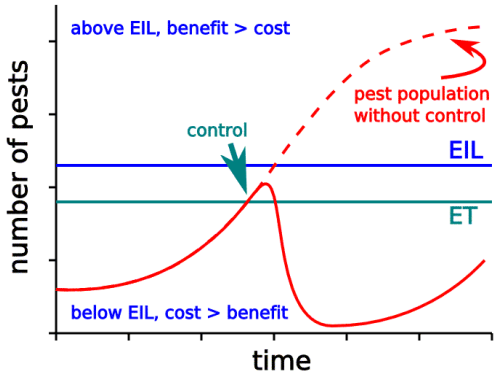
Living with Varroa

Or

Integrated Pest Management

1. What is Integrated Pest Management (IPM)?

IPM is an effective and environmentally sensitive approach to pest management that uses a variety of methods to suppress pest populations below the economic injury level. It does not try to eradicate the pest. IPM uses information on the life cycle of the pest and of the honey bee and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means and with the least possible hazard to people, property and the environment. It relies on monitoring Varroa levels and then uses a variety of different actions to ensure that the levels do not exceed the economic injury level (EIL)



In addition, alternating different unrelated treatments, where available, helps avoid resistance because organisms resistant to one treatment may succumb to one which is different and acts differently.

When Varroa mites first invaded honey bee colonies in the UK, chemical control was relatively easy. Bayvarol and Apistan both of which are based on fluvalinates were easy to use and highly effective; one treatment a year was sufficient to keep the mite under control. The situation changed when the Varroa mite became resistant to fluvalinates. As there are so few effective treatments available now, we have turned to IPM to protect colonies from the devastating effects of varroa.

Originally a parasite of the Asian honeybee, the varroa mite spread to Apis mellifera, the Western honeybee, which has no defences against it. Mites feed on the haemolymph of both larvae and adults, transmitting viruses and other pathogens and shortening the lifespan of the bees. Without intervention and control by the Beekeeper all colonies would die.

Before varroa arrived, beekeeping was a lot easier and it was mostly possible to keep bees without adding any chemical treatment to hives to keep them healthy. Viruses were known to exist but very few caused real problems.

Now bee colonies are threatened both directly and indirectly by the varroa mite. As well as weakening larvae and adults by feeding on the haemolymph, the mites transmit viruses and other pathogens. Many of these viruses were unknown or obscure, but as mite populations expand and migrate across hives, there is an explosion of viruses being found amongst bees.

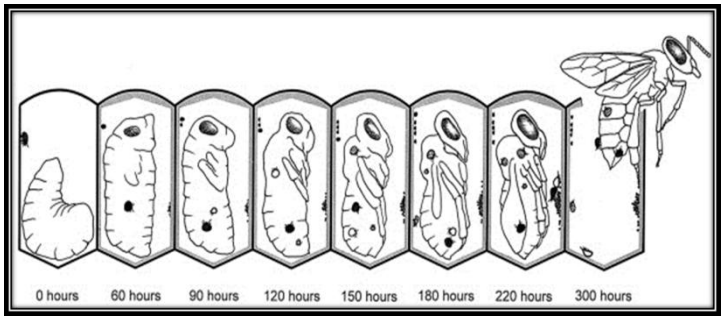
2. The Varroa mite

The Varroa mite is closely related to ticks and spiders and has 8 legs. The body is crab-like, with the head found in the centre of the long axis. Easily seen on pupa against the white body, the mite is very large in comparison with the size of its host. Imagine a tick the size of a dinner plate on your back!

The original host of the Varroa mite is the Asian honey bee Apis cerana, but as many colonies of the European honeybee, Apis mellifera have been moved about the world, and Varroa has spread to this species which has not evolved with it to develop natural defences.

Varroa mites feed on the haemolymph of adult bees as well as larvae which weakens them and reduces their life span, as we have seen with acarine. Foragers which die early do not bring in sufficient food and the honey crop is reduced, and winter bees, which have to live through 6 months or so of winter, dwindle in number to the point at which the colony is no longer viable. Collapsed colonies in spring are very common.

Furthermore, the mites spread viruses when they feed on the haemolymph. Before Varroa, a few viruses which attacked honeybees were known and understood, but there has been an explosion in obscure and new viruses post-varroa. Colonies die from viral infections even after levels of varroa mites have been brought down to below threshold levels.



The Varroa mite reproduces entirely within the hive. An adult female enters a cell containing a larva just before it is capped. She prefers drone brood, probably because she can detect the drone pheromone. The female hides under the larva in the brood food, breathing through special tubes rather like a snorkel. About 4 hours after the cell is capped, the mite establishes a site on the larva at which she, and subsequently her offspring, feed. Some 60-70 hours later, she lays her first egg which is a male and at approximately every 30 hours lays 5 to 6 more eggs, which are females.

The newly-emerged mites pass through two development stages, the protonymph and the deutonymph, and the males are adults after 5-6 days, females taking 7-8 days. Twenty hours after the male has developed into an adult, the first female performs its final moult.

Mating takes place between the male and his sisters within the cell. The male cannot live outside the cell so mating has to take place before the bee emerges. Any females which are not mature also die, but the longer the cell is capped, the more female offspring are mature enough to mate. So infestation in drone cells favours the expansion of the varroa mite over that in worker or queen cells- the reproductive cycle depends on the development of the bee larva.

When the adult bee emerges from its cell, all the mature females leave too. The original mother may enter new cells as well as her daughters so reproduction is rapid. In worker cells the rate of reproduction is between 1.7 and 2.0, increasing to between 2.0 and 3.0 for drone cell occupation.

The life span of varroa mites varies according to the amount of brood present the bee colony. It can be as little as 27 days or as much as 5 months. In summer months when brood is present in the colony, the females may complete 3 to 4 reproductive cycles. In winter broodless periods, mites live on the bodies of adult bees until the colony begins brood rearing.

Population increase can be more than 15% per week, effectively doubling in four weeks. So even after using an effective anti-Varroa treatment, the mite population can be back up to its level of the previous year. Mites are highly mobile within the hive and are spread naturally between hives by robbing, drifting and swarming. This spread is very slow, but fast spreading is caused by beekeepers moving infested hives around for migratory beekeeping.

The harmful effects on bees are serious. Adults have a shortened life expectancy which can cause colony collapse in early spring due to loss of winter bees before the colony has a chance to raise replacements. Adults are lighter in weight and often are born with deformities. Their resistance to disease is diminished and they are especially vulnerable to viruses and other pathogens transmitted by the mites via the haemolymph. Some brood dies, resulting in bees attempting to uncap the cells, with the appearance of pierced cappings and "pepper pot" combs. Diagnosis of damage to a colony which is badly infested can be difficult. At first glance, the foul broods may be suspected as the brood pattern is patchy and "pepper pot", sealed cells partly uncapped, dead pupae and larvae visible.

A small number of mites have little effect on the colony as a whole but it does slow down the rate at which healthy bees are produced to replace normal losses. We have seen the rapid spread of viruses which can cause colony death also the colony as a whole loses its cohesion. Honey bees are social insects but this organisation falls apart and the duties of foraging, house cleaning, brood feeding and rearing and colony defence are no longer regulated as normal. Finally the colony dies or remaining bees abscond.

3. Monitoring mite populations

An important part of IPM, which underpins the approach, is that the infestation level of pests is monitored, and treatments applied only when they are necessary. The level of infestation dictates the action that beekeepers should take so we must know how to monitor and perform it regularly. A light infestation does not require treatment, and the inevitable increase can be

reduced by suitable techniques. A medium level may require some light control and a hive with a high level must be treated immediately with an effective varroacide.

The two main ways to monitor are to count how many mites die naturally each day, and to estimate how many drone cells are infested with mites. Both these activities give an idea of the total population of Varroa in the colony. Monitoring should be carried out at least 4 times a year, i.e. in early spring, at the end of the spring nectar flow, at honey harvest time and in late autumn.

Open mesh floors have been advocated for many years, and lend themselves well to adaptation for counting natural mite mortality. An insert which fits below the mesh is put in place during monitoring, and left for a number of days, say a week. It is then removed and the number of dead mites on the insert is counted. This number, divided by the number of days of collection gives average daily mite mortality, and is an indication of how many mites are in the colony and is a guide to the level of infestation:

	April	July	Aug	Oct
High infestation	>8	>10	>4	>8
Medium	>4 <8	>6 <10	>4	>8
Low	<2	<6	<4	<8

Any time the mite drop exceeds 15 mites per day, the colony must be treated immediately.

To estimate the number of infested drone cells, uncapping forks are used to remove pupating drones The Varroa are more easily seen when the drones are at the stage when the eyes are beginning to colour up. Before that, they tend to disintegrate. Of course, the stage of development of the drone has a bearing on the number of mites – which depends on how many offspring the mother mite has been able to raise. The advice is to check 100 cells and count how many Varroa are seen. The following figures suggest the action to be taken:

	April	July	Aug
High infestation	>4%	>7%	>10
Medium	2% - 4%	3% -7%	>5% - 10%
Low	<2%	<3%	<5%

4. IPM Programme

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Artificial swarm												
Shook swarm												
Drone brood removal												
Queen trapping												
Open mesh floor												
Formic Acid - authorised												
Thymol - authorised												
Oxalic Acid - authorised												
Bayvarol												
Apistan												

5. Biotechnical controls

These are the management techniques which help to reduce the Varroa population:

- Artificial swarm
- Shook swarm
- Drone brood removal
- Queen trapping

6. Artificial swarm

A normal management technique, the artificial swarm is easy to adapt to reduce mite populations. The brood in the parent colony is allowed to hatch and then frames of open brood are added from the artificial swarm. Mites enter and are culled.

The box containing brood is placed 3/4 feet away and at 90 degrees from the original site and left to raise queen cells. The queen is placed alone on the old site in a new brood box filled with foundation and at least one newly drawn comb to which the flying bees return, creating the artificial swarm. A queen excluder is placed below the brood box to prevent the swarm from absconding this should be removed 7 days after the queen has started to lay. After 9 days, the queen cells in the old brood box are culled except for one or a new queen cell of your choice may be inserted. In 21 days after the AS, all the brood in the original box has hatched. The queen in the artificial swarm will have continued to lay, now take 2 frames of unsealed brood and place in the old parent box; now broodless. Varroa mites are enticed into the open cells, and as soon as they are capped the combs are removed and destroyed, thus culling the mites. If required the new queen in the parent colony can be replaced with a new queen of your choice. The original queen, now in the artificial swarm, is later removed and the two colonies re-united removing all the old frames.

It is a highly effective method, up to 90% Varroa removal, and combines normal artificial swarm technique with Varroa control. However, this method is only suitable for the swarming season.

7. The Shook swarm

Timing of the Shook swarm is very important; sometime between late March and June depending on the state of the colony is ideal. I prefer to carry out the procedure as early as possible, providing the weather is warm enough and the colony is strong enough. Too soon and the bees won't draw comb, and it loses critical brood. Too late and the foraging or winter bees are destroyed. In my experience, the colony is invigorated and goes on to develop into a good honey producing colony.

It is an excellent way to completely change brood combs and rid the colony of the Varroa mites and pathogens contained on and in the brood combs. The remaining phoretic mites may be treated resulting in a very effective Varroa treatment of up to 90%. The shook swarm also helps reduce swarming as the wax builders are kept busy.

The queen is found and caged for safety, then the old brood box is placed to one side and the new box is placed on the original site with a queen excluder below the brood box to prevent the colony from absconding. Four frames are removed to make space. One by one the frames of bees are shaken into the space in the new box, then the rest of the frames gently replaced. The queen is released into the box, or she may be kept confined in the colony, in the queen cage, for a short time to allow the colony to settle.
The hive is closed down and the old frames are destroyed and the wax reclaimed.

The colony may now be treated with oxalic acid or an alternative Varroacide. As an alternative to using chemicals, a bait frame of unsealed brood may be placed in the hive to attract the phoretic mites. Once the cells are sealed, the frame must be removed and destroyed. The colony should be fed with strong syrup but it's advisable to wait 2 days to allow the bees to consume the contents of their crops. After a week, check that there is brood present and if so, remove the queen excluder. Leave for another week, if not. If the shook swarm was not treated for Varroa, the first frames of brood can be removed when capped, trapping the Varroa.

Keep checking and continue to feed until all the frames are drawn and the colony can sustain itself. Move frames around to equalise them, as bees find it hard to build wax at the end combs where there is less room for them to cluster when wax building.

Do not add supers until the brood frames are almost fully drawn or the bees will work on the supers instead of the brood frames. Continue checking for swarm preparation and do not use this manipulation as a swarm control method as the colony may easily swarm because it will tend to roar away in vigour and health.

The Shook swarm, in addition to removing a large proportion of Varroa, is an excellent method of changing the brood comb and ridding the colony of harmful pathogens. However, it is time consuming and requires good beekeeping skills. Also there is a risk that the colony will abscond. If the queen gets lost, the colony has no brood left with which to raise a new queen.

8. Drone Brood Culling

Because Varroa mites prefer to reproduce in drone brood, removing it when it is capped makes sense as the breeding Varroa are removed at the same time.

Drone brood appears in readiness for swarming around April and continues until July. Bees have a tendency to build drone comb when left to their own devices, so if a super frame is added to the brood box, they will draw comb underneath the bottom bars and it is almost always drone. As this is in the brood nest, the queen will lay drone eggs in it. Place the super frame at the edge of the brood nest, where drone is normally produced. This will also avoid splitting the brood nest.

When capped, cut off and kill the drone brood by freezing and reclaim the wax. If necessary, repeat at 9-day intervals. The frame can be reused immediately.

Care must be taken not to deprive the colony of drones when they are needed. Although drones' main function is to mate with virgin queens, they may well have other functions not yet determined. Certainly they play a role in temperature regulation just as the workers do. Do not let drone brood emerge or the Varroa population will increase as it will have allowed Varroa to breed.

This is an easy manipulation for everyone and requires no special equipment. The colony tolerates the removal of drone brood well under normal circumstances. One huge benefit is that it uses no chemicals. But it is a time-consuming operation with limited results. Still, it is another weapon to help reduce Varroa population.

9. Queen trapping.

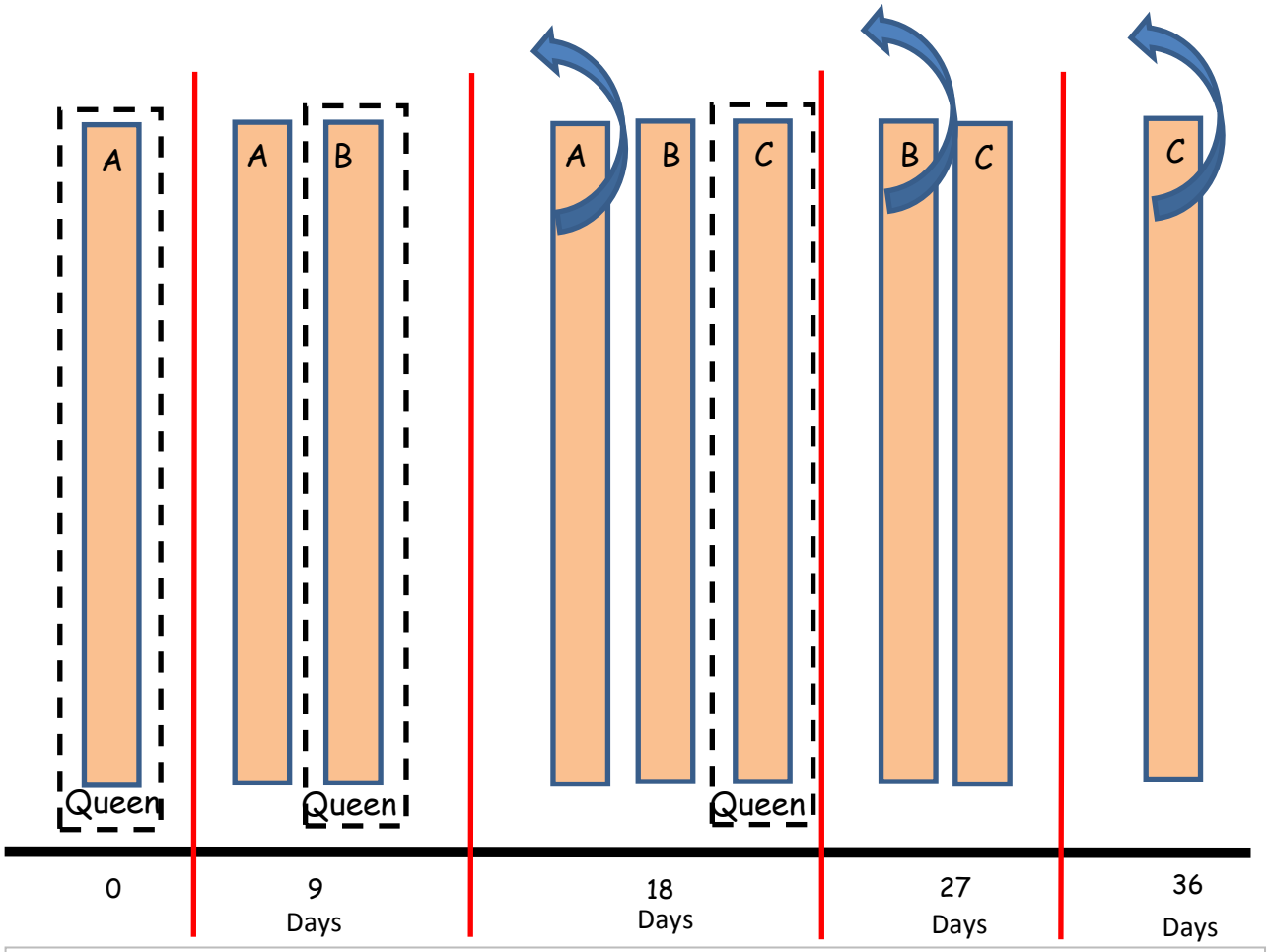
Another technique which has excellent results which is best carried out during late June and July. The Varroa are enticed into brood and culled as follows.

The queen is confined to one empty drawn brood frame which is placed in a special outer frame – see diagram on next page. This is put into the colony in the middle of the brood nest but as it is wider than a normal frame, it may be necessary to organise frame spacing with a dummy board. This first frame is marked to identify it.

After 9 days, she is moved to a second empty drawn frame. At this stage the colony must be inspected for queen cells as the bees may respond by attempting to raise a new queen. Any found are destroyed.

The first frame is left in the hive for a further 9 days, making a total of 18 days. After 18 days, the first frame is destroyed and the wax reclaimed.

The procedure is repeated for the second and third frames, marking them for identification, although there is no need to inspect for queen cells as the only available larvae are on the frame with the queen. She is released and returned to the colony when she has been confined to the third frame for 9 days. It is left to incubate for a further 9 days while the queen continues her normal life in the hive. It is important that the incubating bee larvae in the cells are not allowed to emerge. Varroa are trapped and destroyed. The colony may still swarm so it must still be monitored for swarm preparations.



The queen is caged for on three combs A, B, and C in succession. They each remain in the colony for a further 9 days while the Varroa mites enter the brood cells to breed. The combs containing the mites trapped in the sealed brood are then removed.

Although there is a loss of brood for a month, it has been shown that high honey yields are still maintained.

The photograph shows a queen trap. It encloses a frame in queen excluder mesh so that the workers can feed the queen but she is confined to the frame to lay her eggs. This technique can be very effective, as much as 90% of the Varroa is removed and no chemical treatment is applied. However it is a time-consuming technique and good beekeeping skills are needed as it is a complicated method. It relies on exact timing of manipulations. There is a danger that it can harm or weaken the colony if used in the wrong season such as late summer.

10. Open Mesh Floors

Open mesh floors are now standard, live mites which drop off the bees then fall through the mesh onto the ground. It is important that the hive stand is not a solid surface to allow the mites to fall so that they cannot then climb back up into the hive. It is estimated that 20% of the phoretic mite population fall off the comb.

11. Treatments and European regulations

Any veterinary medicine must by law have been approved by the member state in the European Union before it can be legally marketed or applied. Approval is a lengthy and expensive process for the pharmaceutical industry so economic and business considerations apply. Rigorous assessment must show that the product is safe for the user and the target animal, as well as the end consumer. Any pharmacologically active substances that remain in the honey must comply with the Maximum Residue Limits (MRL). It must also be effective and of required quality. Since the beekeeping fraternity is relatively small there is no incentive for the development of medicines for bees.
In the UK it is the VMD, an agency under Defra, which is the body responsible for such authorisation. A product authorised in one member state is not authorised for use in another state because there are widely differing circumstances, practices, climates etc. throughout Europe.

However, products authorised in one member state may in special circumstances be used in the UK under the cascade system. The principle is, if there is no suitable veterinary medicine authorised in the UK, the veterinary surgeon responsible for the animal, may prescribe a product that has been authorised in another member state.

12. Generic Substances

Naturally occurring substances have been used extensively in many European states to help control Varroa, and these are commonly known as generic substances i.e. the organic acids and essential oils.

The legal position regarding generic substances is complex, and with good reason. There is always the danger that such substances will be misused, causing harm to bees, users, consumers and the environment by being ineffective or leaving residues in the hive and its products. Generic substances have not been approved by the VMD. Because bees are food producing animals any veterinary medicine must be authorised by the VMD before administration.

13. Authorised Veterinary Medicinal Products for use in the UK

a. Bayvarol (flumethrin)

b. Apistan (tau-fluvalinate)

These are applied as laminate strips hung between frames in the brood nest. Bees walk over them and pick up the chemical so that it is passed around the hive by social interaction. They are left in for a minimum of 6 weeks and maximum 8 weeks. If left in longer, the dose diminishes and resistant mites are bred. There is no detectable residue in honey.

c. Apiguard (thymol)

This is available as a slow release gel matrix in a small tray which is opened and placed on the brood frame bars. Thymol evaporates to a steady level, then the bees enter the container to clean it up and remove the gel, which sticks to their body hairs and gets distributed around the hive. Temperatures above 16C are recommended so that evaporation is higher and the bees more active in cleaning out the gel. Prior to treatment of the hive, remove all honey supers, close or replace open or screened hive floors with solid floors and reduce the hive entrance to normal size After 2 weeks the tray is replaced and the second left in for a further 2 weeks.

d. **Apilife VAR** (thymol, eucalyptol, menthol, camphor).

This is impregnated oasis tablets which may be applied in the spring before honey flow or in late summer after the honey harvest has been taken. The optimum temperature for use is between 20-25°C. Prior to treatment of the hive, remove all honey supers, close or replace open or screened hive floors with solid floors and reduce the hive entrance to normal size. Break the tablet into 3-4 pieces and distributed them on the top of the frames for 7 days. The treatment is repeated 3-4 times according to the infestation and size of hive and colony. The residuals of the tablets should be removed after the last treatment.

e. Thymovar (thymol)
These are impregnated sponges which may be applied in the spring before honey flow or in late summer after the honey harvest has been taken The optimum temperature for use is between 20-25°C. Prior to treatment of the hive, remove all honey supers, close or replace open or screened hive floors with solid floors and reduce the hive entrance to normal size. Apply one THYMOVAR strip per colony, broken into 2 or 3 pieces, placing them on top of the frames close to, but not directly over, the brood. After 3 weeks remove the pieces and repeat for a further 3 weeks. When finished it is recommended that all pieces are removed and discarded.

f. Maqs Strips (formic acid)
These are impregnated strips that act as a fumigant penetrating the brood cap, killing the male mites as well as immature female mites. Treatment lasts 7 days and may be used at any time with temperatures between 10C and 29C. There is no residue in honey or wax.

14. Varroacides which are Authorised for Import to the UK under the cascade scheme are:

a. Apivar
This is applied as a strip, in the same manner as Bayvarol and Apistan as it is a contact miticide. The strips should be removed after 8 weeks maximum and destroyed, never re-used. Amitraz, the active ingredient is unstable so biodegrades rapidly in honey therefore there are no detectable residues in honey.

b. Checkmite (courmaphos)
An impregnated strip made by Bayer Animal Health

c. Api-Bioxal
This is a measured quantity of Oxalic acid dihydrate which is mixed with sucrose and water according to the manufactures instructions. 5 ml is trickled between each seam of bees during broodless periods normally in December or January.

d. Ecoxal
An Oxalic product

e. Formidol
This is a pad pre-soaked in 85% solution of Formic Acid.

15. Veterinary Medical Administration Records

The VMAR require the beekeeper to maintain records of the purchase of all medicinal products. These must include the name of the product, the batch number; the date of acquisition; the quantity acquired and the name and address of the supplier. When the medicine is given to the bees, the beekeeper must record a hive reference number, the name of the product, the date of administration and the quantity administered together with the withdrawal period if applicable. Finally, when disposing of unused medicine the beekeeper must note the date of disposal, the quantity of product involved, and how and where it was disposed of. These records must be kept for five years following administration of the product. Any adverse reaction should be reported to the VMD.

16. General

Varroacides are often developed from pest control of crop and livestock. When adapted for use in bee colonies, they have been specially prepared and packaged to be safe and effective. Never use home-made treatments of these chemicals, as this may be unsafe for the user, leave residues in the hive products, and contribute to the rapid development of resistance in Varroa mites. It is widely believed that such is the case in countries outside the UK.

The important point to remember is to treat only when necessary, that is when your monitoring method indicates that a treatment is necessary. However, the standard period for treatment is summer immediately after the honey crop has been removed. This must be early enough for the bees which will go into winter to be healthy and survive their normal lifespan. Without this, shortened lives result in dwindling numbers at the critical period in early spring and the colony will collapse as it has insufficient bees to be viable, that is, to care for new brood to replace themselves with young bees. To achieve this, I treat during the first week of August.

Any chemical may leave residues, therefore only authorised proven medicines should be used and manufacturers' directions followed closely. Never treat with supers on unless there is an emergency, and then it is better to remove the supers anyway. Do not treat just before or after a honey flow unless the product specifies this may be done.