SYNOITA

Our Science ... Your Pest Solution

Insecticides remain the mainstay of many pest control and public health programmes and for these to be compromised by insect resistance is a global concern. Although new insecticide molecules are under development to control insect resistant strains, the need to protect and extend the useful life of current insecticide molecules remains a priority.

What is Insecticide Resistance?

The World Health Organization's (WHO) definition of resistance is - *"The inherited ability of a strain or organism to survive doses of a toxicant that would kill the majority of individuals in a normal population of the same species"*

For an insecticide to be effective it needs to be able to reach the target site and within the target organism, at a sufficient concentration, to affect the biological process occurring at that site.

Our industry must begin to understand the *basics of resistance*, the *mechanisms of resistance* and the *approaches to resistance management* in order to plan effective strategies to prevent or overcome these challenges.

The four types of mechanisms of resistance are:

- ***Reduced Penetration*** – Occurs where there is a modification of the insect's cuticle (exoskeleton) that prevents or slows the absorption or penetration of the insecticide.
- ***Metabolic Resistance*** – Once the toxin has penetrated the insect's cuticle, the toxin is then subjected to metabolic enzymes that degrade the toxin in an attempt to be more easily eliminated from the insect's body.
- ***Target Site Resistance*** – Results from molecular modifications to the site of action of an insecticide that may in turn result in insensitivity and thus resistance.
- ***Behavioural Resistance*** - Describes any modification in insect behaviour that helps to avoid the lethal effects of an insecticide. This does not have the same importance as the physiological resistance mechanisms.

Pest species that are repetitively exposed to sub-lethal doses of toxins (insecticides) over time are more likely to develop one or multiple resistance mechanisms.

Major Factors That Influence Resistance Development

It is known that low insecticide rates may hasten the evolution of resistance by increasing the mutation frequency. Stress is a general enhancer of mutation rates. Pests receiving sub-lethal doses are highly stressed and are likely to have more than normal mutations, resulting in major gene resistance in future pest populations. Our best effort at avoiding this is by ensuring that we deliver a lethal dose to the surface by consistently applying the correct deposit rate in the most appropriate formulation.

Variable or non-consistent deposit rates are generally associated with:

- Incorrect application equipment (such as pumps, nozzles etc.)
- Incorrect application methods
- Incorrect formulations being used for the task at hand

Variable deposit rates can often result in deposit rates that are less than half the required rate to deliver a lethal dose. The World Health Organisation developed a standard for both application equipment and the methods used in applying residual sprays to surfaces for vector control. This standard ensures that deposit rates are uniform on all surfaces, especially vertical surfaces, which are prone to run-off. Below is a breakdown of these standards that should be adhered to:

- **Dosage Rate as per label instruction:** For example, 50ml per 5L of water applied to 125m^2. This is the required mix in order to achieve the target dosage rate measured in milligrams of active ingredient per meter squared. This is the dosage rate that the product has proven its efficacy level at.
- **Tank Pressure:** This determines the flow rate of the insecticide mix out of the nozzle over time. This is measured by a pressure gauge that should come fitted to your correct spraying equipment.
- **Speed, Distance & Motion:** This refers to the speed at which the nozzle moves over the surface and the distance the nozzle is away from the surface being sprayed. The speed should be at 2.2 seconds per running meter and the distance that the nozzle should be away from the surface should be 45 cm at all times unless crack and crevice pin stream nozzles are used.
- **Type of Nozzle:** For surface treatment label recommendations are based on Flat fan 8002E nozzles. These are the correct nozzles to use on porous surfaces. However, with painted and other non-porous surfaces 8001E nozzles should be used and the dosage rate stated on the label should be doubled, excluding the water component (e.g. Where the label states 50ml per 5L of water applied to 125m^2. You would now put 100ml per 5L of water applied

INSECTICIDE RESISTANCE

Graeme Steart

to 250m^2). This nozzle change eliminates run-off of the insecticide mix on vertical surfaces. Run-off reduces the even deposit rate on a surface.

Note: The cost per square meter remains the same as both the insecticide and the square meter coverage are doubled.

Using the correct formulation is **vital** in order to achieve a successful result. In order for the active ingredient to deliver a lethal dose it is required to make contact with the insect's cuticle. Particulate formulations offer structure for the active ingredient to bind onto, which in turn facilitates long-term efficacy. These particulate formulations comprising of; Wettable Powders (WP), Wettable Granules (WG), Suspension Concentrates (SC) and Capsule Suspension (CS), promote contact points and enhance delivery of a lethal dose on a surface over a period of time.

Emulsifiable concentrates (EC) are not comprised of particulates and thus, due to the lack of structural support, are unable to offer long-term effective coverage on a surface. Water is used with insecticide mixes to assist as a carrier and to facilitate even coverage of the active ingredient over a treated surface. With EC formulations, once the carrier has evaporated or absorbed into the surface, the active ingredient quickly diminishes over a short period of time due to the lack of particulates. This can result in sub-lethal dose amounts of active ingredient being available to the insect pest and in turn promotes possible insecticide resistance. This has been observed in clinical trials where identical active ingredient dosages were used. In this trial one formulation was supported by capsule suspension and the other was an emulsifiable concentrate. The capsule suspension gave efficacy lasting 9 months versus the emulsifiable concentrate that only offered 9 hours.

Approaches to Resistance Management

Rotation of chemical classes and the use of integrated control approaches is key in achieving success over an insect pest population. Not only does it result in a more effective and sustainable program in combating the pest over a period of time but these approaches are key to resistance management.

Rotation of chemical classes is often misunderstood and merely changing the brand of your product is not equivalent to rotating the classes of active ingredient groups. Classes of active ingredients are generally categorized by their mode of action. Common examples of active ingredient classes are Synthetic Pyrethroids, Natural Pyrethrum, Neonicotinoids, Phenylpyrazole, Carbamates etc. Being aware of the active ingredient class that you are using is critical to ensure that the correct rotation is put into effect. It is good practice to rotate classes of chemicals on a 3-monthly basis, however certain programs may not be conducive to this.

Breaking the insect pest's lifecycle is often key to controlling the pest effectively. Egg and larvae stages of the lifecycle often result in exponential population growth for the insect pest and therefore it is critical to implement an integrated approach to your control program that incorporates this important life stage. Using different chemical classes against different life stages of the insect pest is imperative, as using the same mode of action for these different life stages often results in gene mutation and possible resistance forming in future pest populations.

Piperonyl Butoxide (PBO) is an active ingredient that has minimal, if any, insecticidal properties. However, when combined with certain other classes of active ingredients it benefits the formulation in various ways and potentially offers superior advantages over other products that may not be formulated with PBO. Mono-oxygenase resistance exists under metabolic resistance and can account for approximately 90% of insecticide resistance encountered. Piperonyl Butoxide (PBO) offers a key tool in overcoming Mono-oxygenase resistance.

Education around these principals of pest control is imperative and pest controllers in the field should have a solid understanding of these fundamentals in order to ensure an effective and sustainable approach to pest control. It is up to us as insecticide users to responsibly and correctly utilize the chemical molecules that are currently available to our industry.

For more information or further training on the principals discussed here, please contact your local Synvita trained sales representative or our head office via info@synvita.co.za.