Fall Armyworm (FAW) and Insecticide Resistance Management (IRM)

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Topics

- What & Why IRM?
- FAW IRM Strategy
- Best Practices & Resources
- How to ensure IRM successful?


Photo: Bayer Crop Science

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Insecticide Resistance Management (IRM)

"IRM refers to the strategies for delaying or suppressing increase in the pest population to overcome intended effects of a product such as insecticide or Plant Incorporated Protectant (PIP)"

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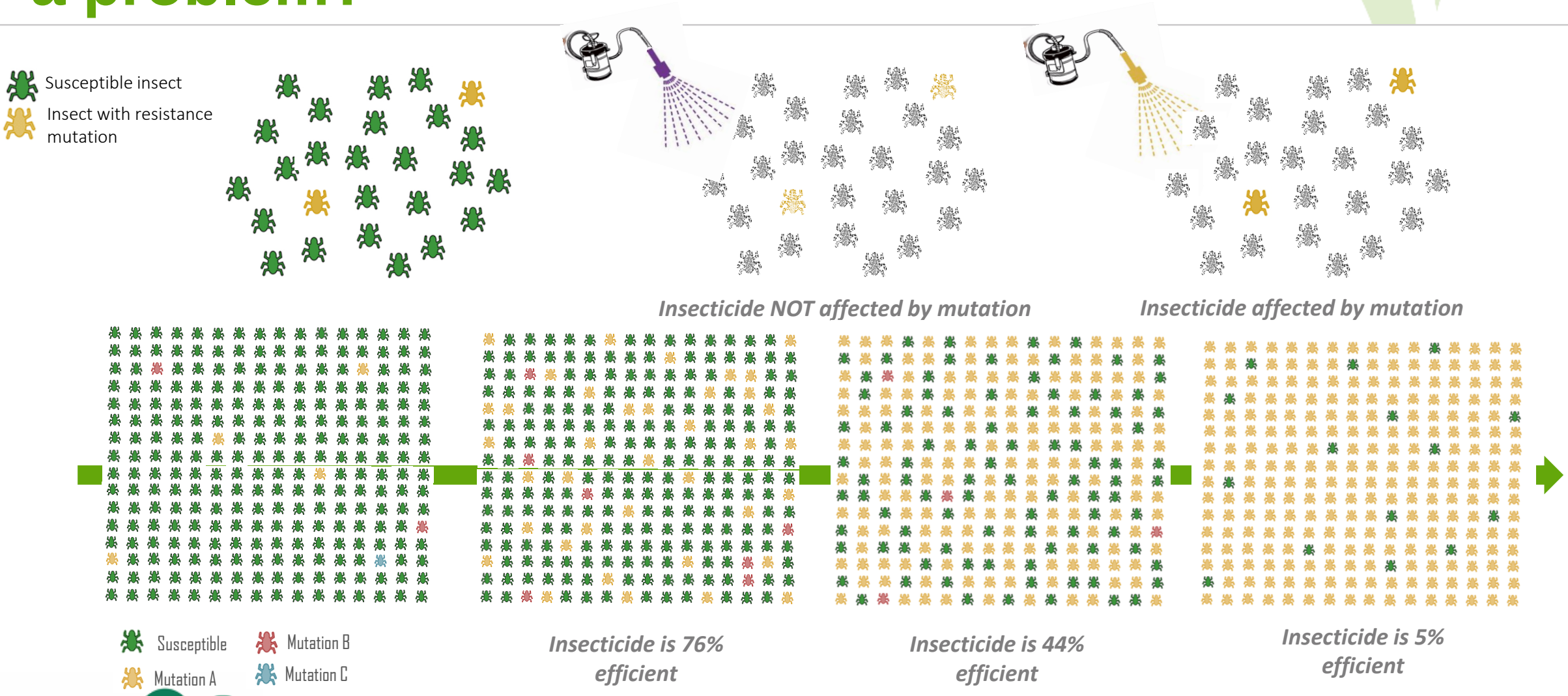
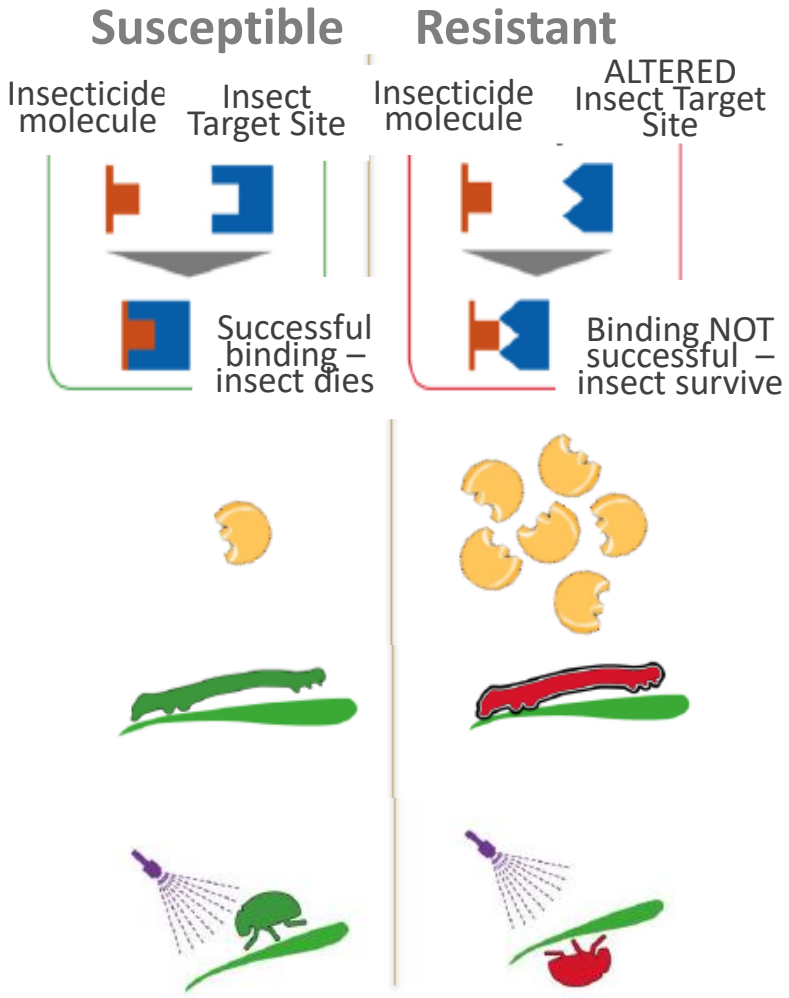
How does insecticide resistance become a problem?



Source: IRAC

Mechanisms of Resistance

1. Target Site Resistance
   - Insect can modify the shape of the protein and prevent the insecticide from interacting at the site of action when a mutation occurs in the receptor protein, causing resistance. Insecticides have specific site of action within an insect, usually a receptor protein.
2. Metabolic Resistance
   - Insect enzymes that break down unwanted molecules are either significantly increased in amount or modified to become more efficient to break down the insecticide.
3. Physical Adaptation
   - Insect adapt physically by protecting itself from the insecticide like thicker cuticle, extra waxy covering, or faster excretion of waste. Does not offer much protection but becomes more effective with other mechanisms.
4. Behavioral Adaptation
   - Insect behaviors changes like reduced exposure to the insecticide and allowing it to survive although not common.



Source: IRAC

IRM Prolongs the Effectiveness of an Insecticide or PIP)

- As industry, … ensure the product works effectively the longest possible time due to significant investments; product development/ introduction costs millions of dollars & takes ~10 years
- As regulator, … ensure effective and safe product is available
- As researcher/ extension agent, … ensure safe & effective product is available for recommendations
- As farmer, … ensure that crop is protected from pests, i.e. FAW

Source: IRAC

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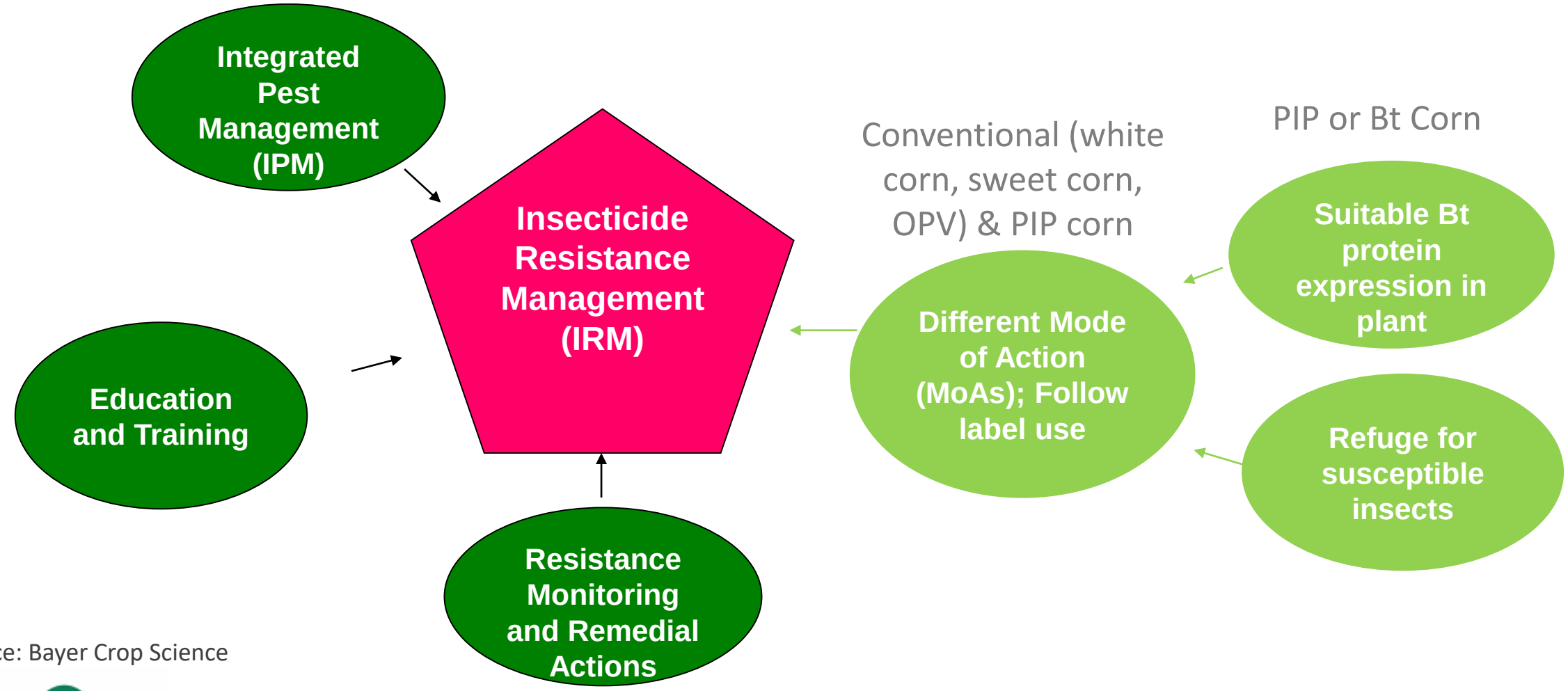
Elements of IRM

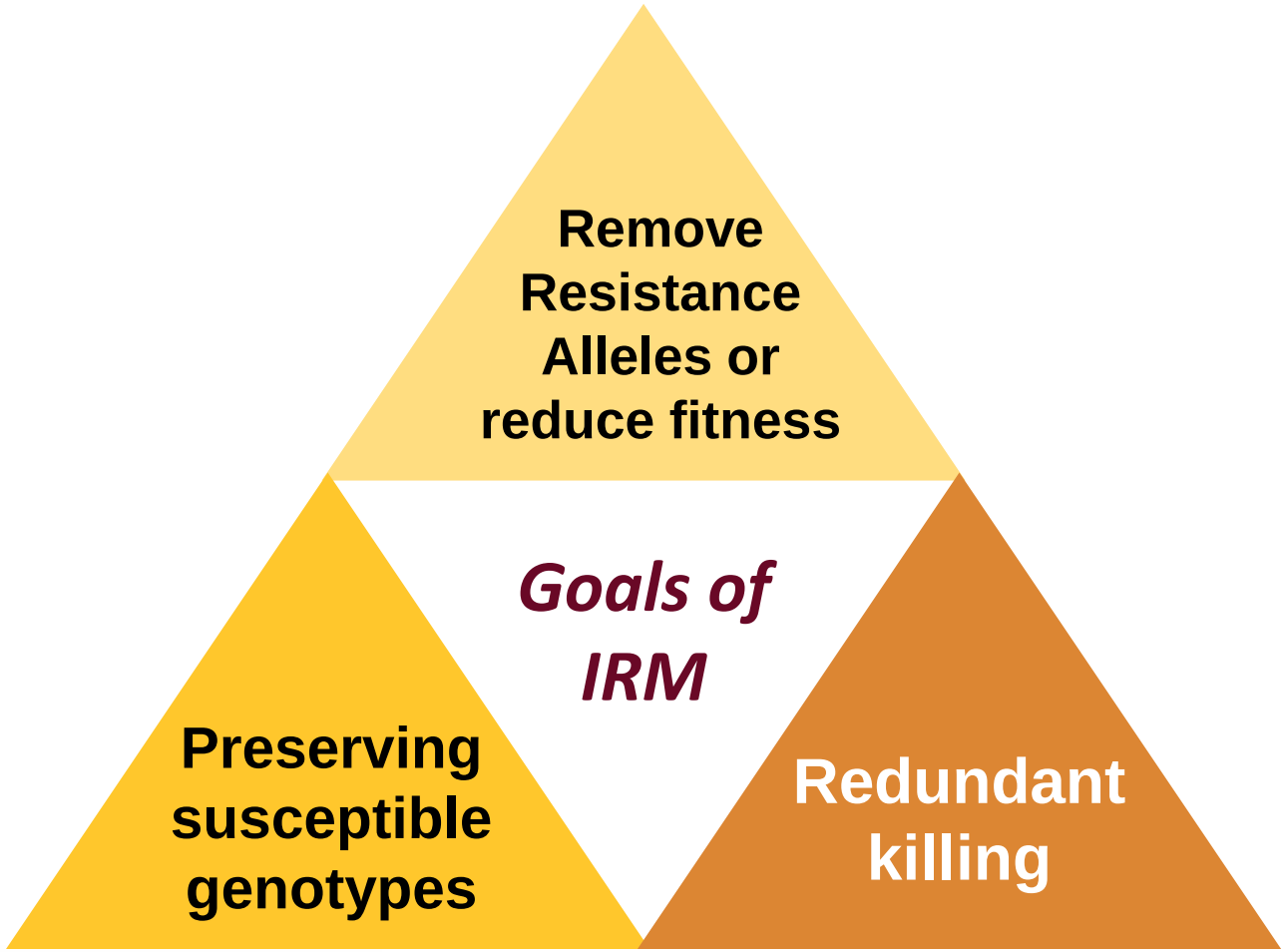


Source: Bayer Crop Science

IPM: Host Plant Resistance, Crop Rotation, Cultural Practices, Monitoring & Scouting, Threshold Based Sprays, Recommended Doses, Biological Control, Chemical, Plant Incorporated Protectant

How IRM be achieved?

The goals of IRM are dependent on pre-existing resistance at high frequencies within field populations or if it is being considered upon introduction of a new technology



// Increase dose, treat vulnerable stages, use AIs that confer low level of resistance, Use synergists, Mixtures with different Mode of Action (MoAs)

// Reliance on thresholds, reduced application rates, NO persistent products, untreated refuges, treat only specific stages

// Redundant killing through mixtures or sequential applications of different MoAs

Source: Bayer Crop Science

Conventional Corn: Use Insecticides with Multiple Mode of Action

Fertilizer and Pesticide Authority Approved Insecticides against FAW Including Mode of Action

No.	ACTIVE INGREDIENT	Mode of Action (IRAC)	MoA Group
1	THIODICARB	1. ACETYLCHOLINESTERASE (ACHE) INHIBITORS	1
2	CARBOSULFAN	1. ACETYLCHOLINESTERASE (ACHE) INHIBITORS	1
3	SPINETORAM	5. NICOTINIC ACETYLCHOLINE RECEPTOR (NACHR) ALLOSTERIC MODULATORS - SITE I	5
4	EMAMECTIN BENZOATE	6. GLUTAMATE-GATED CHLORIDE CHANNEL (GLUCL) ALLOSTERIC MODULATORS	6
5	BACILLUS THURINGIENSIS VAR. KURSTAKI	11. MICROBIAL DISRUPTORS OF INSECT MIDGUT MEMBRANES	11
6	BACILLUS THURINGIENSIS VAR. AIZAWAI	11. MICROBIAL DISRUPTORS OF INSECT MIDGUT MEMBRANES	11
7	LUFENURON	15. INHIBITORS OF CHITIN BIOSYNTHESIS AFFECTING CHS1	15
8	INDOXACARB	22. VOLTAGE-DEPENDENT SODIUM CHANNEL BLOCKERS	22

No	ACTIVE INGREDIENT	Mode of Action (IRAC)	MoA Group
9	CHLORANTRANILIPROLE	28. RYANODINE RECEPTOR MODULATORS	28
10	CYANTRANILIPROL	28. RYANODINE RECEPTOR MODULATORS	28
11	TETRANILIPROLE	28. RYANODINE RECEPTOR MODULATORS	28
12	CHLORANTRANILIPROLE +THIAMETHOXAM	28. RYANODINE RECEPTOR MODULATORS & 4. NICOTINIC ACETYLCHOLINE RECEPTOR (NACHR) COMPETITIVE MODULATORS	28 & 4
13	PYRIDALYL	UN COMPOUNDS OF UNKNOWN OR UNCERTAIN MOA	
14	(Z)-9-TETRADECENYL ACETATE	Unknown	
15	(Z9.E12) 9,12-TETRADECADIEN-1-OL	Unknown	

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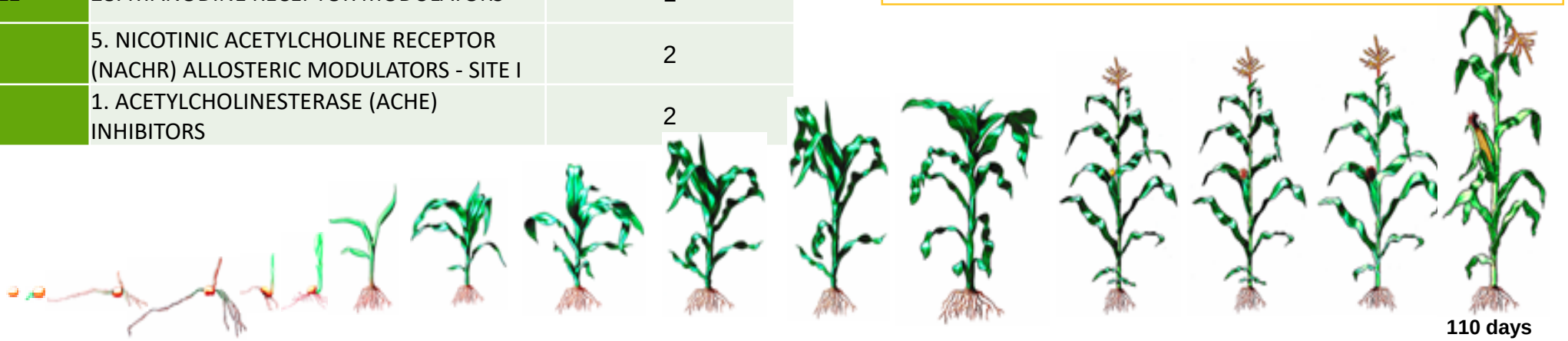
Sources:
Fertilizer and Pesticide Authority, list of approved insecticides as of Oct. 2020
IRAC, MoA group

Conventional Corn: Use Insecticides with Multiple Mode of Action

Example of Spray Program

Active Ingredient	Mode of Action Group (IRAC)	MoA
TETRANILIPROLE	28. RYANODINE RECEPTOR MODULATORS	1
CHLORANTRANILIPROLE	28. RYANODINE RECEPTOR MODULATORS	1
CYANTRANILIPROLE	28. RYANODINE RECEPTOR MODULATORS	1
SPINETORAM	5. NICOTINIC ACETYLCHOLINE RECEPTOR (NACHR) ALLOSTERIC MODULATORS - SITE I	2
THIODICARB	1. ACETYLCHOLINESTERASE (ACHE) INHIBITORS	2

- Always follow label recommendations
- Start early applications/ based on threshold
- Use different MoA
- ~7 Days Spray interval under high infestation, depending on product



Window 1 (0-30 days) | **Window 2 (30-60 days)** | **Window 3 (60-90 days)**

Seed Treatment MoA 1	Foliar Spray MoA 2	Foliar Spray MoA 1	Foliar Spray MoA 2

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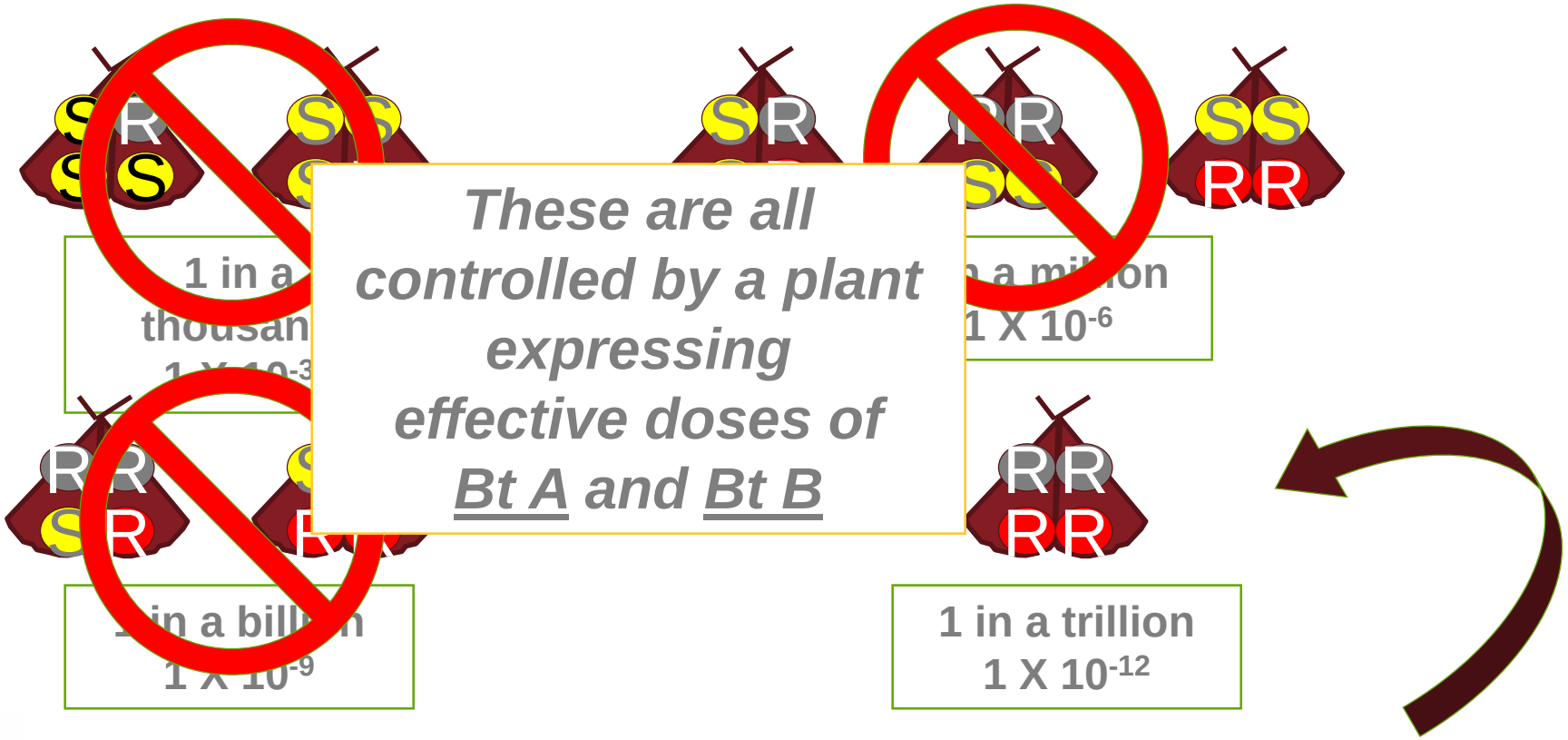
Sources:
- Fertilizer and Pesticide Authority for list of insectides
- IRAC for Mode of Action
- Bayer Crop Science for Corn Growth Stage

In PIP (Bt Corn) : Use Multiple Mode of Action and effective dose to remove resistance alleles

- Resistance allele frequency for **Bt *A*** R **= 1 in a thousand**
- Resistance allele frequency for **Bt *B*** R **= 1 in a thousand**



- ***Refuge must be adequate for one-in-a-trillion survivor***

Source: Bayer Crop Science

In PIP (Bt Corn) : Use refuge or non-Bt corn to preserve susceptible insects

- Maintain a population of insect pests not exposed to Bt proteins
- Lack of exposure to Bt proteins allows susceptible insects to mate with rare resistant insects that may emerge
- Susceptibility to Bt technology passed on to offspring, helping preserve long-term effectiveness Bt corn

Source: Bayer Crop Science

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Case: Philippines IRM Strategy for PIP Bt Corn, focused on Asian Corn Borer (ACB)

Dose, refuge, Two MoAs	// Dual mode of action and effective dose drives excellent to good control against target pests // Refuge, Refuge In Bag (RIB) ensures refuge compliance

Resistance Monitoring	// Sentinel sites planted annually to monitor pest damage besides other non-targets
	// Resistance monitoring assays done annually and reports submitted to BPI
	// F2 studies – investigate non-recessive resistance in ACB

Surveys and outreach	// National IRM surveys – every two years (Cross-Industry effort)
	// Outreach – Crop Life Philippines, IRAC Asia/CLA, BCP
	// Protocols, guidelines review, annual activities

Next gen Tech and modeling	// Resistance Modeling for enhanced IRM plan – refuge increase in RIB // Next generation technology advancement in progress

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Enhanced IRM Strategies being discussed by various stakeholders through seminars and workshops

Seminar-Workshop on Updates on IRM Strategy for GM Crops in the Philippines on February 26-27, 2020.

Bureau of Plant Industry & Fertilizer and Pesticide Authority Workshop on the Harmonization of Guidelines on February 11-13, 2020

Source: http://biotech.da.gov.ph

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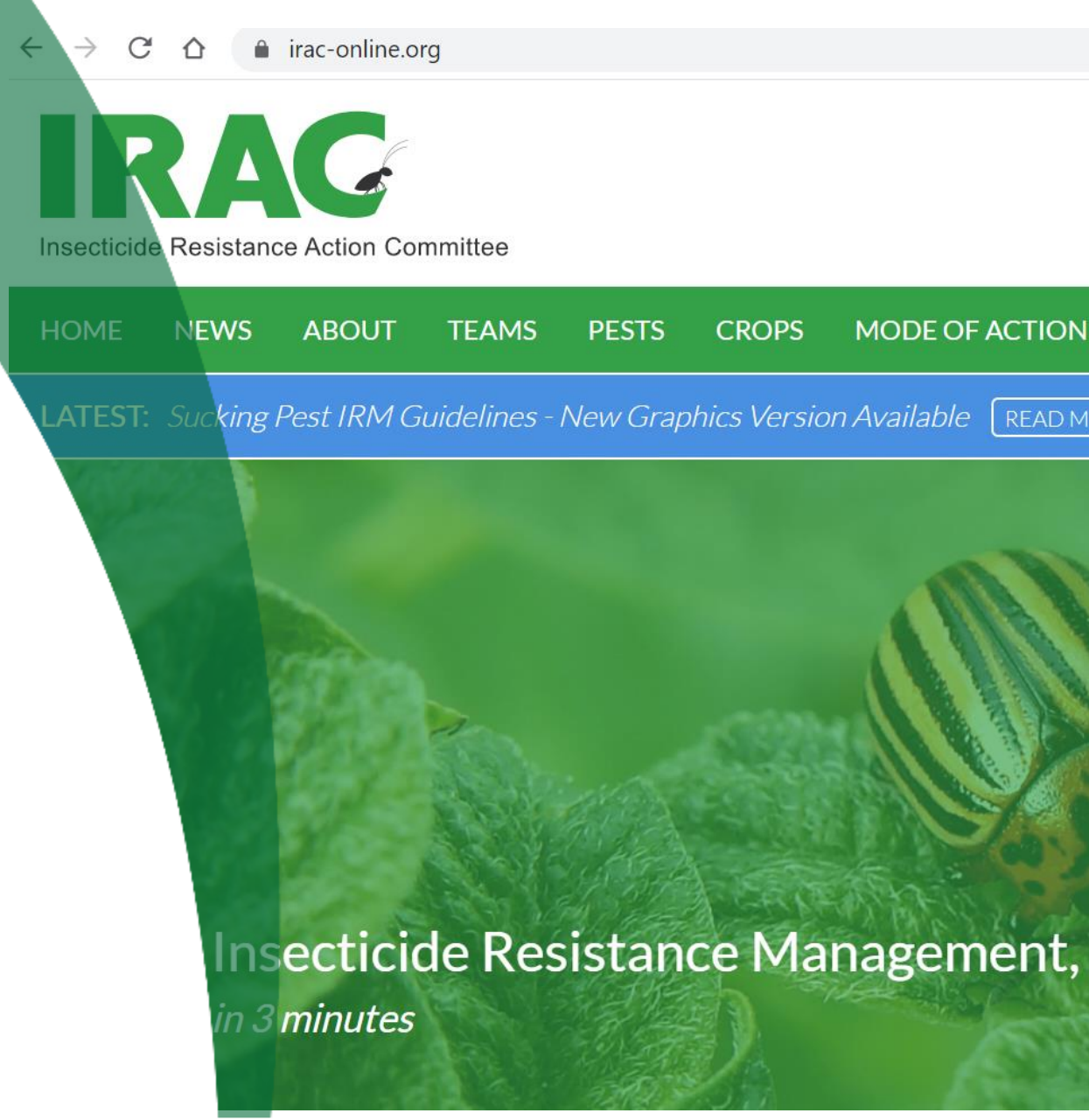
Resources

1. Insecticide Resistance Action Committee https://irac-online.org/
2. CABI www.cabi.org/isc
3. CropLife Philippines https://www.croplife.org.ph/
4. Department of Agriculture, Provincial/ City/ Municipal Agriculture Offices
5. Research agencies, universities, and extension offices
6. Industry or company resource/ representatives



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Recommendations for Successful IRM

1. IRM Strategy should be holistic and enhanced by relevant stakeholders
   - should cover insecticides and Plant Incorporated Protectant in corn
   - focus can be identified based on risk assessment of pest biology/ habits & products
2. Information dissemination and tracking can be intensified, i.e. digital tools
3. Farmers should follow the IRM recommendations

BPI-FPA SEMINAR AND HARMONIZATION WORKSHOP

DOST-PCAARD, Jamboree Rd, Los Baños, Laguna

The Bureau of Plant Industry in collaboration with the DOST- Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) has organized Bureau of Plant Industry (BPI)-Fertilizer and Pesticide Authority (FPA) Seminar Workshop on the Harmonization of Guidelines on February 11-13, 2020 at DOST, PCAARRD

The said seminar-workshop aims to (1) finalize the draft BPI-FPA Joint Field Trial Guidelines, (2) streamline the Plant-Incorporated Protectant (PIP) registration and Insect Resistance Management (IRM) data requirements, and (3) draft guidelines for the procedure on label expansion.

During the workshop, three draft guidelines have been prepared. It was agreed that BPI and FPA will present the draft documents to the head of respective agencies for review and comments before proceeding to stakeholder's consultation.



IRM Monitoring

Table 1. Places and number of Farmers
Table 2a. Extent of Bt Corn Adoption
Table 2b. Aggregated Data Bt Corn Adoption
Table 3. Occurence and Damage of ACB
Table 4. Occurrence of Other Pests
Table 5. Designated Monitoring Sites and Responsible Persons

Source: http://biotech.da.gov.ph/News.php

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Thank you.

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