IRAC Susceptibility Test Methods Series

Introduction & Overview

Version: 3 *(June 2009)*

Introduction:

One of the most important factors governing the management of insecticide/acaricide use is the availability of sound baseline data on the susceptibility of the target pest to the toxicant. Baseline data can be defined as data obtained from a strain with no history of selection with the toxicant or toxicants with the same or related site of action showing cross resistance. Currently a wide range of bioassay and biochemical tests are employed to characterize the susceptibility of target pests to insecticides and acaricides. Unfortunately the results from different test methods may not be comparable since they measure different parameters which can lead to difficulties over the interpretation of monitoring data.

IRAC (Insecticide Resistance Action Committee), in fulfilling its aim of providing expert advice to CropLife International on all technical matters relating to insecticide and acaricide resistance, has addressed this issue with the aim of recommending a range of bioassay techniques to monitor insecticide and acaricide susceptibility for selected pest species of economic importance.

Objectives:

The specific objectives of the project were to:

(1) review the range of monitoring techniques currently available,
(2) select those most appropriate for future monitoring studies or develop new methods if appropriate to harmonize methodology,
(3) improve standards of susceptibility monitoring,
(4) allow a greater degree of comparison between studies.

Choice of methods:

Changes in insect/mite susceptibility to toxicants can take various forms, which often influences the sensitivity of given bioassay techniques in detecting these changes in the target population. Because tests may measure different parameters, a single test method is unlikely to provide a complete picture of the susceptibility of a given population. The methods presented here were chosen as being:

(1) reliable and reproducible under field usage allowing comparisons between tests;
(2) simple and easy to perform using a minimum of resources;
(3) consistent in distinguishing between susceptible and resistant phenotypes;
(4) relevant as far as possible to field performance of products;
(5) useful for a range of toxicant groups.

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The tests should not be taken as the only acceptable method of measuring changes in susceptibility, but they are the methods most likely to satisfy these criteria.

Function of the tests:

The tests can be used to characterize the susceptibility of a target pest population to one or more toxicants at a given instance, and to monitor changes in susceptibility through space and time.

Data generated from the tests can be used to aid in distinguishing between field control failure as a result of insecticide/acaricide resistance or other factors, to assist in the design of resistance management strategies and to gauge the success of these strategies over time.

Limitations of the tests:

The tests cannot normally be employed to predict the onset of insecticide/acaricide resistance nor as operational tools to guide immediate spray decisions. The tests are specific to particular life-history stages and can only detect changes in susceptibility expressed in that stage. They can only be used with confidence for toxicants which have been validated in the development of the methodology. As susceptibility testing often involves rearing the test sample for one or more generations in laboratory of glasshouse conditions, results from the tests may vary with the generation of pest tested, the sex/age/condition (including disease) of these organisms and the test holding conditions. These should be standardized as far as possible.

Sampling Procedures:

Data generated using the tests relates only to the test sample. Conclusions relating to the target population can only be made if the sample is truly representative of the population, thus sampling bias must be rigorously avoided. Consideration should be given to the crop or host plant sampled, the time and frequency of sampling, the crop-treatment history, the number, age, sex and life-history stage of organisms collected and the number, size and location of sampling areas. It must be ensured that test organisms are not the offspring of only one or a few females which can often be a problem with laboratory rearing.

Experimental design and analysis:

Meaningful documentation of changes in pest population susceptibility can only be made in comparison with appropriate baseline strains or populations. The choice of a susceptible baseline strain is critical and many laboratory strains are artificially susceptible compared with field populations.

Generally, the use of commercial formulation of the test compound is preferred to the use of technical material.

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The choice between using a single discriminating dose or a range of doses depends on the objective of the test. If the objective is to detect a large change in suscepibility in a small portion of the population, then a single discriminating dose is more appropriate. This should be selected as a dose which gives complete kill or high mortality of a susceptible population but zero or low mortality of a homogeneous resistant population.
If small changes in susceptibility are suspected or there is a range of resistance phenotypes already present in the population, the use of more than one dose is preferred. The choice of doses will depend on the range of resistance factors expressed. However, it is important to remember that if the population is heterogeneous in terms of susceptible and resistant phenotypes, the use of probit analysis is invalid.

Results should be recorded in terms of percentage mortality and corrected for mortality in the untreated using Abbott's formula. A standard form for use with all methods is appended.

Criteria for assessment should be carefully defined and strictly applied. Results from susceptibility tests will not always relate directly to field performance. This is because field performance is the result of a complex interaction of factors including environmental conditions, application equipment and pest pressure, in addition to the susceptibility of the population to be controlled. Results from the tests do, however, give an indication of the potential for field control failure due to a change in susceptibility of the pest.

Validation of the test methods:

The methods are initially presented as drafts and are granted an IRAC recommendation after a period of 2 years' field testing. The status of each method i.e. draft, proposed, approved is given under the "Details" section of each method The performance of each test against the criteria outlined above needs to be rigorously evaluated to ensure that the methods are satisfactory. To facilitate this process a standard data recording sheet parts I and II is available. Recipients are requested to return copies of completed recording sheets to the IRAC Coordinator, Alan Porter. Details are available by email at: aporter@intraspin.com

Modification of the test methods:

Minor changes, particularly with respect to the design of test containers, can generally be made without harming the validity of the method. However changes should not be made to quantified parts of the method, e.g. test holding temperature, duration of leaf dipping etc. Any changes should be clearly recorded with the test results.