Varroa Management: Concepts and Practice

Randy Oliver ScientificBeekeeping.com



Beekeeping used to be much easier

CORONAVIRUS PANDEMIC

This virus pandemic affects humans



Varroa kicked off a virus pandemic in honey bees



DWV is normally a relatively benign virus that can be transmitted via the egg or nurse bees



Some variants of DWV became a problem with the arrival of this novel vector.

You don't necessarily observe deformed wings

Brood begins to die from various viruses

Parasitic mite syndrome

2

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DWV collapse



Varroa didn't kill this colony — DWV did!



Manage epidemics by controlling the vector

VARROA MANAGEMENT CONCEPT: Varroa management is all about <u>controlling the vector of viruses.</u>

Virus prevalence strongly correlates with the degree of varroa infestation.



After Francis (2013) Varroa-virus interaction in collapsing honey bee colonies. PLoS ONE8(3): e57540

Managing the Mite



VARROA MANAGEMENT CONCEPT: We'll likely <u>all_</u>eventually use resistant stock and biotechnical methods

Selective Breeding for Varroa Resistance



Our eventual goal is to keep bees that can control varroa all by themselves!

Alphen and Fernhout Zoological Letters (2020) 6:6 https://doi.org/10.1186/s40851-020-00158-4

Zoological Letters

REVIEW

Natural selection, selective breeding, and the evolution of resistance of honeybees (Apis mellifera) against Varroa

Jacques J. M. van Alphen^{1,2*} and Bart Jan Fernhout²

Bees can come up with all sorts of ways to fight the mite!



Open Access

VARROA MANAGEMENT CONCEPT: It is not necessary to kill a single mite in order to control varroa...

...all that's necessary is to halve the mites' rate of reproduction.

The simplest method for selection for resistance:

John R. Harbo*, Jeffrey W. Harris



USDA-ARS, Honey Bee Breeding, Genetics and Physiology Laboratory,

"By <u>comparing the growth of mite populations</u> in each colony, one can determine which bees are more resistant to mites."



United Archives

Walking the walk a California experiment in "traditional breeding"



Each spring we track ~1500 nucs, with new queens grafted from proven mite-resistant colonies.



Then we start the "varroa race."

We identify potential breeders by performing in-field mite washes on ~1500 hives in June.



Nucleus colony, 5 frames of bees, 3 frames of brood, started April 1, r = 0.019

Compare the rates of mite buildup by washes.



Resistant colonies are able to reduce their mite counts without help.



We monitor potential breeders for a full year.



Some colonies laugh at varroa.

Zeroes are heroes!



PROOF OF CONCEPT:

Mite-resistant colonies are often the strongest and most productive colonies in a yard.



Confirming gentleness while taking mite counts.

We eliminate the queens of any nonresistant colonies each year.

Colonies holding <2% infestation after a full year, as percent of operation



Progress has been slow, but steady...

Breeding problem: the alleles for resistance may not be carried by the queen!



Some day, varroa will be only a minor problem. Until then, monitor and control the mite.

VARROA MANAGEMENT CONCEPT: Understand varroa population increase and decrease.



Sealed brood = Mite reproduction taking place
Mites increase when brood present; then decrease when broodless.





The amount of varroa increase is a function of the number of months that a colony is rearing brood.



Overall increase in mite population, Overall increase in mite population,



Shorter winters mean more varroa increase!

VARROA MANAGEMENT CONCEPT: Use "Randy's Varroa Model" to create your mite-management strategy



Use the Model to figure out the number of mite treatments necessary for your operation. Randy's Varroa Model v 18. Best run in Excel. Set zoom (lower right) to 90%, then view in "Full screen." Input starting values into green cells for Colony Type, and Mite Immigration (described in their respective tabs), and then adjust your starting mite population to match your measured alcohol wash count at any date. In order to plan your mite management strategy, then enter mite reductions from treatment into the horizontal yellow cells by date. For advanced users, customization details to right.



IMPORTANT: the alcohol wash reflects the proportion of mites on the adult bees, so early in the season it underestimates the degree of buildup of the actual mite population since most of the mites are in the brood (refer to "% mites in brood "above). When the colony reduces the broodnest in autumn, the mite infestation will appear to explode. **WARNING:** simulations reflect median expected values-- actual hive-to-hive mite counts typically vary greatly! **Once the alcohol wash count exceeds 15 mites, there is typically a decrease in colony performance.**

A free download, best run in Excel



Trish Harness has developed an online version! <u>chickabuzz.com/model.html</u>

VARROA MANAGEMENT CONCEPT:

The number of *necessary mite reductions*

(treatments) per year

is dependent upon the number of months

that a colony is rearing brood.



Two 90% efficacy treatments may be (barely) enough in areas with a winter brood break.



At least 3 high-efficacy treatments will be required in Mediterranean areas with year-round brood (only if there is not excessive mite immigration).



Four treatments per year minimum for almond pollinators in California.

VARROA MANAGEMENT CONCEPT: Understand exponential growth the more mites in a hive, the greater their *absolute* rate of increase (total additional mites per day).

Mite buildup vs. starting count (r = 0.021)



the steeper the curve!

VARROA MANAGEMENT CONCEPT: It's better, *and easier*, to <u>keep mite levels low</u> <u>all season</u>, rather than to try to later bring them down!

Mite control by three low-efficacy treatments



Colonies with low mite counts are more productive VARROA MANAGEMENT CONCEPT: You get the most bang for the buck by controlling mites prior to swarm season.



Average reproductive rate per mite over the course of a mid-latitude season with a 3-month brood break



Varroa enjoys its greatest <u>reproductive success</u> when the colony is in swarming condition.



Nip the infestation in the bud!



Take-home concept:

Proactive control of mites early in the season results in healthier bees and

easier mite control later on.

Reactive beekeeper

Proactive beekeeper





"I'm not treating because I *have* high levels of mites; I'm treating because *I don't want* high levels of mites." Russel Heitkam





AHB build small cells. Otherwise, doesn't appear to help.



Dee Lusby

Allowing colonies to swarm only reduces the mite pop by ~30%, and loads the landscape with more mite factories!

Screened bottom boards, a.k.a. open-mesh floors? Questionable benefit.



Drone brood trapping – helps a bit.

Sugar dusting. Requires twice-a-week treatments. Table 1. Temperature tolerances of varroa and honey bees.

Effect on varroa	°F	°C	Effect upon the bees	
	80	26.7	Adult bee comfort zone	
In-hive	82	27.8		
temperature range	84	28.9		
preferred by varroa	86	30.0		
	88	31.1		
Optimal varroa	90	32.2		
reproduction	92	33.3		
Varroa mites stressed	94	34.4	A. mellifera broodnest temperature	
	96	35.6		
	98	36.7		
Varroa unable to reproduce	100	37.8	Adult bees and brood relatively tolerant of temperature	
	102	38.9		
	104	40.0		
Mites seriously	106	41.1	Typical thermal treatment	Adult bee and brood short-term temperature
stressed	108	42.2		
Mites die fairly rapidly	110	43.3		
	112	44.4		tolerance
	114	45.6	Increasing danger to adult bees and brood	
Mites die rapidly	116	46.7		
	118	47.8		

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Thermal treatment is a plausible method

Surprisingly poor mite kill in the sealed brood unless temperature is quite high



Springtime splitting with queen cells is highly effective!

Create an induced brood break by starting with queen cells.



Days from nuc make up

Hit 'em with oxalic dribble on Day 18 (or apply Apivar)

RECEIPTE



Hobbyists can perform brood separation.





VARROA MANAGEMENT CONCEPT: Never take your eyes off varroa!


Don't rely upon visual inspection – most mites are on the underside



At least half the mites are typically hiding in the brood.



Stickyboard counts give a rough estimate, but are erratic and time-consuming.

Sugar roll/shake: questionable detection

It's quickest and most accurate to monitor the infestation rate of a half-cup of adult bees



Dawn detergent works as well as 90% alcohol, with less agitation required.

Don't shake – swirl!



To avoid peering through foam to count mites, use a **10x magnifying** mirror (6-inch diameter) placed about 4 inches below the bottom of the cup.





My first-generation mite wash agitator – bulky.

Second-generation work great, but expensive to build.



Gen-4: better cup, quicker drop, built-in magnifying viewer, less fabrication to build.

Monitor the mites; don't allow counts to climb above:

- 1-2 in springtime,
- 6 during summer

VARROA MANAGEMENT CONCEPT: Late-season drift of mites can hurt you.

Mite Immigration 2019



Mite drift is a real thing. Be aware of high-mite neighbors!



Mite drift is a real thing

VARROA MANAGEMENT CONCEPT:

Monitor mite levels in June in order to identify any "mite disseminators"



September 2015 mite counts in our operation (after treatment in June and August)



Mite Wash Count



Mite Wash Count



June mite counts from 4 typical yards. Typically, around 10% of colonies are high-mite outliers. Identifying the outliers helps greatly in overall mite management. Also for breeder selection.

VARROA MANAGEMENT CONCEPT:

Successful varroa management is easier with identification of (and special attention to) the outliers.



My sons now find it to be cost-effective to sample <u>every hive</u> <u>in our operation</u> early each summer.

Monitor mite levels



Blind beekeeping leads to surprises

Plan your management strategy



Use "Randy's Varroa Model" to figure out a mite management plan that fits your operation and objectives.



Treatment Options



Mite management fact: wishful thinking has never worked!

VARROA MANAGEMENT CONCEPT: Going "treatment free" is no excuse for practicing poor animal husbandry.



This puppy is suffering from a mite infestation – treat it!



Selective breeding <u>is done at the queen level</u>. Allowing <u>colonies</u> to collapse is counterproductive.



Don't use "treatment free" as an excuse for neglectful beekeeping. Control varroa for the benefit of everyone.





Some mite bloodlines are developing resistance to amitraz.

Commercial beekeepers will need to learn to use alternatives.





ANTI-VARROA MITE STRIP Kills Varroa, not the honey bee No-mess application

ACTIVE INGREDIENT TOU-HOVALINATE (CAS# 10285 Log-e) OTHER ///CREDIENTS: TOTAL

KEEP OUT OF REACH OF CHILDREN CAUTION See side panel for additional precautions/directions Contents: 100 Strips Net Wt. 1 lb 5 oz (600g) DOKECTIONS FOR USE 1 - - -

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LPA Ray 140 2724-40 EPA Ru, Pau 2724-10

Altritates and ZCRCC

Apistan may work again in rotation, but is not sustainable



Hopguard (hops beta acids)


Essential Oils

Thymol – well proven Others – some may hold promise





Apiguard Thymovar Apilife VAR Homemade



50g Apiguard in a $1\frac{1}{2}$ " rim, repeated at ~10 days. OK in <u>hot</u> weather. 95%+ efficacy in my California operation

Best applied in mid August after pulling honey

Thymol take homes:

- A safe, "natural" treatment
- Excellent August treatment, but takes 2 doses, 10 days apart.
- Causes disruption of broodrearing.
- Bees must come in contact with it.
- Good for rotation with oxalic acid.

Organic Acids:

Formic—vaporizing (penetrates cappings) Oxalic—non vaporizing

Formic Acid Lots to be said for it!

The only treatment that penetrates the cappings.



Formic gives colonies a fresh start

Downside: colonies may supersede some queens.

Option: cage the queen elsewhere during treatment

Formic Pro: 1 strip, repeated at 10 days, fewer queen issues

Formic Pro — 2 strips at once. May induce queen replacement.

Plenty of alternative application methods (not all approved).

Formic take homes:

- "Natural," with no persistent residues.
- Most rapid mite kill very good for "cleansing" of high-mite hives.
- Can penetrate the cappings.
- At lower dose, a good knock-back treatment.
- Can be used on nucs if one side covered.
- Short setback of broodrearing.

Oxalic acid: Safe and natural

SENAGE MUTANT DE

Dribble method Apply 5 mL per bee space

ScientificBeekeeping.com



Oxalic strength ---

OA Crystals

Sucrose

Dist. Water

Oxalic Acid Treatment Table Articles By Publication Date Bee Behavior and Biology 🛆 Save 🗖 PDF 🔤 Email 🎸 Print Varroa Management Be sure to read "Oxalic Acid – Questions and Answers" and "The Learning Curve – Part 3" before using oxalic acid. It is **Bee Nutrition** critical to apply it correctly, or you risk seriously harming your bees!" Colony Health – Diseases, Viruses, CCD 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 **Pesticide Issues** dihvdrate !!!! Nosema ceranae Also note that if you use hard water, some of the oxalic acid will precipitate out as calcium oxalate, and thus reduce Almond Pollination the efficacy (you'll easily see the white precipitate if this is the case. Miscellaneous articles 'Hot" 4.2% w:v "Medium" 3.2% w:v "Weak" 2.5% w:v Notes **Research Updates** 1 0.75 0.6 Oxalic crystals must be **Beginner's Pages** measured by weight. Sugar and water are 10 10 10 Please Share about the same by weight or volume (1 pint of either granulated 10 10 10

Search

sugar or water weight 1

Home Contact Me

Go!

Mixing instructions above

•There may be advantages to using glycerin rather than sugar as the humectant.

Toomema suggests using a lower concentration in up to 20 mL per seam, and

perhaps the addition of thymol.



Can be applied in a gentle stream from a garden sprayer, calibrated at 5 mL per second.



Great early-winter "clean up"



During summer, confine the queen to create an induced brood break.

Confining the queen with queen-excluder division boards

QX division board

Confine the queen to one drawn comb

Insert QX

Insertat



Queen confined to this frame for two weeks

On Day 21 hit 'em with an oxalic dribble!

MITE CONTROL USING A 14-DAY BROOD BREAK WITH OXALIC DRIBBLE

- Day 1: Confine the queen to one "varroa trap" frame, using queen excluder dividers.
- Day 14: Release the queen.
- Day 21: Remove the varroa trap frame and dribble the colony with oxalic acid.

(The above schedule is to make it easy to do on the same day of the week. If there's a great deal of drone brood, you could increase to day 17 and 24 for slightly higher efficacy)

OXALIC ACID VAPORIZATION (OAV)

Cheap, relatively quick, and not necessary to open the hive.

But how efficacious is it?

Oxalic vaporization not yet approved during summer or while honey supers are on.

Mite drops with OAV <u>at 4-day intervals</u> Seattle beekeeper with possible mite drift



Take home: It takes a lot of OAVs if the colony contains brood

Determining the dose of oxalic acid applied via vaporization needed for the control of the honey bee (*Apis mellifera*) pest *Varroa destructor*

It may take 3-4 g OA per brood chamber for best efficacy.

Cameron J. Jack, Edzard van Santen & James D. Ellis



Oxalic take homes:

- A food-grade miticide, no worry about contamination.
- Liquid application safer to handle than formic or OA vaporization.
- Little setback of broodrearing, and no queen issues.
- Poor efficacy if brood present, especially with vaporization.

VARROA MANAGEMENT CONCEPT: Understand the limitations of, and best windows for use of each treatment option



Use appropriate treatments for time of season, colony condition, amount of brood, temperature, etc.



Appropriate treatments for time of season Use appropriate treatments for time of season, colony condition, amount of brood, temperature, etc.

VARROA MANAGEMENT CONCEPT: Rotate treatments to avoid the development of resistant mites



R: Randy's California hives, split 4 ways after almonds and oxalic'd (enter a



Typical mite management, our operation Effective, no residues, no resistance, easy on bees

We need a sustained-release treatment that can be applied during the honey flow!



Extended-release oxalic acid (dissolved in glycerin)

Very promising, research in progress
State of California Department of Pestic Pesticide Research A DPR-REG-027a (Est See Instructions on Reverse

This application method is not yet approved by EPA! I do not advocate or encourage use of this treatment method without a permit!

Pesticide Research Authorization

1	Resparcher	And the second second			STREET,	an den	and subject		Contraction Sec. 2		
R	esearcher	Randy Oliver	Randy Oliver								
Firm Name Address		ScientificBeel	Mobile Phone # E-mail Address		randy@randyoliver.com						
		14744 Meado									
CI	ty, State Zip	Grass Valley,	Type or print address information for use as a mailing labe								
P1 2.	Product Nam	8		3. U.S. EPA Reg	. or EUP No (If any) 4. F	Pesticide Reg.	Type (check one)	S. Fumigant		
I	oxalic a	acid dihydrate	4.98	91:	266-1	X	Fed CA	Ves No			
	6. Active Ingredient(s)				Maximum Rate [AJ.)	8. Method of Application (check one or more				
		oxalic acid d	99	40 g/hive		🗆 Aerial 🛛 Handheld					
						Ground Chemigation					
						onge					
	9. Type of Pesticide (check one or more)										
	□ Insecticide □ Herbicide □ Defoliant □ Rodenticide □ Plant Growth Regulator □ Pheromone										
	Sprav A	diuvant 🗆 Fungicid	ant 🗆 Ner	Nematicide Miticide on honey bees							
	10. Formulation			Idue Tolerance	12. Multiple Applications	13. N Each	13. Max Size of 14. Max # Each Trial , of Trials		15. Total Area Units		
	OA di	ssolved in glycer	in 🗆 Yes [300 hives		2	600 hive		
	16. Stage of Growth (check one or more - Pre- and Post-harvest cannot both be selected on one KA)										
	Seeds Pre-plant Pre-emergent Growing season Pre-harvest Post-harvest Dormant										

Oxalic/Glycerin strips? Research by Aluen CAP in Argentina

Tedious to insert 4 strips per box



Easier to lay across the top bars. Swedish sponges work better than shop towels

Experimental treatment: 25g ea OA & glycerin in half Swedish sponges.



Test in moderatestrength double-deep hives during a nectar flow

THE FULL

One 25g OA sponge



One half OA sponge gave inconsistent mite control, perhaps due to lack of surface area for exposure.

Two 25g OA sponges



Two 25-g half-sponges gave very good control!



Brood looked good in OA-treated hives.

Incredible efficacy in high-elevation yards without surrounding colonies.

Mite infestation rate change after 77 days during nectar flow --High-elevation yards B&C



Excellent mite reduction at 77 days. Even better results from hives left in Nevada July - Nov. OA/gly is a <u>long-term treatment</u>, and appears to work best in yards where there <u>is little mite immigration</u>.

RobberGard - Stop Bees and ...

Would entrance guards increase efficacy?

INTERNATIONAL JOURNAL OF ACAROLOGY 2020, VOL. 46, NO. 6, 405–408 https://doi.org/10.1080/01647954.2020.1806923



Check for upda

Control of *Varroa destructor* development in Africanized *Apis mellifera* honeybees using Aluen Cap (oxalic acid formulation)

Sóstenes Rafael Rodríguez Dehaibes^a*, Facundo René Meroi Arcerito ^{(b)c,*}, Elissa Chávez-Hernández^a, Gonzalo Luna-Olivares^a, Jorge Marcangeli^c, Martin Eguaras ^{(b)c,d} and Matias Maggi^{c,d}

Its efficacy does not appear to be affected by temperature or humidity.



Enthusiastic feedback from others.

Question:

Are there better matrices for OAE than the Swedish sponges?



Oxalic/glycerin (1:1) absorption, and release after 20 days in hive.										
Matrice	g/6 tare	g/6 saturated	g OA/gly per 24 sq in	Absorption relative to sponge	6 @ 35C, 51% RH	20-day 6@ 35C, 51% RH	% loss of OA/gly	Loss in weight per pad	Notes	
Swedish sponge	3.4	60.6	57.2	1.0	59.5	47.2	22%	2.1		
Swisspers cotton	3.8	71.5	67.7	1.2	70.0	59.5	16%	1.8	Frayed, indicating bee action	
Maximizer	4.8	68.2	63.4	1.1	69.1	60.1	14%	1.5		
Acrylic felt	2.5	37.3	34.8	0.6	36.8	32.2	13%	0.8	propolized	
Pig Mat	3.1	33.9	30.8	0.6	33.5	30.9	8%	0.4	chewed	
Chipboard	12.6	37.8	25.2	0.6	41.6	41.0	2%	0.1		

12.1

7.5

3.2

gone

0.4

n/a

only 2

Workwipes

Handiwipes

1.6

0.7

12.1

7.8

10.5

7.1

0.2

0.1



I ran preliminary tests in hives.



Cotton pads were difficult to apply. Bees did not shred and drag through hive. Adding thymol to the OA didn't help. But cotton still looks promising!

Questions for field trial:

1. Is there a minimal dose (surface area of OAE pad) necessary to obtain good efficacy in double deeps?

2. Can you dose with OAE proportional to

the mite infestation rate?

3. How do Swedish sponges, Maximizer pads, or acrylic

felt compare in field efficacy?

Spill Tech Maximizer Lightweight pads. 11¢ compared to \$1





We applied 1 – 4 strips per hive, according to the initial mite infestation rate

Swedish Sponges



It clearly took a full-sponge equivalent for good mite reduction, even at low mite levels.

Maximizer Pads



Maximizers worked nearly as well as sponges. Acrylic felt did not work well.



Mite Counts Very high efficacy with 3-4 strips Swedish sponge Maximizer pad 1-strip 158% increase 1-strip 402% increase 3-strip 91% decrease 3-strip 90% decrease

Take homes:

1. For full efficacy of OAE with pads laid across the top bars between the brood chambers, it takes about 55 sq in (355 cm²) of matrix surface area, holding 50 g of OA dissolved in 50 g of glycerin.

2. The pads must be placed so that bees walk over them – not under a hive cover. A shim between the brood chambers may help.

3. For cardboard strips hung over the frames, it (surprisingly) requires <u>more</u> surface area (80-115 sq in/ 520 – 740 cm²) per double-deep hive.

4. We don't yet know whether it helps to divide the matrix, but got good results last year with it divided into two pieces.

5. Maximizer pads are a lower-cost alternative to Swedish sponges, and are a bit easier to scrape off the top bars after treatment.

Effect of winter treatment with OAE upon colony strength and mite level







November – late January treatment.

No significant effect upon colony strength.

OAE reduced mites over winter, but at only 37% efficacy. ??????





This treatment is safe and easy to apply. Neutralize hands and tools with a strong baking soda solution.



The 1:1 formulation is easy to prepare, and crystallizes for easier handling.

We like the ease of application of pads laid over the top bars, but strips hung over the frames also works well.

NZ beekeepers are allowed to mix their own

4 Own use exemption

- (1) Schedule 2 of the ACVM (Exemptions and Prohibited Substances) Regulations 2011 provides for an exemption from registration under the ACVM Act referred to as the 'own use' exemption. The exemption applies to a substance or compound prepared by a person for use on animals or plants that they own, or on any land, place or water that they own or occupy.
- (2) In a beekeeping context, the 'own use' exemption is commonly used when a beekeeper prepares and applies preparations containing generic substances, such as oxalic acid or formic acid, to their own hives for control of *Varroa* mites.

In New Zealand, OA/gly kits are available to beekeepers.

They mostly use hung strips (staples) of cardboard, using a 1:1.5 solution, and apply 3-4 hung strips per brood chamber.





I've tested NZ strips – they worked well. Can be used in single-high hives or nucs.

Oxalic Acid Dihydrate CAS NUMBER: 6153-56-6

ER

GLYCERI

table Glycerin ood Grade / USP

And other & Castern

swallowed or to ious eye damage.

ner tightly closed. Keep container in a intilated area. Keep container dryon heat. Keep away from sources of y containers pose a fire risk residue under a fume hood. Ground containing material. Keep away from such as oxidizing agents, metals,

and remove any contact lenses

mang she upper and lower lide

GLYCERIN

Not yet approved – experimental only! But may be a game changer for varroa management.



Appropriate treatments for time of season

OAE would be a great treatment option for use when honey supers are on the hive!

Remember: use it in rotation.

Take home:

We still have much to learn about how best to use OAE. Lots more experimentation to do!
Randy's Recipe for Healthy Hives:

- Keep young, vigorous queens.
- Provide good nutrition.
- Control varroa <u>all year</u>.
- Minimize toxins in the hive.
- Be proactive rather than reactive.



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Beekeeping Through the Eyes of a Biologist

BEEKEEPER FUNDED RESEARCH Thanks for your support!



Median between-treatment mite drop counts from 48 of John Carson's hives in Alberta, following 3.5-g OAVs every 6 days



Mite wash counts taken from 5 hives on Oct 9 indicated that infestation rates were down to 1-2%, so he vaped again Oct 14 (drop count not taken)

Daily mite drops, 9 vaporizations, Kevin Gow, Seattle



9 applications to barely hold the mites

Mite drops after OA vaporizations, data from Ed Lutman in Florida



Ed saw no apparent effect until starting 2-day intervals

Queen lays eggs Mites enter cells Mites emerging No mites in brood In trap 1 2 3 4 5 6 7 8 9 10 11 12 13 14 14 15 16 17 18 19 20 21 In trap 8 9 10 11 12 13 14 15 16 17 18 19 20 21 15 16 17 18 19 20 21 In hive 1 2 3 4 5 6 7 8 15 16 17 18 19 20 21 In hive 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21



Minor mite reduction from brood break/ trapping alone