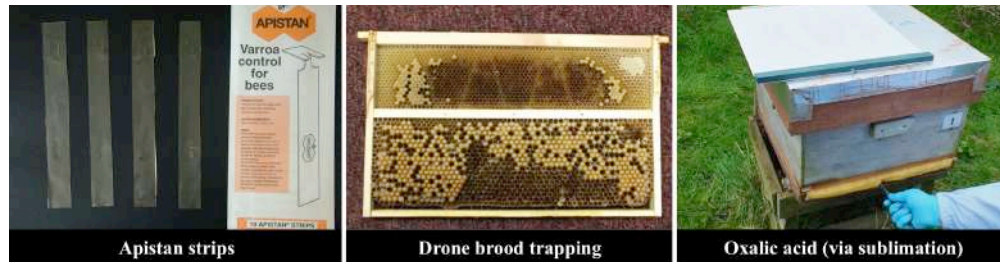


Comparing Efficacy of Varroa Control Methods

Varroa mites are harmful to honey bees. Beekeepers use various methods to control varroa. Some of these are shown below. All can kill varroa. But how do they compare in efficacy, including the proportion killed and duration of control?



LASI research has shown that 2.25g oxalic acid (OA) applied in winter via sublimation to a broodless hive, in which all varroa are phoretic on adult bees and so can be contacted by OA, kills 97.6%. By contrast, trapping varroa in drone brood in spring for one month kills 46%. As 97.6% is roughly double 46% the first method appears twice as effective. However, if we compare surviving proportions, 2.6% v. 54%, the first method seems more than twice as effective.

Which is the correct measure? The proportion surviving is more relevant to varroa management because it is the survivors that reproduce and start to build back the population. The number of doublings to get back to the original level is a useful measure of efficacy. This is because populations grow geometrically, 2-4-8-16, rather than arithmetically, 2-3-4-5, when conditions are favourable. After treatment the varroa population in a colony will be low, and will grow geometrically as the varroa will not be competing for cells to breed in.

If 2.6% of the varroa survive it will take slightly more than 5 doublings to build back to the original level, 2.6-5.2-10.4-20.8-41.6-83.2, versus slightly under 1 doubling if 54% survive, 54-108. This indicates that OA applied to a broodless hive is 5 to 6 times as effective as trapping in drone brood.

To a beekeeper an even more useful measure of efficacy is control duration. LASI measured varroa population growth over one year, following the treatment of broodless hives with OA in winter to the next winter. On average, varroa increased 40 times, or just over 5 doublings, 1-2-4-8-16-32-64. One year's control, therefore, must reduce varroa populations by 5-6 doublings. By coincidence, this is what treating broodless hives once with OA in winter does.

What about the efficacy of other methods? Apistan kills about 99% non-resistant varroa but only 30-60% resistant varroa. This makes a big difference in the duration of control, which reduces from 1.3 to 0.2 years.



OA efficacy depends greatly on brood, as varroa in sealed cells are protected. Just 500 cells, the area of the palm of your hand, can allow 17% to survive so that in less than 3 doublings the varroa will build back to pre-treatment levels, 17-34-68-136. In hives with a frame or more of sealed brood about 60-70% will survive, building back to pre-treatment levels in less than one doubling. This shows the importance of treating broodless hives. One OA treatment to a broodless hive is 10 times more effective as to a hive with brood.

Hygienic behaviour reduces annual varroa build up by over 50%, to about 20 times per year, on average. This increases the duration of control from a single treatment of OA in a hive without brood from 1 year to 1.25 years.

The table gives information on varroa control methods tested by LASI (2-8) plus others (9-12). The efficacy of fumigation with thymol or formic acid is affected by temperature, and whether or not the queen is caged. These methods are only highly effective when the queen is caged and much of the varroa kill is due to the caging itself. However, after going to the trouble of caging the queen for 3 weeks, so that there is no sealed brood, it may be better to use OA as OA is more effective and less material is needed. Control methods also vary in other ways including harm to colony, time to apply, cost, & approval.

Varroa Control Method	Conditions	Varroa Survival	*Doublings to Build Back Up	Control Years
1. Apistan strips	Varroa not resistant	c.1%	6.7	1.3
2. Apistan strips	Varroa resistant	30-60%	1	0.2
3 ^a . Oxalic acid, 2.25g x 1	0 sealed brood cells	2.4%	5.3	1.0, 1.25 ^c
4 ^{a,b} . Oxalic acid, 2.25g x 2	0 sealed brood cells	0.4%	8	1.5
5 ^a . Oxalic acid, 2.25g x 1	500 sealed brood cells	17%	2.6	0.5
6 ^a . Oxalic acid, 2.25g x 1	>3000 sealed brood cells	60-70%	0.5	0.1
7. Drone brood trapping x 1	1 month, all drone brood removed	54%	0.9	0.17
8. Drone brood trapping x 2	2 months, all drone brood removed	29%	1.8	0.34
9 ^d . Thymol, 25g; 12.5g x 2	Italy, summer, queen caged 22 days	3.2%	4.97	0.93
10 ^d . Thymol, 25g; 12.5g x 2	Italy, summer, queen not caged	23.9%	2.07	0.39
11 ^e . Thymol, 12.5g; 12.5g x 1	Canada, summer, queen not caged	24%	2.07	0.39
12 ^f . Formic acid, 360g;180g x2	Italy, summer, queen caged 32 days	5.4%	4.2	0.8

*) number of times the varroa population in a colony must double to build back up to the pre-treatment level; a) by sublimation; b) 2 applications 1-2 weeks apart; c) colonies with high levels of hygienic behaviour, >95% removal of freeze-killed brood in 2 days; d) data from Italy using Apiguard®, 12.5g of thymol in 50g of gel, applied twice in late summer at 10 day intervals; temperatures averaged 24C, range 14-34C, which is considered ideal for thymol fumigation (Giacomelli et al. 2016. Apidologie. DOI: 10.1007/s13592-015-0408-4; e) data from Canada using Apiguard® over 20 days in summer (Mattila & Otis 2000, American Bee Journal (Dec): 947-952); f) Formic acid was applied as Varterminator (4 packs in total, each 250g product containing 90g formic acid) (Giusti et al. 2017 J. Apicult. Res. 56: 162-167. DOI: 10.1080/00218839.2017.1291207)

 <p>US University of Sussex Life Sciences</p>	<p>LASI does research on honey bees & social insects, trains students, & provides outreach. This Information Sheet was written by Professor Francis Ratnieks and sponsored by the Eva Crane Trust. LASI research on controlling varroa has been funded by Rowse Honey, Burt's Bees & The Esmée Fairbairn Foundation. ©2017 www.sussex.ac.uk/lasi</p>	 <p>LASI LABORATORY OF APICULTURE AND SOCIAL INSECTS</p>
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