Pest Control Newsletter

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Insecticide Resistance

Insecticide resistance is an increasing problem in controlling many insect vectors of human diseases. It is the development of ability in a population of a pest species to tolerate doses of toxicants that have proved lethal to the majority of individuals within the same species. This process is generally believed to be the result of evolution that the susceptible insects are killed after their exposure to an insecticide but the remaining ones being genetically resistant to the insecticide are able to survive and have a better chance to reproduce. If this generation cannot be eliminated within a short time, insecticide resistance will be developed under this stringent biological selection mechanism over generations.

The time for resistance development depends on the volume and frequency of applications of insecticides used against them and the inherent characteristics of the insect species involved. The more generations are exposed to an insecticide, the higher the potential is for a population to develop resistance. Insects with short life cycles, abundant progeny and low migration rates are therefore likely to shorten the time for resistance development.

Mechanisms of Insecticide Resistance

Extensive studies have been conducted to understand the mechanisms of insecticide resistance. Behavioral resistance has been demonstrated in insects which modify their behavior so that they avoid the areas sprayed with the insecticide. Even if the insects are exposed to the insecticide, studies have also shown that some insects have developed physiological modification mechanisms that decrease the penetration of the insecticide through cuticle or intestine, increase sequestration/storage of the insecticide in fat depots or other inert organs, and accelerate excretion of the active ingredients of the insecticide.

Mechanisms of resistance have been studied in more detail at the biochemical level. The two major biochemical bases of insecticide resistance that have been found are target-site resistance and detoxification enzyme-based resistance. Target-site mechanisms refer to the situation that the binding site for the insecticide has been altered and rendered the insecticide less effective or even ineffective. The organophosphates and carbamates target acetylcholinesterase in nerve synapses. The organochlorines and synthetic pyrethroids target sodium channels of the nerve sheath. The GABA receptor (the inhibitory neurotransmission channel in insects) is the target for pyrethroids, avermectins and cyclodiene. Alteration of amino acids at these binding sites therefore reduces the sensitivity to these insecticides. Detoxification mechanisms usually involve the over-expression of enzymes which are capable of detoxifying insecticides, or the substitutions of amino acids within these enzymes, resulting in modified levels or activities of detoxification enzymes that metabolize insecticides. The three major enzyme groups involved in the metabolic detoxification process are oxidases, esterases and glutathione S-transferase (GST). There may be many kinds of physiological and biochemical mechanisms, but resistance is often due to an insensitive target-site or increased detoxification.

Management of Insecticide Resistance

Development of insecticide resistance is inevitable, but measures can be taken in order to delay or prevent the resistance level reaching the limit that a pesticide must be abandoned. One of the measures is to employ the same insecticide instead of switching to another insecticide until an unacceptable level of resistance is detected. Besides, when carrying out pest control operations, the application of the insecticide should be limited to a target area instead of complete coverage of large geographical areas in order to reduce the selection pressure producing resistance. For the same reason, the insecticide should be applied to selected resting sites only, e.g. application of a residual insecticide to specific resting areas within a house rather than to all of the areas of the house. Rotation of pesticides, use of synergists and use of biopesticides may be other choices. Although switching to other insecticides which are not affected by the resistance may be one of the alternatives, the best solution to insecticide resistance is to employ other control methods, e.g. biological control, environmental management, personal protection measures, or a combination of the control methods which known as integrated pest management. In this way, both the amount of insecticide to be used and the insecticidal selection pressure for the development of resistance can be reduced.

Ms. S. M. YIN, Pest Control Officer

Common species of Cockroaches in Hong Kong

Introduction

The climate of Hong Kong is suitable for many species of insect, and there is no exception for the highly adaptive cockroaches. The Pest Control Advisory Section of Food and Environmental Hygiene Department has handled at least 13 species of cockroaches locally. The most commonly found species in Hong Kong include *Periplaneta americana* (American cockroach), *Periplaneta austrailasiae* (Australian cockroach) and *Blattella germanica* (German cockroach).

Periplaneta americana

The oval-shaped body of *P. americana* is reddish brown in color, and measures around 4 to 5 cm in length. There are 2 large dark spots on the thorax, surrounded by a pale margin. Wings are well developed in adults but they are only occasional fliers. *P. americana* mainly inhabits dark moist places such as inside sewer systems. They readily access domestic areas in search for food. *P. americana* is a long-lived insect. It takes 6 to 12 months for the nymph to mature, and the adult can survive up to more than 1 year.

Fig.1 Thorax of P. americana (left) and P. austrailasiae (right)

The boundary of the thorax pattern of P. americana is loosely defined, and there is a yellowish T-shaped mark in the front. The colors of the thorax pattern of P. austrailasiae are more distinct. The two yellowish stripes on the edges of wings can also be seen in the figure.

Periplaneta austrailasiae

P. austrailasiae is in general slightly smaller than *P. americana* but they have a similar appearance. The dark spots on the thorax are more contrasting and there are 2 conspicuous yellowish stripes near the base of wings. Comparing with *P. americana, P. austrailasiae* prefers drier environment and hence is more commonly seen in places like warehouses and storerooms. The life span of *P. austrailasiae* is usually 4 to 6 months.

Fig.2 Blattella germanica adult (left) and nymph (right)

Blattella germanica

An adult German cockroach is about 1.5 cm in length and light brown in color. Two nearly parallel black stripes can be seen on the thorax. The stripes extended to the abdomen region in nymphs. *B. germanica* is very successful in adapting to indoor environment, particularly at areas with high humidity such as kitchens and bathrooms. They are frequently seen in households, warehouses and even offices. Nymphs become mature in about 60 days and the life span of adults can reach up to 5 months.

Others species

Although not as commonly seen as the 3 species described above, species like *Supella longipalpa, Pycnoscelus surinamensis* and *Opisthoplatia orientalis* are not rare in Hong Kong. *S. longipalpa*, also known as Brown banded cockroach, is similar to the German cockroach in size and is also commonly found in domestic environment. Due to its higher tolerance to drought, the *S. longipalpa* may have a wider distribution than the German cockroach. *O. orientalis* and *P surinamensis* are more easily found in rural areas with dense vegetation. Despite the fact that they may enter indoor areas on occasions, they are generally not considered as pests.

Prevention and control

The principle of preventing and tackling cockroach infestation is no different from other pests. Keeping the environment clean and tidy is of top priority to avoid the provision of food and hiding/breeding place for cockroaches. Food and waste should be handled and stored properly. Cracks and cervices that may allow the passage or hiding of cockroaches should be sealed. Chemical treatment could be used to supplement environmental improvement. Residual insecticides containing synthetic pyrethroids could be used as barrier to prevent intrusion of cockroaches, while knock-down insecticide is effective in controlling small scale infestation. However, treating areas with high cockroach density with knock-down spray is not advised as the fleeing of cockroaches may cause serious nuisance and problems of environmental hygiene. Poisonous bait with active ingredients such as hydramethylnon, fipronil and boric acid is more appropriate although it might take a longer time to achieve the desired result. For areas which are sensitive to chemical treatment, trapping provides a good alternative to the use of insecticides.

Fig.3 Other common species in Hong Kong (from left) Supella longipalpa, Pycnoscelus surinamensis and Opisthoplatia orientalis

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