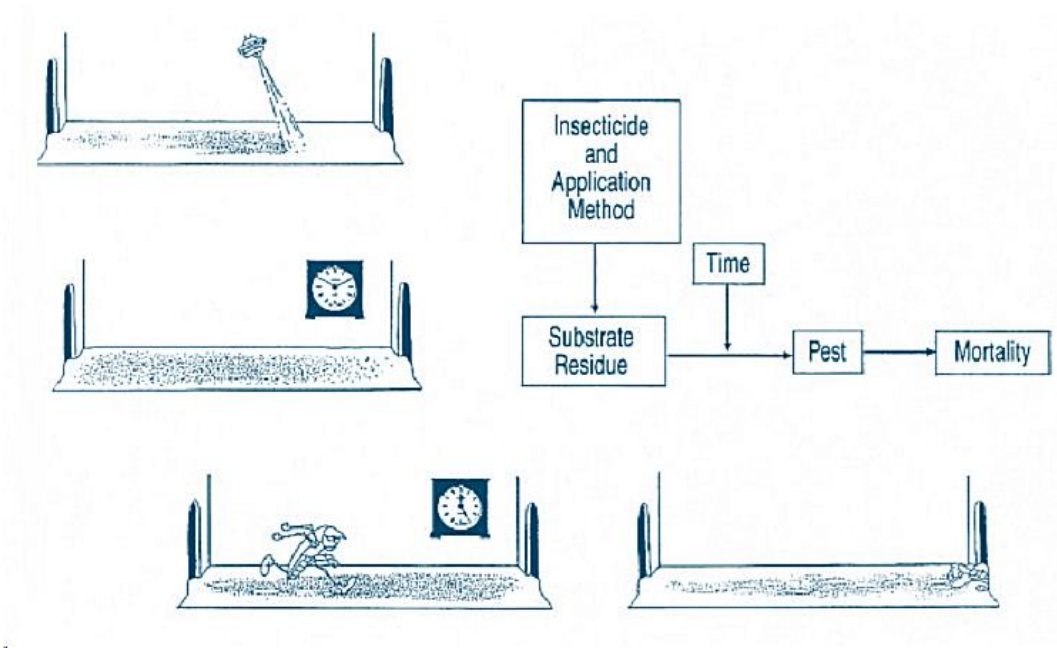
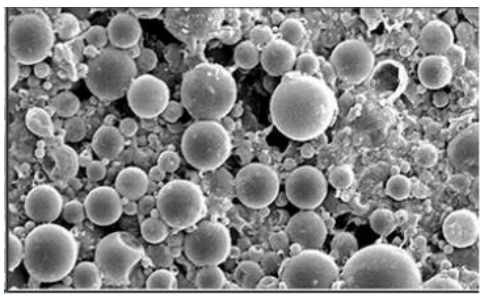
1 Introduction

Efficacy of an insecticide treatment depends on the combination of active ingredient and formulation, and how it is applied to substrates. Time is the primary factor that influences how long the application remains effective against the target pest. Next in importance are the habits of the pets, such as movement and foraging. The objective is to treat substrates that will be contacted by pests when it is in or leaves a harborage. This must occur while the residue is lethal. When these parts are in sequence, control is achieved.

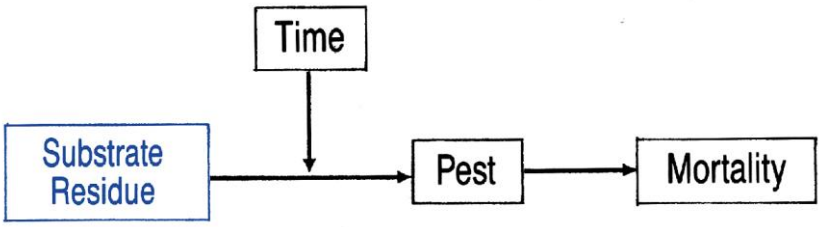


BASICS OF INSECTICIDE APPLICATION

Insecticide formulations are the means for delivering the active ingredient to a substrate. Common formulations include, microencapsulated (ME, MC), wettable powder (WP), soluble concentrate (SC), and dust (D). These are designed specifically for the active ingredient and how it will be used; some active ingredients are available in more than one formulation. A SC may be suitable for soil application, but a ME better for surface treatments. Formulations can influence the activity of applications by how they form a residue and how the target pest is exposed to it.



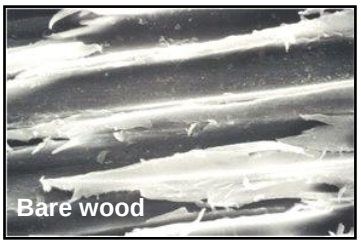
Microcapsules



SUBSTRATE AND RESIDUE

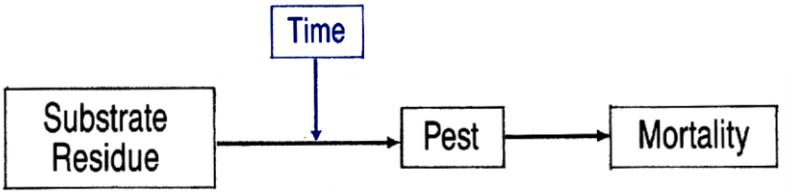
Spraying a surface may seem to be a simple process, but there is a lot to consider if the treatment is to be effective and cost efficient. The objective is to apply droplets of insecticide to establish a surface residue which will be contacted by the target pest. While the equipment and the spray droplets remain the same, the composition and surface of the substrate can be significantly different.

Wood. The surface of unfinished wood is a matrix of grooves and cavities. The size and shape of these features depends on the type of wood. They are very distinct in the pine lumber used for house framing, and the hardwoods used in bed frames and furniture. Insecticide spray droplets may be deposited in grooves on the wood surface. Legs of insects crawling on that surface may not contact the dry residue in the grooves. Thorough application to these substrates is necessary, and SC and WP formulations are effective.



Fabric. The fiber and weave of household fabrics and furniture coverings enable them to absorb liquid insecticides. Plant-based material such as cotton, readily absorb liquids, and blends of cotton and synthetic fibers are also absorbent. Polyester-based fabrics can retain insecticide residue on the surface longer than cotton or cotton blends. Stain-protection finishes applied to furniture fabrics act by trapping liquids, including insecticides, at the surface. This may increase the contact with an insecticide residue.

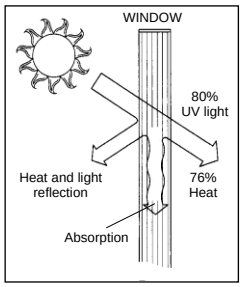
Concrete, brick, and vinyl. Concrete and brick are porous materials and readily absorb liquid insecticide. The surface is uneven and pitted with cavities; these features can hold insecticide. The result is that crawling insects have only limited contact with an application residue. And the residue may be exposed to environmental conditions, such as ultraviolet light (a component of sunlight) and may be removed by wind and rain. Concrete foundation surfaces and slabs is slightly alkaline (pH 8), but this does not influence the efficacy of insecticides.



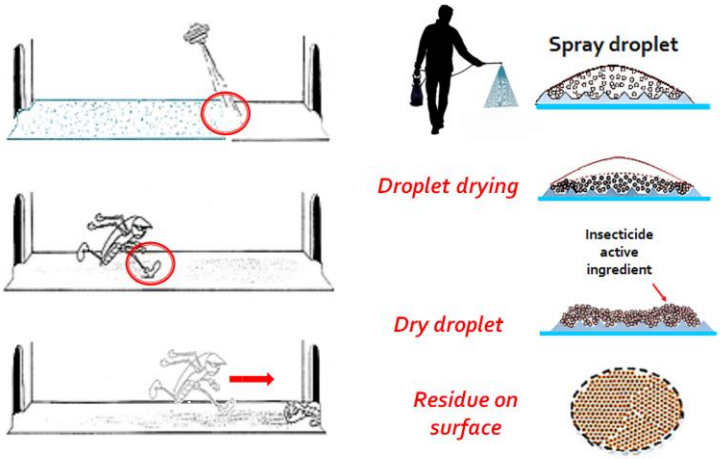
TIME

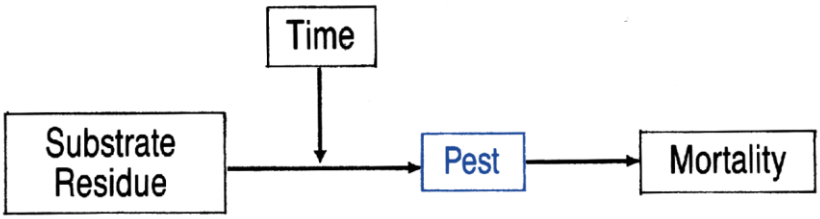
The time between insecticide application and contact by the target pest on the treated surface is important to achieving control. The residual toxicity of insecticide on exposed surfaces is limited by environmental conditions or other events that remove the residue, and by the insecticide itself. Some formulations, such as ME and SC formulations usually remain effective longer than others.

Time is a factor for applications indoors and outdoors. For flea control, spraying indoor carpeting is the typical method to control the larvae. However, it can take a few days for the liquid insecticide to be contacted by larvae. During this time the insecticide may be exposed to damaging ultraviolet light passing through windows, or damaged or disturbed by foot traffic or vacuuming. The initial residue may be less effective by the time adult fleas emerge from their protective pupal cases at the base of the carpet and crawl to the surface.



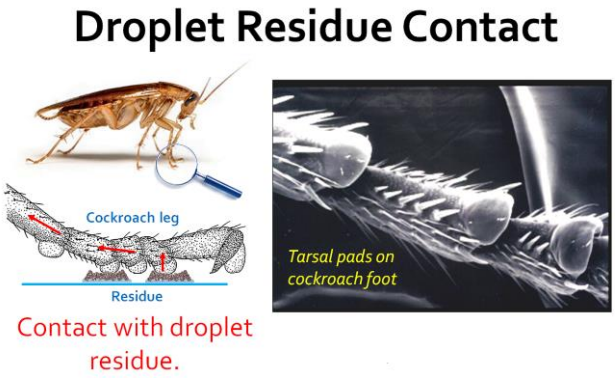
The residue of wood protection insecticides is expected to remain effective for long periods. Liquid and foam applications to structural wood produce a residue at the surface and immediately below the surface. The surface residue will degrade within weeks of application. However, below the surface, where the liquid moved during and after treatment, there is a stable residue protected from environmental conditions. This residue may last for years, depending on the active ingredient.

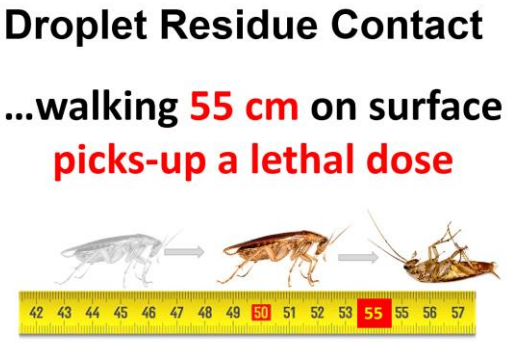




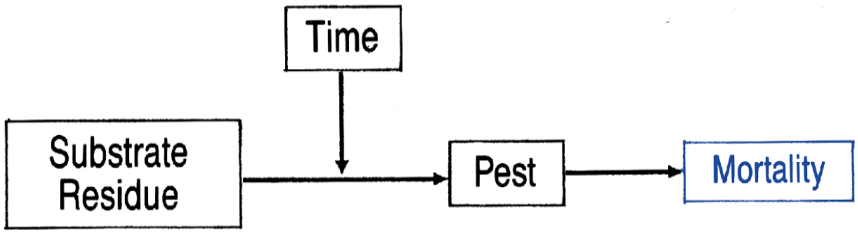
PEST

The pads on the feet of insects contact the surface during walking and climbing. The bottom of an individual tarsal pad can completely cover one (dry) droplet residue. The movement of legs and the spines on the feet helps dislodge residue on the surface, which can be picked-up by the tarsal pads. Residue on the pad enters the body directly or is transferred to the mouth when the legs are groomed.





Insects that forage at night, such as cockroaches and bed bugs, remain in narrow harborages during the day. This activity pattern limits their exposure to insecticide residue unless harborages and surrounding surfaces are treated. Adult bed bugs leave their harborage to feed only every 3 to 4 days and may not have to travel far to find a host. German cockroach females carrying an eggcase leave a harborage about every 5 days to eat and drink. These foraging habits influence the efficacy of spray applications.



MORTALITY

Insects and other pests die within hours or days after exposure to an insecticide, whether by direct spray, contacting a dry residue, or eating toxic bait.

Lethal dose (LD_{90}). The effectiveness of an insecticide can be measured in the lethal amount needed to kill 90% of the target pest, the LD_{90}, or the time it takes to kill 90%, the LT_{90}. Insecticide manufacturers recommend a final (application) dilution that is a balance between a low concentration (LD) and a short mortality time (LT).

- When ants carry bait back to the nest, the concentration of active ingredient has to be low so that these individuals are not killed. But the concentration must be enough so that a lethal amount accumulates in the body of the queen and larvae that are fed by the workers.

- Cockroach gel baits lose about half their moisture content in the first two days after application. This essentially doubles the concentration of active ingredient in the bait.

Knockdown (KD_{90}). Another way to evaluate an insecticide is to determine when 90% of the exposed pests are knocked down, this is the KD_{90}. The insect is not dead, but it is not moving and usually on its back. Death may be hours later, but the insect is essentially controlled. Consider knockdown and cockroach baits: adults and nymphs become inactive soon after their first feeding. They do not eat again and usually remain in the harborage; death is usually in 3 to 4 days. It seems to the customer to be immediate control because they see fewer cockroaches, but death takes several hours to days.

The time for 90% knockdown of the exposed pests can be more valuable than the time for mortality. Pest status is often based on their presence in the living space, and the absence of cockroaches in the kitchen or bites from bed bugs is an indication of control. The target pest may simply be inactive and will not die until days later, but the perception of control begins with knockdown.