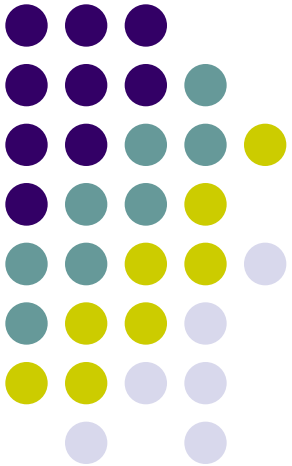
Update on DBM diamide resistance from Thailand: causal factors and learnings

Sukonthabhirom,S; Dumrongsak,D; Jumroon,S; Saroch,T; Chaweng,A; Tanaka,T



Status of diamide resistance in DBM

- **DBM larvae in Thailand** are historically notorious for their **speed of developing resistance to new products.**

Diamide insecticides observed

- Flubendiamide
  - Takumi 20%WDG
    - (Field recommended dose = 6 g/20 L (=60 ppm ai))

- Chlorantraniliprole
  - Prevathon 5% SC
    - (Field recommended dose = 30 ml/20 L (=75 ppm ai))

Thailand: Areas of Diamide Resistance by DBM

1. Bang Bua Thong district, Sai Noi district , Nonthaburi province.
2. Sali, Songphinong district , Suphannburi province.
3. Tha muang district , Kanchanaburi province. 4. Lat Lum Kaew district, Pathum Thani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Thailand - Diamondback Moth “R” to flubendiamide occurred in 15 months
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DBM was the target for diamide insecticides

- Insects targeting with the Diamide: mainly DBM
  - *Spodoptera exigua* and *S. litura:* farmers less concerned because they can use Ammate, Success or Rampage to control them.

The first diamide insecticide in Thailand

- **Flubendiamide** (Takumi® 20WDG) insecticide, representing the IRAC Mode of Action Group 28, **was registered in Thailand in May, 2007.**

- At that time, **Takumi**® was a novel diamide product that offered growers **excellent control of diamondback moth** and other lepidopteran larvae in a crucifer market where few other insecticides were adequately effective.

Other insecticides in markets for DBM control

- The products in markets for DBM control

Ammate -(indoxacarb)	not effective for DBM
Success -(Spinosad)	not effective for DBM
Abamectin -	not effective for DBM
Rampage (chlorfenapyr)	not effective for DBM
Pleo - (pyridalyl)	effective in some area
Pegasus - (diafenthiuron)	effective in some area
Hachi Hachi - (tolfenpyrad)	some effectiveness.

- Growers are willing to rotate to other chemistries if they are effective

Thai farmer practice

- The period from planting until harvest of Chinese kale or Chinese radish is about 50-60 days

- Farmers will **start DBM sprays 15 -20 days post planting** **on a 3-5 day spray interval** **(high infestation could mean 10 sprays per cropping season).**

Thai farmer practice

- Most farmers alternate with the existing insecticides in the markets, however most insecticide partners gave no maximum protection of DBM.

- At that time, farmers used flubendiamide at the recommended dose of 4-6 g prod/20 L (with long hose high pressure pump).

Field recommended dose of flubendiamide 20%WDG has been increasing in Thailand

Year	g/20 liter	a.i. (ppm)
2007	4-6 g	40-60
2009	6-8 g	60-80
2011	>12 g	>120

Susceptibility of diamide insecticide to DBM from literature

- Flubendiamide
  - EC50 = 0.004 mg ai/liter from Japan
    - (Tohnishi et al.,2005) *J. Pestic. Sci.*, **30**(4), 354–360.

- Chlorantraniliprole
  - LC50 = 0.050 ppm (technical bulletin of Rynaxypyr)
  - LC50 = 0.221 - 1.104 mg ai/liter from China
    - (Wang, X. et al.,2010) *J. Econ. Entomol*. 103(3): 843-848.

Thailand - Diamondback Moth "R" to flubendiamide occurred in 15 months and is cross "R" to Rynaxypyr® not yet registered.

Status of diamide resistance of DBM in Thailand (year 2008-2010)

- For flubendiamide and chlorantraniliprole in **2008-2010**

Insecticide	Population[1]	LC50 (mg/liter) (95%FL)	RF[2]
Flubendiamide	Tub Berg	**0.160 (0.0366-0.811)**	**-**
	Tha Muang	**0.246 (0.113-0.593)**	**1.5**
	Sai Noi	**10.6 (3.84-22.8)**	**66.3**
Chlorantraniliprole	Tub Berg	**0.225 (0.0535-0.587)**	**-**
	Sai Noi	**7.97 (4.09-13.7)**	**35.4**

[1] Tha Muang, Tub Berg, and Sai Noi population was tested in 2008, 2009, and 2010 respectively.

[2] Resistance factor = LC50 of a population / LC50 of the Tub Berg population, the most susceptible field population in 2009.

Status of diamide resistance of DBM in Thailand (Feb-Mar 2011)

- For flubendiamide in **2011**

Insecticide	Population	LC50 (mg/liter) (95%FL)	RF[2]
Flubendiamide	Tub Berg[1]	0.160 (0.0366-0.811)	-
	Tha Muang	770.776 (123.325-26336.853)	4,817
	Sai Noi	65.148 (2.706-157.405)	407
	Lat Lum Kaew	4,256.6 (2690.1-9373.2)	26,603

[1] Tub Berg population was tested in 2009.

[2] Resistance factor = LC50 of a population / LC50 of the Tub Berg population, the most susceptible field population in 2009.

Status of diamide resistance of DBM in Thailand (Feb-Mar 2011)

- For chlorantraniliprole in **2011**

Insecticide	Population[1]	LC50 (mg/liter) (95%FL)	RF[2]
Chlorantraniliprole	Tub Berg[1]	0.225 (0.0535-0.587)	-
	Tha Muang	19.739 (7.317-92.434)	87
	Sai Noi	34.364 (12.053-60.586)	152
	Lat Lum Kaew	174.438 (137.081-219.782)	775

[1] Tub Berg population was tested in 2009.

[2] Resistance factor = LC50 of a population / LC50 of the Tub Berg population, the most susceptible field population in 2009.

The diamide resistance of DBM in Thailand has been increasing

- Increased RF of DBM to **flubendiamide** from past to present
  - Tha Muang: RF **1.5 → 4,817** (Year 2008-2011)
  - Sai Noi : RF **66.3 → 407** (Year 2010-2011)

- Increased RF of DBM to **chlorantraniliprole** from past to present
  - Sai Noi: RF **35.4 → 152** (Year 2010-2011)

The field recommended dose of diamide insecticide should be reconsidered

- Field recommended dose from the bottle label of **flubendiamide** to DBM is **60 ppm** ai
  - Tha Muang: LC50 = **771 ppm** (Year 2011)
  - Sai Noi : LC50 = **65 ppm** (Year 2011)
  - Lat Lum Kaew: LC50 = **4,256 ppm** (Year 2011)

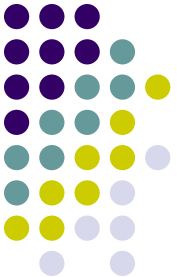
- Field recommended dose from the bottle label of **chlorantraniliprole** to DBM is **75 ppm** ai
  - Lat Lum Kaew: LC50 = **174 ppm** (Year 2011)

Resistance mechanisms to diamide insecticides need to be clarified

- It **is speculated that metabolic mechanisms play a major role** in the **development of insect resistance to diamide insecticides** in Thailand.

- The breadth of **cross resistance** of diamide insecticide needs to be investigated.

Causal factors of diamide resistance in Thailand



- **Continuous plantings** of crucifers

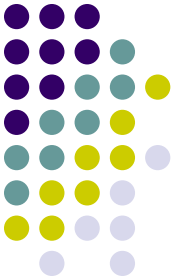
- High selection pressure from **frequent spraying**

  (over-dependency on a single mode of action)

  (Farmers used flubendiamide **more than 4 to 5 times per crop)**

- Crucifer growers **minimally rotate to other non-crucifer crops** such as chili and lettuce

Causal factors of diamide resistance in Thailand



- Farmers **always use tank mix** with other insecticides **to control the same target pest and other pests at the same time** to reduce labor cost for spraying.

- **Tank mix** used by farmer **could increase severity of multiple/cross resistance** in DBM, if it has already obtained high frequency of resistance gene.

- Currently, **IRM information** for DBM is not available to Thai growers.

In summary

- The resistance of DBM to diamide insecticide has been increasing dramatically.
- Effective insecticide partners for rotation in spraying program have to be investigated and recommended.
- Crop rotation and IPM should be performed to decrease selection pressure.
- Need to establish IRM strategy and transfer to farmers.

Acknowledgments

- Office of Plant Protection Research and Development, Thai Department of Agriculture

- TJC company for supplying flubendiamide

- DuPont company for supplying chlorantraniliprole and supporting my registration fee for this workshop

THANK YOU