

Overview of an Insect Resistance Management (IRM) Program for Plant Protection Insecticides*

In order to preserve the maximum efficacy of crop protection products over an extended period of time, growers need to ensure that control plans are based on sound Insect Resistance Management (IRM) principles. Resistance management is dynamic and therefore such plans should be addressed at all levels within academia, industry and often implementation will need to be customized to local conditions depending on crop and pest(s). Since the registrants or manufacturers of crop protection chemicals are better positioned to assess their products strength and weaknesses, it is common that the primary lead for developing the appropriate resistance management strategies and tactics are technical representatives from the chemical industry. The registrants or manufacturers have clear knowledge of their products and also stand gain or lose the most from action or inaction. As such, resistance management is already an integral part of product stewardship among registrants or manufacturers. Product stewardship involves collaboration between registrants or manufacturers via organizations such as CropLife America and IRAC-US in order to develop implementable IRM plans which represent clear value to growers and consumers alike. It also involves creating precise product use directions and restrictions on labels which maximize the net benefits of each product while also ensuring product safety, low environmental impact while maximizing the collective product lifespans over the long term. For companies, prophylactic resistance management approaches or tactics which delay or minimize resistance development are of tremendous importance to trigger new product development ideas and are critical drivers for the long-term sustainability of crop protection chemicals.

Key goals for an IRM plan for insecticides could include:

- Understand the mode of action of a product to determine its proper place and fit among existing group of insecticides through research and field development.
- Establish the baseline susceptibility of high resistance risk key pests (especially in regions which have a history of resistance issues) prior to and/or in the early years of commercialization. **These may include:**
 - Identification of a proper susceptible pest strain early in the product launch cycle for future comparisons.
 - Development of a workable diagnostic test to quickly determine resistance.
- Develop educational literature for growers, researchers and extension agents to increase resistance management awareness particularly at the grower level.
- Utilize Integrated Pest Management (IPM) practices
- Monitor product performance over a wide range of geographies and observe/track field performance of relevant changes in the susceptibility of pest populations over time.

- Train technical staff to identify and report any case of “field failure” and promptly assess the basis of non-performance.
- Work with regional experts to address concerns.
- Investigate the mechanism(s) of resistance in field relevant resistance populations.
- Investigate the genetic basis for such resistance.

Development of a Resistance Management Program as a component of IPM

Certain insect pests have a known propensity to develop resistance quickly especially when insecticides are over-used. Since resistance development is not easily predicted (scale and location), the use of such insecticides should be based on acceptable resistance management approaches which integrate local resistance management strategies which may have been established already for the specific crop and region. It is likely that IRM tactics will need to be customized, validated and tested again over time while integrating new products or new approaches --which represents the dynamic nature of IRM. Many IRAC-US member companies collectively participate to develop common IRM language on their product labels and also encourage responsible product stewardship. This ensures that at least key insecticides which form the corner-stone of insect pest management remain effective for insect control. Often times, IRM plans involve the use of treatment windows during the crop cycle where natural biological control agents and alternate control methods (e.g., pheromones/male confusion, genetic breeding for crop resistance to pests) have a place in overall pest management. If resistance to a certain insecticide is suspected in a region (frequent reports of non-performance), all related products which possess a similar mode of action and mechanism of resistance, may also not provide adequate control. If such poor performance cannot be attributed to improper label use/application techniques or due to unfavorable weather conditions, a resistant strain of insect could be the cause for field failure. Growers are encouraged to immediately contact the company’s local technical representatives to better understand the cause for the field failure and initiate proper remedial measures through collaborative action. As a follow up, some surviving insects are collected (reared) and tested for resistance either by using a discriminating dose or a full laboratory bioassay is conducted to confirm the presence/absence of resistance. Based on the outcome, the company personnel along with the regional extension agents or pest control advisors discuss the best alternative method of control for the region. Modern insecticide labels emphasize implementing resistance management strategies and outline some specific guidelines.

Key Strategies for Insecticide Resistance Management:

- Avoid repeated sequential use of insecticides within a single mode of action for season-long control of any target insect species which has more than one generation per crop per season. Rotate with an insecticide with a different mode of action. For insect species with multiple or overlapping generations, the insecticide resistance management plan should utilize a “treatment window” approach. A treatment window is a period of time in the crop cycle in which the target pest are present at economically damaging levels and need to be treated. Within this treatment window (such as soil applications, early, mid and late crop foliar applications), single or multiple applications should be made.
- In this treatment window, prepare a plan utilizing insecticides with different modes of action and follow planned rotation guidelines, which are to be used only when pests are observed at economically-damaging levels. Always avoid using less than labeled rates of any insecticide when used alone or in tank mixtures. This is particularly important if the resistance is partially dominant. The full dose will need to be applied to ensure that no heterozygous genotypes survive to inbreed and give rise to homozygous resistant strains.
- Applications should target against early insect developmental stages or newly-emerged adults whenever possible. Early instars are easier to control than late-stage instars. The hard cuticle protects insect pupae from the effects of insecticides. Avoid treating insects when in the quiescent pupal stage (especially for pests which have a single-generation per crop cycle).
- When possible, encourage the availability of refugia (fallow lands, crop rotation, weeds or other alternate hosts) where susceptible populations can survive and interbreed with selected populations from crop areas.
- Integrate local IPM practices specific for the crop and use area, for preventing or delaying a pest’s ability to develop resistance. Use of “physical” toxicants such as oils, soaps etc. serve to counteract directional selection of modern, highly-selective insecticides such as pyrethroids, neonicotinoids or diamides.
- Tank mixtures which involve using two or more insecticides for the same target insect are not recommended. However, tank mixtures of pesticides which utilize two different modes of action against two different insects (or mites) are acceptable. Avoid using lower-than label rate tank mixtures.
- If field failures are common and resistance is a reasonable cause, immediately consult your local company representative or agricultural advisor for the best alternate method of control for your area and begin remedial measures.

Resources for Insect Resistance Management Information:

- Contact your local extension specialist, certified crop advisor and/or product manufacturer for additional insect resistance management recommendations.
- Product labels. Compare product labels which have a similar mode of action.
- Visit the Insecticide Resistance Action Committee (IRAC) website at <http://www.irac-online.org/> for more information on Mode of Action (MOA) classification and other relevant information on specific resistance management strategies.
- Visit the Michigan State University website which serves as a repository for all reported resistance cases www.PesticideResistance.com

***This document applies to synthetic insecticides and does not apply to PIPs (Plant Incorporated Protectants) or Insecticide Traits or Public Health Products**