Diamide Resistance Updates – Contributing Factors and Some Learnings from the Philippines

IRAC Philippines  Diamide Working Group

Sixth International Workshop on Management of the Diamondback Moth and Other Crucifer Insect Pests

Kasetsart University, Thailand
March 23, 2011
IRAC Philippines Diamide Working Group
Formed in 2009

Presently, under the umbrella of CropLife Philippines Product Stewardship Committee

Closely coordinating with IRAC International and IRAC SEA on resistance management programs
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Intensive Commercial Production Areas of Cabbage

- Ilocos
- Benguet
- Bukidnon
- Davao
- Cebu
# Registered and Commonly Used Insecticides in Vegetables

<table>
<thead>
<tr>
<th>Chemical Sub-group</th>
<th>Active ingredient</th>
<th>Mode of Action</th>
<th>Main Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organophosphates</td>
<td>Profenophos, Malathion</td>
<td>AChE inhibitors</td>
<td>1</td>
</tr>
<tr>
<td>Pyrethroids</td>
<td>Deltamethrin, Cypermethrin, Fenvalerate</td>
<td>Sodium Channel modulators</td>
<td>3</td>
</tr>
<tr>
<td>Avermectins</td>
<td>Abamectin</td>
<td>Chloride Channel Activators</td>
<td>6</td>
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<tr>
<td>Indoxacarb</td>
<td>Indoxacarb</td>
<td>Sodium Channel blockers</td>
<td>22</td>
</tr>
<tr>
<td>Diamides</td>
<td>Flubendiamide, chlorantraniliprole</td>
<td>Ryanodine receptors modulators</td>
<td>28</td>
</tr>
<tr>
<td>Spinosyns</td>
<td>Spinosad</td>
<td>nAChr allosteric activators</td>
<td>5</td>
</tr>
<tr>
<td>Diafenthiuron</td>
<td>Diafenthiuron</td>
<td>Mitochondrial ATP synthase inhibitors</td>
<td>12</td>
</tr>
<tr>
<td>Nereistoxin analogues</td>
<td>Cartap</td>
<td>nAChr channel blockers</td>
<td>14</td>
</tr>
</tbody>
</table>
DIAMIDES – What are they?
DIAMIDES

Main Group and Primary Site of Action – Ryanodine Receptor Modulator

Active Ingredients

- Chlorantraniliprole
- Flubendiamide
Current Diamide Registrations in the Philippines
Chemical subgroup: Diamides

Flubendiamide and Chlorantraniliprole were registered in 2006 and 2007 respectively.
Crop: Cabbage
Report: Reduced efficacy against DBM in Cebu (September 2010)
Intensive Commercial Production Areas of Cabbage

- **Ilocos**
  - Elevation: 100-2845 ft
  - Temp.: 25-28 deg.C

- **Benguet**
  - Elevation: 1,500-3,900 ft
  - Temp.: 18.5-23 deg.C

- **Bukidnon**
  - Elevation: 100-2845 ft
  - Temp.: 25-28 deg.C

- **Cebu**
  - Elevation: 1,500-3,900 ft
  - Temp.: 18.5-23 deg.C

- **Davao**
  - Elevation: 100-2845 ft
  - Temp.: 25-28 deg.C

Cabbage is planted throughout the year.
DuPont in-house Program

Highly susceptible FIELD populations from Calauan, field La Trinidad, and field Liliw

<table>
<thead>
<tr>
<th>Country</th>
<th>Location</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philippines</td>
<td>Buguias, PHIL</td>
<td>4</td>
<td>1</td>
<td>3</td>
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<tr>
<td></td>
<td>Calauan, PHIL</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>La Trinidad, PHIL</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Liliw, PHIL</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial Year Total</td>
<td></td>
<td>6</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Philippines Total</td>
<td></td>
<td>18</td>
<td></td>
<td></td>
</tr>
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</table>

Proposed DC Rates:
DC1 = 1 ppm (LC\textsubscript{95})
DC2 = 5 ppm (5x LC\textsubscript{95})
Susceptible Populations:
Those with susceptibility level similar to that of susceptible field populations $\Rightarrow \geq 95\%$ mortality @ 1 ppm

1 ppm = LC95 of susceptible field populations

5 ppm = 5x LC95 of susceptible field populations

- Significant survivorship (i.e. 20%) at this rate is indicative of incipient problems and greater risk of resistance developing quickly.
- Requires more intense education and IRM implementation at the field level.
Philippines – *Plutella xylostella*
(IRAC Bioassay Method No. 018):
Overall Summary of Results from 2010 QI Field Monitoring Survey

**Proposed DC Rates** (based on data from Susceptible Populations):

DC1 = 1 ppm (susceptible strain LC$_{95}$)
DC2 = 5 ppm (5x LC$_{95}$)

<table>
<thead>
<tr>
<th>Counts of data points</th>
<th>2010</th>
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<tr>
<td>Rate2 = 1</td>
<td>16</td>
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<tr>
<td>Rate3 = 5</td>
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Field Location: Sudlon2, Cebu (2010)

Plutella xylostella-Potency Comparison
Chlorantraniliprole (solid) vs Flubendiamide (dashed)

Sudlon2, Cebu:
• Chlorantraniliprole:
  1 ppm: 34% mortality (1 rep only)
  5 ppm: 38% mortality (1 rep only)
• Flubendiamide:
  1 ppm: 16-31% mortality
  5 ppm: 13-28% mortality
Field Location: Dumalan-Dalaguete, Cebu (2010)

**Chlorantraniliprole (solid) vs Flubendiamide (dashed)**

- **Dumalan-Dalaguete, Cebu**
  - **Chlorantraniliprole:**
    - 1 ppm: 28-34% mortality
    - 5 ppm: 41-59% mortality
  - **Flubendiamide:**
    - 1 ppm: 34-38% mortality
    - 5 ppm: 47-63% mortality
Background

- Responding to the report of lower sensitivity of DBM in Cebu to Diamide insecticides, the IRM-Diamide WG Philippines team launched a quick farmers' survey to learn about possible influencing factors.

- Data was gathered from 100 cabbage growers in Cebu on August 20-24, 2010.
Profile of Representative Cabbage Growers in the Cebu, Philippines
Usage of Diamide Insecticides

- Among the 100 cabbage farmers interviewed:
  - More than half (54%) claimed to have experience using both Flubendiamide and Chlorantraniliprole
  - 19 farmers confirmed using only Flubendiamide as their diamide brand, 26 claimed using Chlorantraniliprole exclusively
  - 10 farmers mentioned using Chlorantraniliprole + Thiamethoxam

Incidence of use

- Use of diamide compounds among cabbage growers is very pronounced
- Flubendiamides and Chlorantraniliprole are the more popular compounds being used
- Use of multiple (at least 2) diamide brands may suggest rotation only within the diamide family
Usage of Diamide

- Amongst the 100 cabbage farmers interviewed:
  - Insecticide applications for cabbage per season reaches a maximum of 12 sprays per season
  - Out of these 12 sprays, 63% are of Flubendiamides; while 55% are of Chlorantraniliprole

Frequency of spray

- Share of Flubendiamide slightly ahead over Chlorantraniliprole, in terms of % share of sprays
Evaluation of Flubendiamide

- Among those who have used Flubendiamide:
  - Average dose rate per spray is at 6.45ml
  - Majority (61%) found the efficacy and control of Flubendiamide at around 50 to 80 percent; while 16% rated Flubendiamide at 80 to 100 percent control
  - Majority (at 52%) still placed Flubendiamides residual effect at 4-7 days, while 41% of users claimed residual effect of 7-14 days

Dosing

- Average dose rate slightly exceeds the recommended dose (3-5ml)
- Those who rated Flubendiamides at around 50-80 percent efficacy were found to be overdosing more, at 7.38ml
Evaluation of Chlorantraniliprole

- Amongst those who have used Chlorantraniliprole:
  - Average dose rate per spray is at 17.57ml
  - Around 33% of farmers who have used the brand rated the efficacy at 80-100 percent; 40% meanwhile said efficacy is only at 50-80 percent.
  - Same with Flubendiamide, a big majority of Chlorantraniliprole users (at 73%) placed the residual effect at 4-7 days. Higher residual effect (7-14 days) for Chlorantraniliprole was at 23%.

Dosing

- Overdosing also being practiced for Chlorantraniliprole (15 ml), especially by those who rated the efficacy at 80-100 percent (19.30 ml)
Rotation

- Very few practice rotation with other compounds
  - Very few practice diamide rotation with compounds from other chemical classes/modes of action
  - Their habit tells us that brand rotation is more pronounced than compound/mode of action rotation

- Likewise, incidence of tank-mixing with other insecticide compounds, with different modes of action, is very low
- In some cases there was mention of fungicides as well as insecticides in the tank-mix
## Summary of Survey Findings

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Incidence of use</td>
<td>High incidence of diamide use</td>
</tr>
<tr>
<td>Frequency of spray</td>
<td>12 sprays in a season; around 70% or higher uses diamide products</td>
</tr>
<tr>
<td>Rotation</td>
<td>Rotation with compounds from other chemical classes/modes of action is generally not practiced</td>
</tr>
<tr>
<td>Dosing</td>
<td>Observed overdosing</td>
</tr>
</tbody>
</table>

*Based on survey of 100 farmers in Sudlon Cebu*
Recommendation

- A more comprehensive study program needs to be carried out in order to arrive at more conclusive results and sound recommendations for the use of Diamide insecticides in conjunction with crop protection products from other modes of action as well as other insect resistance management strategies.
Other things to be considered
Other things for consideration...

- Diamides were first introduced in the highlands of Northern Philippines (Benguet area) and have been successfully used since 2006.

- Monitoring programs have shown that susceptibility levels in the area is still higher compared to the hotspots of Central Philippines (Cebu in the Visayas).

- The DBM is an excellent adaptor and survivor allowing them to proliferate under different situations that will favor their reproduction.
Other things for consideration…

- Companies have approached resistance management as individual entities not as a coordinated group.
- Even if there are programs, these are not sustained long enough and wide enough to really make a considerable impact.
- Other crops/plants that serve alternate host continuously exist in the farm.
- Products available for use in the market will not be used by the farmers unless there is active promotion of programs for resistance management.
Other things for consideration…

• The industry cannot do it alone….

• THERE IS A NEED FOR ALL STAKEHOLDERS TO WORK TOGETHER FOR OUR GOOD INTENTIONS TO WORK
Sustainable production of good quality and high yielding vegetables
Acknowledgement

Our working group would like to acknowledge IRAC International and IRAC SEA in supporting our efforts in promoting insect resistance management in vegetables.
THANK YOU FOR YOUR ATTENTION

Maraming Salamat Po