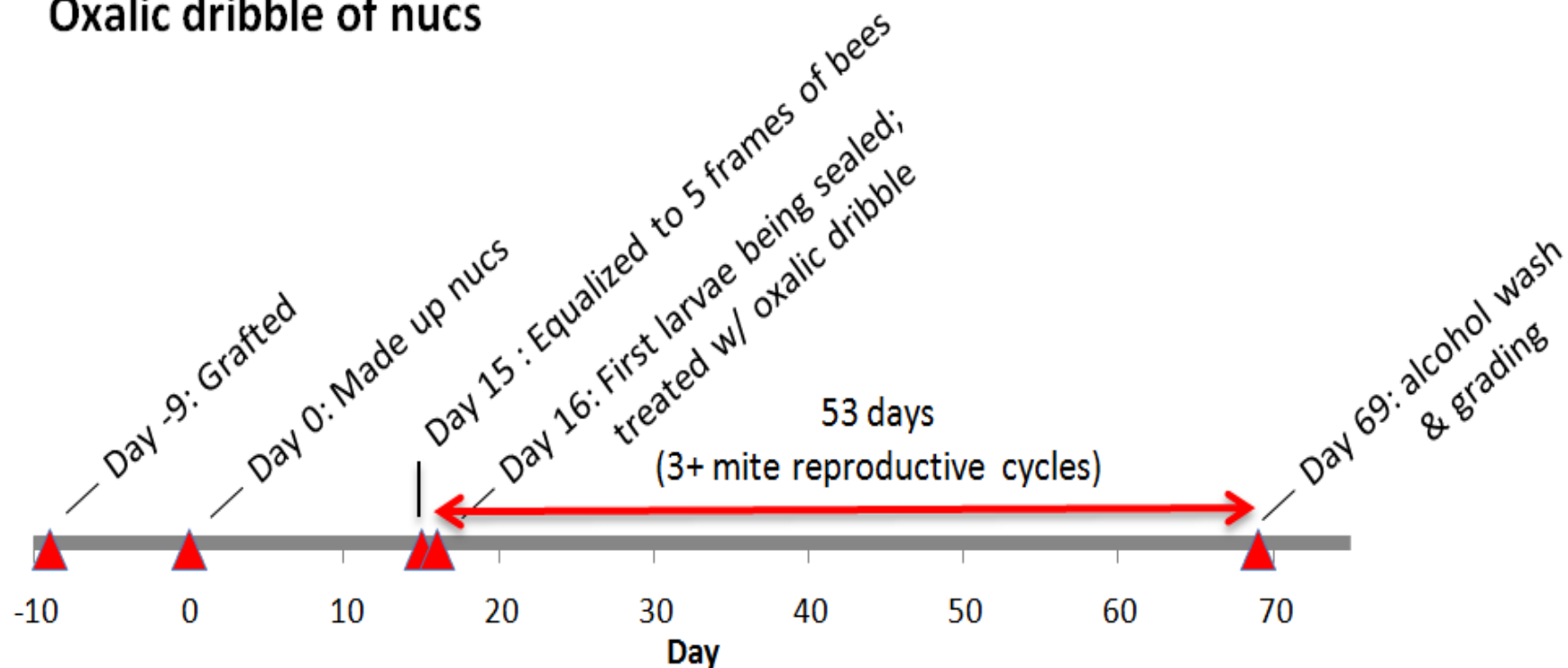






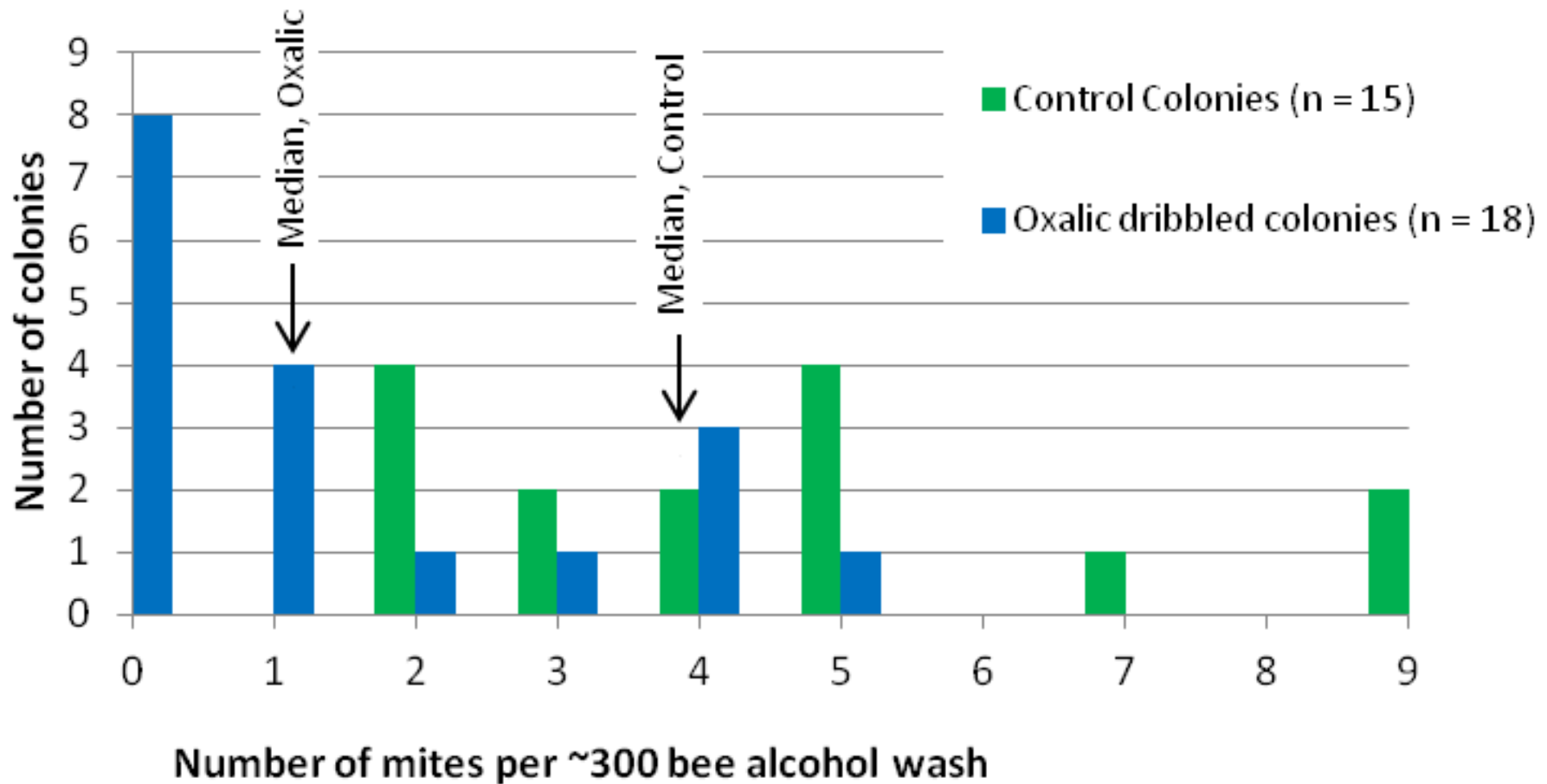
## Timeline, Trial 2

### Oxalic dribble of nucs



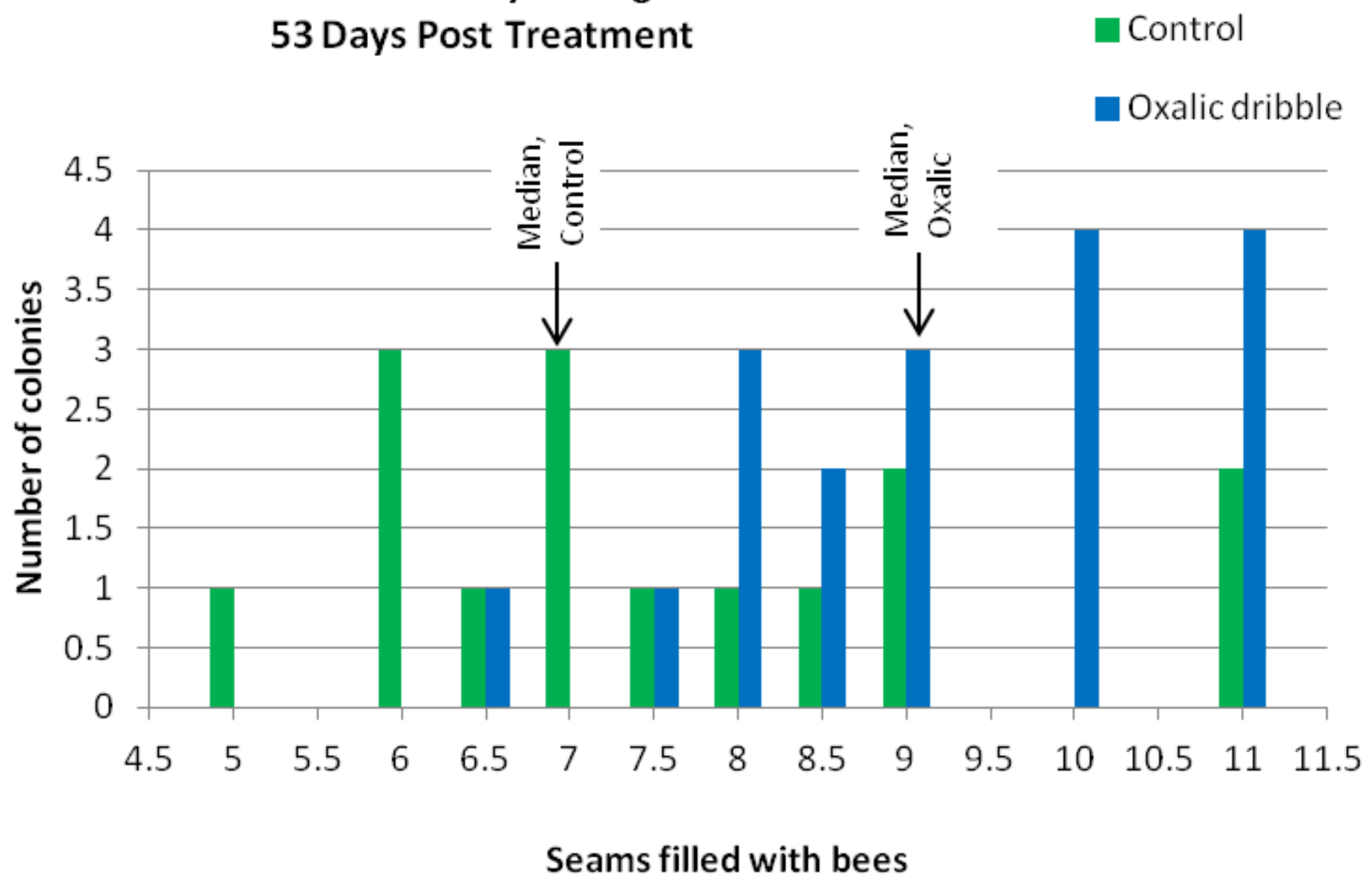


## Trial 2: Mite Infestation Rate in Nucs 53 Days Post Treatment





## Trial 2: Colony Strength 53 Days Post Treatment







**Doesn't appear to harm queens**



Graft #	Queen(s)	No. cells	Day	Graft date	Sealed	Incubator	Nucs by	Early ripe	Typ mate	Typ eggs	Check/oxalic	Nuc yard(s)
			Fri	3/9	3/13	3/16	3/18	3/19	3/28	3/31	4/6	
			Sat	3/10	3/14	3/17	3/19	3/20	3/29	4/1	4/7	
			Sun	3/11	3/15	3/18	3/20	3/21	3/30	4/2	4/8	
			Mon	3/12	3/16	3/19	3/21	3/22	3/31	4/3	4/9	
			Tue	3/13	3/17	3/20	3/22	3/23	4/1	4/4	4/10	
			Wed	3/14	3/18	3/21	3/23	3/24	4/2	4/5	4/11	
			Th	3/15	3/19	3/22	3/24	3/25	4/3	4/6	4/12	

**Create a spreadsheet to keep track of dates**

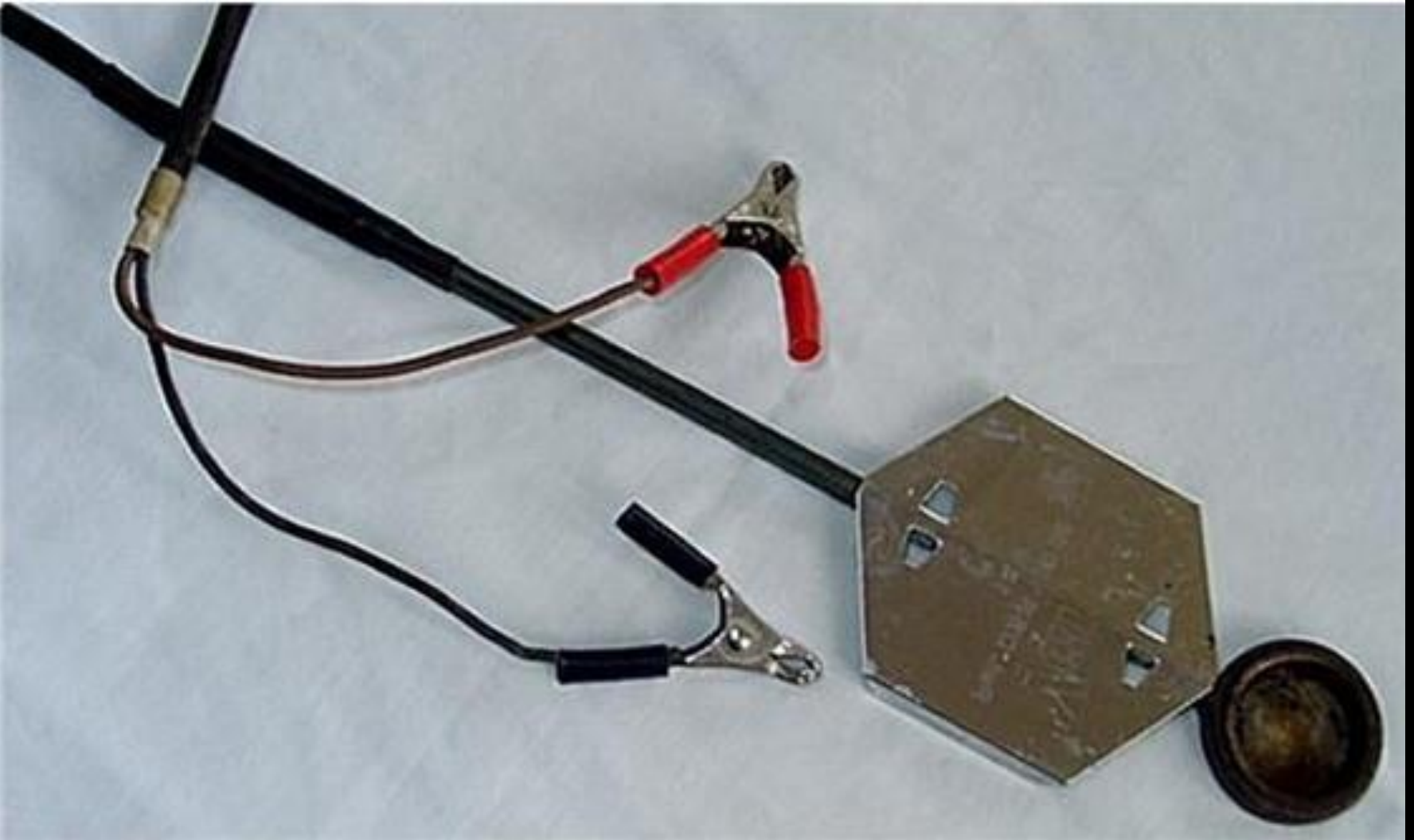
# Vaporization (Sublimation)



**A Magic Wand?**







Useful where winter comes on suddenly.



**Simple Varroa vaporizer.**





**Vaporized oxalic is dangerous!  
Wear a respirator.**



Other issues:  
Cooked bees  
Burnt wood or plastic







**Sublimation may be easier on the bees.**

# Recently published

*Journal of Apicultural Research*, 2015  
<http://dx.doi.org/10.1080/00218839.2015.1106777>



## 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

<b>Dribble</b>		<b>Sublimation</b>	
<b>Pros:</b>	High efficacy	<b>Pros:</b>	Perhaps higher efficacy
	Very safe to apply		No opening of the hive
	Quick		Can do in freezing weather
	Little equip needed		Perhaps gentler to the bees
	No syrup mixing		
<b>Cons:</b>	Requires opening hive	<b>Cons:</b>	Vapor fog is hazardous
	May be problematic in freezing weather		Requires specialized vaporizer and energy source
	Easier with helper		Problems with hot tip



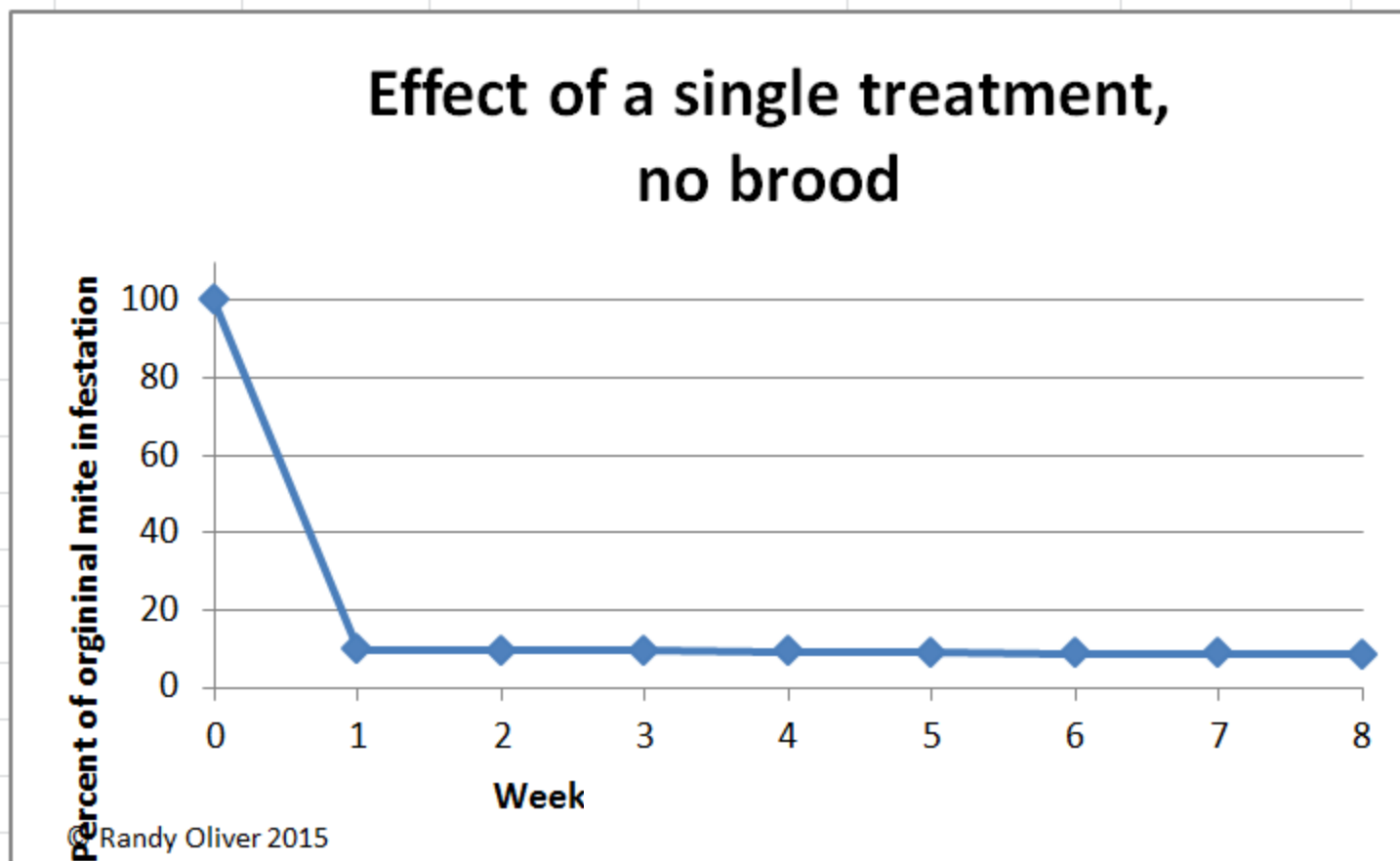
Instructions: type values into for the two yellow cells and hit enter

Percent of full broodnest present **0** % A full broodnest with substant

there may be only 50% or less of a full broodnest present. Adjust this value to

Expected weekly kill of the phoretic mites by the treatment **90** % fil

See ↑





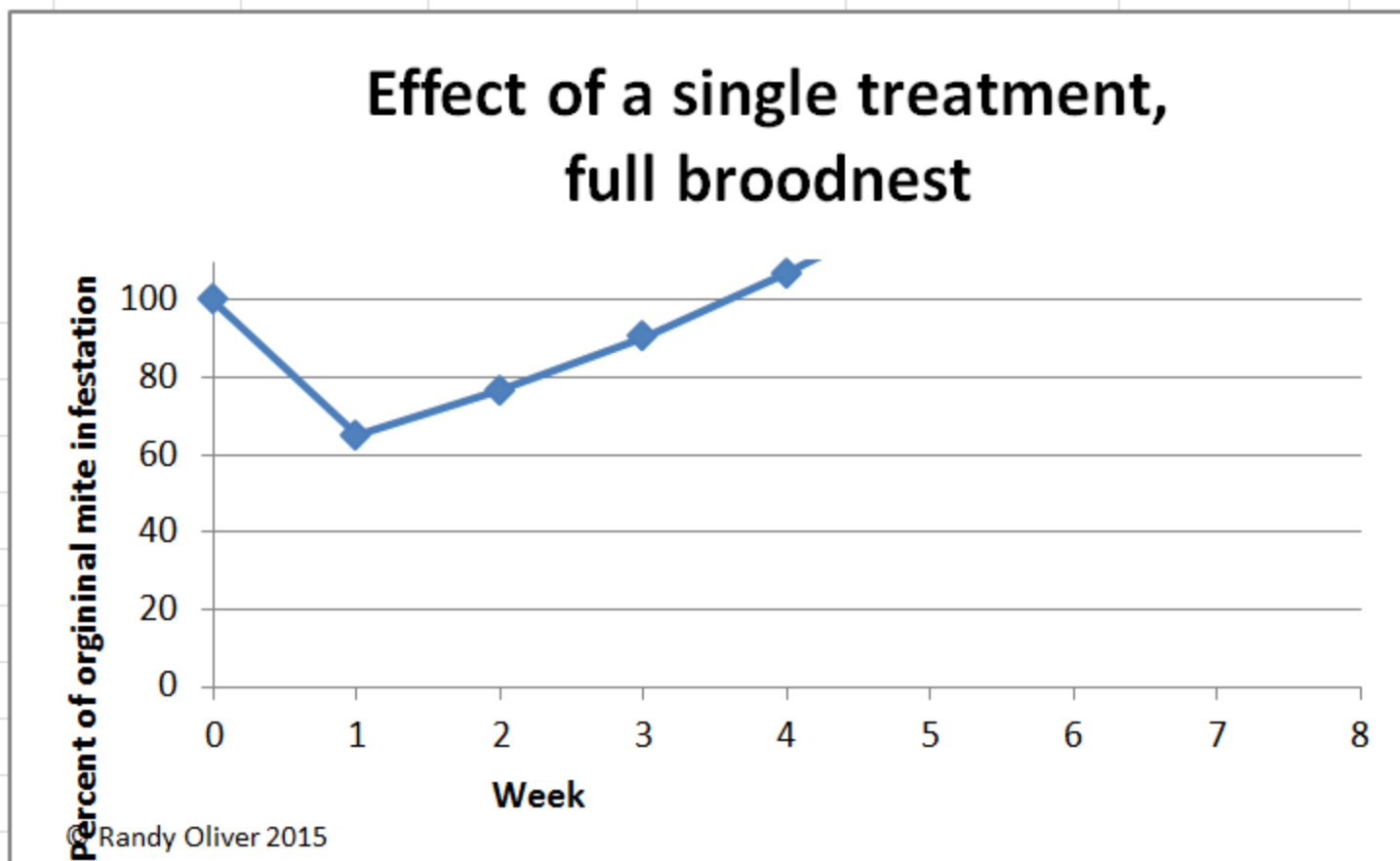
Instructions: type values into for the two yellow cells and hit enter

Percent of full broodnest present **100** % A full broodnest with substantial

there may be only 50% or less of a full broodnest present. Adjust this value to

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

See No







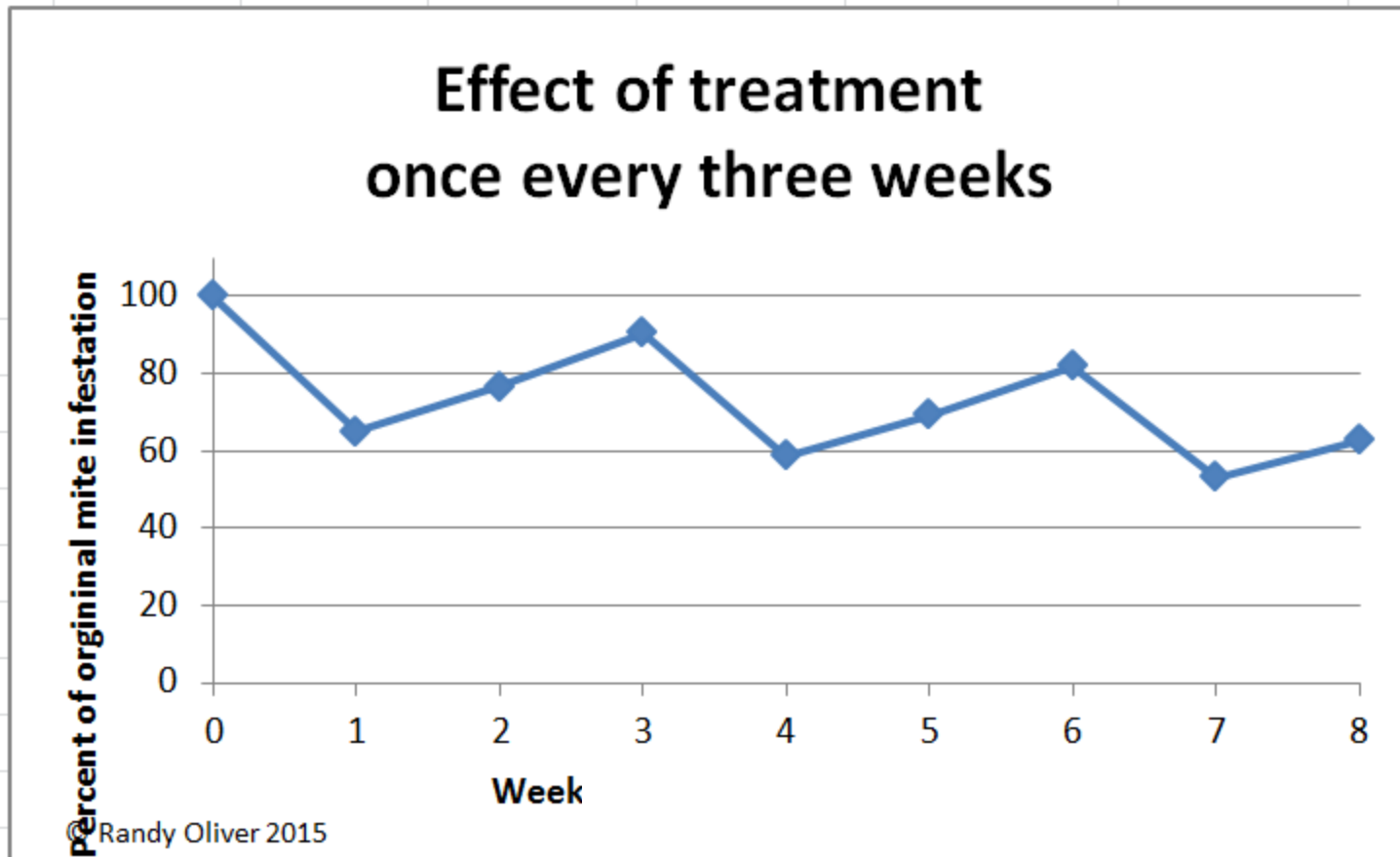
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See No

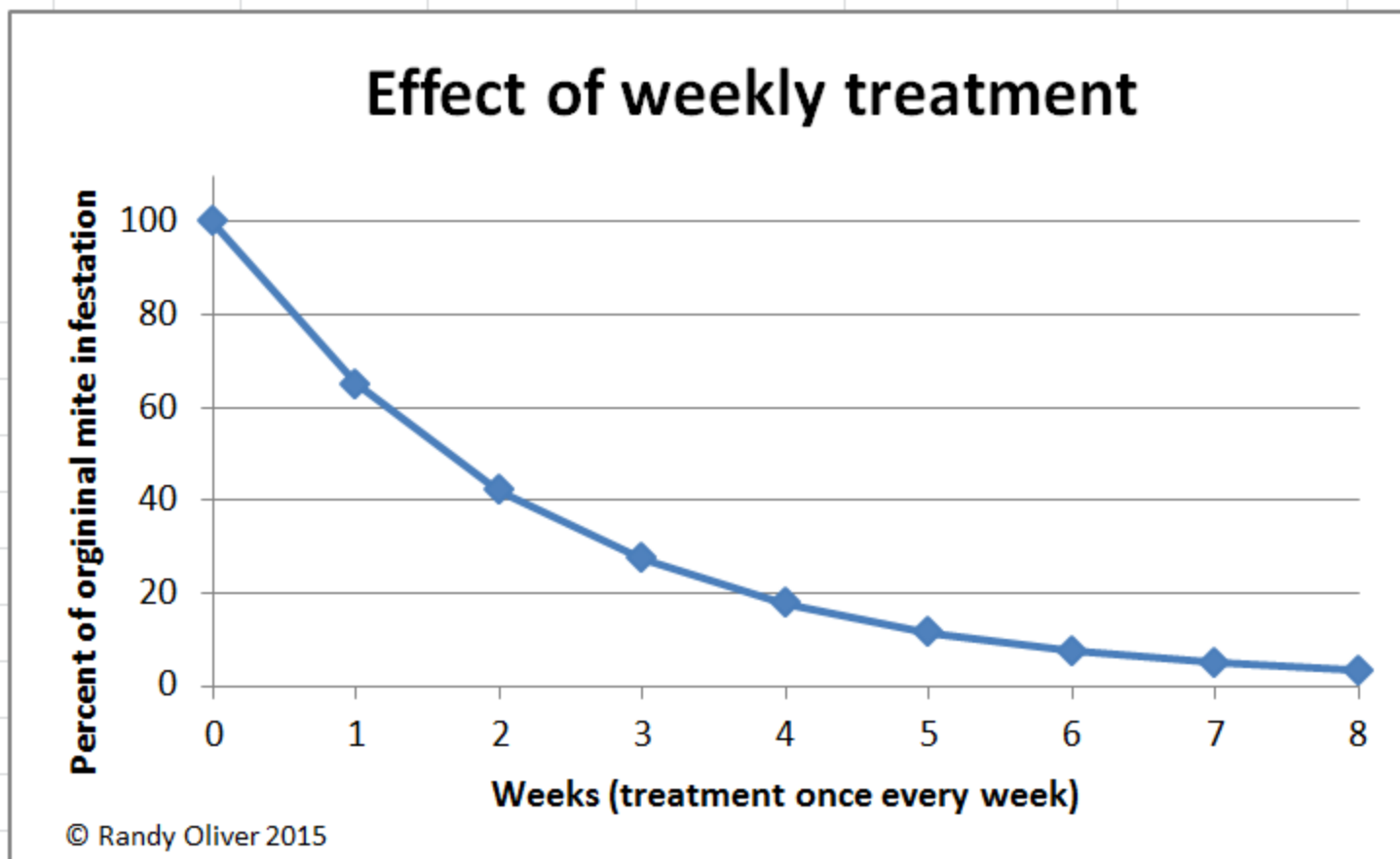




Instructions: type values into for the two yellow cells and hit enter

Percent of full broodnest present **100** % A full broodnest with substantial  
there may be only 50% or less of a full broodnest present. Adjust this value to yc

Expected weekly kill of the phoretic mites by the treatment **90** % fill in  
See [Not](#)



# **Another application method**





Apidologie

© INRA, DIB and Springer-Verlag France, 2015

DOI: [10.1007/s13592-015-0405-7](https://doi.org/10.1007/s13592-015-0405-7)

**Original article**

# **A new formulation of oxalic acid for *Varroa destructor* control applied in *Apis mellifera* colonies in the presence of brood**

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Oxalic/glycerine on cardboard strips.



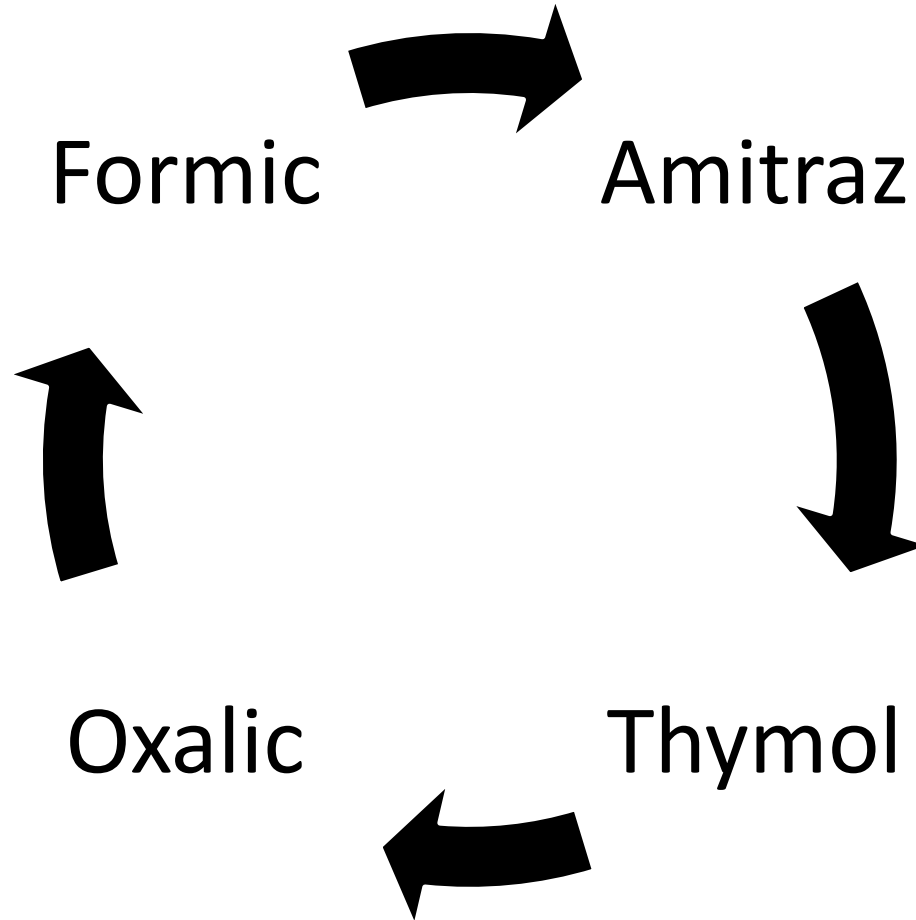
# A Critical Closing Thought

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

Lodesani (2009) Limits of chemotherapy in beekeeping: development of resistance and the problem of residues.



# Practice some sort of rotation of treatments





*Happy beekeeping!*  
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