Advances in insect pest management on vegetables

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Resistant Varieties (Examples)

Eggplant

- **Leafhopper resistant eggplant varieties**
  - ***Manjari Gota*, *Vaishali*, and *Mukta Kesi* are reported to be less susceptible**

Eggplant

- **Eggplant fruit and shoot borer resistant eggplant varieties**
  - **Pusa Purple Long, Banaras Long Purple and Turbo reported to be tolerant or resistant**

Eggplant

- **Spotted (*Epilachna*) beetle resistant eggplant varieties**
  - **Arka Shirish, Hissar Selection 14 & Shankar Vijay**

Tomato

- **Tomato Yellow Leafcurl Virus**
  - **TYLCV-resistant and tolerant tomato varieties for some strains of the virus are commercially available**
  - ***Sankranthi*, *Nandi*, and *Vybhav***

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Thrips resistant peppers

Seedling Protection

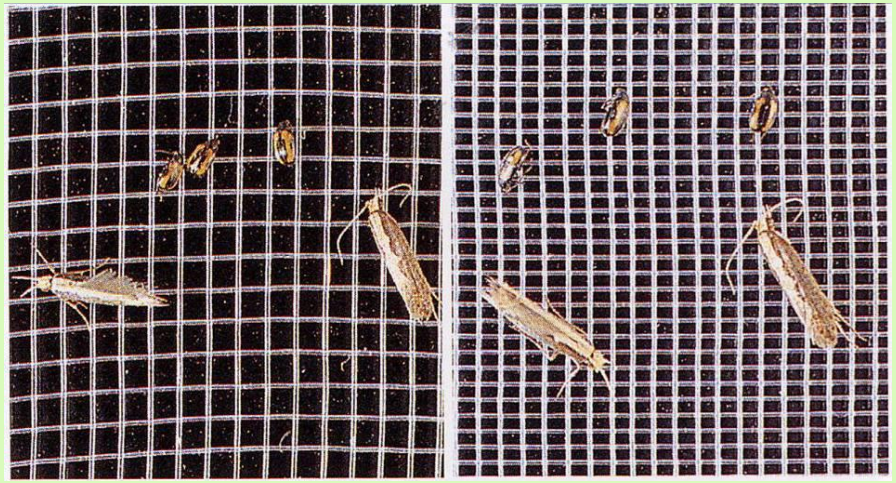
- **Seedling Protection through net-tunnels (individual farmer's level)**
- **Protects the seedlings against early season sucking pests such as aphids, whiteflies, thrips and leafhoppers**

Seedling Protection through net-houses (community level)

Cover crucifer seedlings with a fine nylon mesh net to prevent diamondback moth adults laying eggs on their leaves

This method will postpone DBM infestation, reduce the need for control measures so early in the season and help in conservation of natural enemies

It would also reduce the flea beetles.



Existing cabbage crop

Cabbage seedling production

- Plant seedbeds away from old plant stalks
- Destroy the old plant stalks


Eggplant seedlings grown under small net-tunnels to prevent insect infestation

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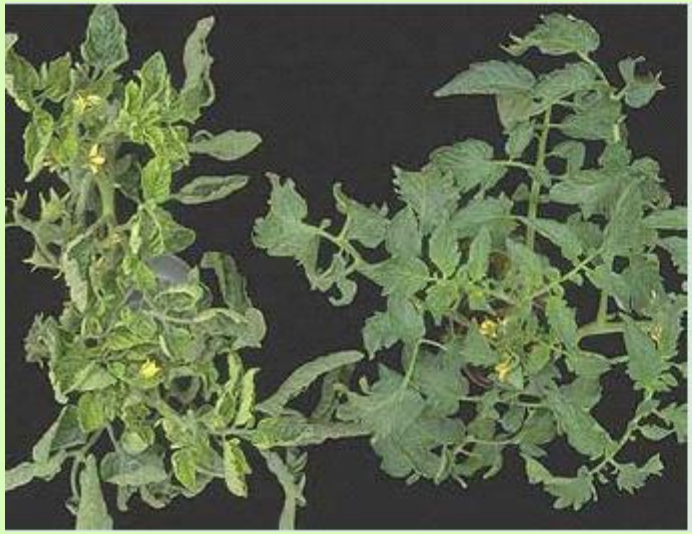


Grow seedlings in an insect-proof net-tunnel (50-mesh size or finer) to prevent early infection of seedlings by whitefly feeding. If non-insect proof nets are used, spray insecticides to control entry of whitefly into the structures.

Soil drenching of tomato seedlings with imidacloprid or neem could protect the crop from whitefly. A subsequent spraying after few weeks will prolong the protection



Maintain seedbeds away from cropped areas and from other susceptible plants

Protect transplants with mesh netting (40-mesh or higher) to exclude thrips

Cabbage webworm (*Hellula undalis*) attacks only the growing point. Thus only seedlings, up to 4 weeks after transplanting, need protection

Soil application of granules at the time of transplanting as well as sprays once every 2 weeks after first application within 3 days after transplanting is effective

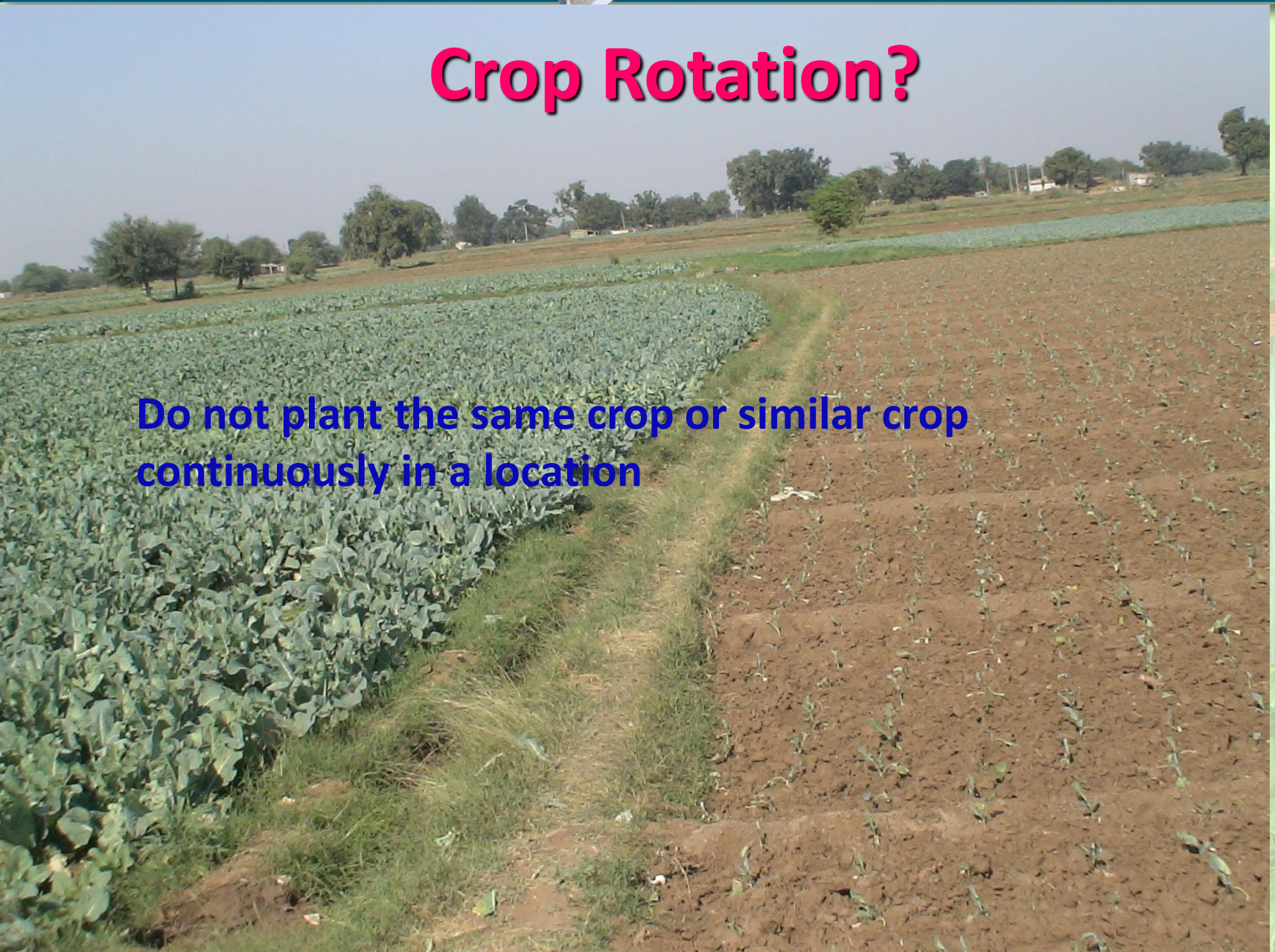
Beanflies

The critical period is the first three to four weeks after germination of legume (*e.g.*, yard-long bean) seedlings

- Weekly spraying of systemic pesticides during the first four weeks is effective against beanflies
- Banding of systemic insecticides along the seeds at sowing gives satisfactory control
- Seed coating with carbofuran or carbosulfan before sowing protects plants against bean flies for two to three weeks. One or two additional sprays may be necessary to further protect the crop

Cultural Control

Crop Rotation?



Do not plant the same crop or similar crop continuously in a location

Crop Rotation

- As EFSB feeds almost exclusively on eggplant, crop rotation can be effective. Stopping planting within a community for 2 seasons will reduce the pest population substantially

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- **Planting of vegetable legumes after a green manure or braasica crop would reduce the incidences of bean fly**

Leafy brassica

Vegetable legume

- Rotate the tomato crop (susceptible) with other crops such as grasses or brassicas (tolerant), followed by onion (resistant) and then dry fallow during hot, dry weather if possible to manage root-knot nematode

- **Avoid overlapping tomato crops that allow the whitefly to subsist and develop new populations which would spread the TYLCV disease**

Tillage

- Repeated ploughing of the soil at the end of the growing season during hot, dry weather of the fallow period exposes root-knot nematodes to desiccation and death

Manuring

- Adding organic matter to the soil reduces nematode populations
- The effectiveness of a soil amendment depends on ammonia production. The amount of ammonia produced varies with the level of nitrogen in the organic amendment

  e.g., Oil-cakes and animal manures have high nitrogen contents of 2–7% and are the most nematicidal amendments but they must be applied at 4–10 t/ha to be effective

Solarization

- Solarization for 4 to 8 weeks in small gardens is also possible. It is most effective when conducted during the hottest season of the year. Most plant parasitic nematodes are killed between 44 and 48°C. The depth of penetration with solarization is about 5 to 10 cm

Mulching

- Less infestation of aphids on vegetable brassicas in mulched plantings
- Use mulches of rice straw, yellow plastic or UV-reflective material to reduce landing of whitefly in tomato

- Mulching with rice straw enhance plant growth and induce tolerance to bean fly damage
- Mulching with rice straw reduce the damage of thrips on onion

Irrigation

- Flooding of the soil before planting would reduce the incidences of flea beetle in vegetable brassicas and *S. litura* in different vegetables

- **Overhead irrigation/Sprinkler irrigation reduces DBM damage in cabbage**

- **Increasing the quantity of irrigation water would reduce the incidences of thrips on onion**

- **In-row sprinkler irrigation would reduce the incidences of thrips on onion**

- **Overhead sprinkler irrigation would also reduce the incidences of thrips on onion**

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Trap crops & Barrier crops

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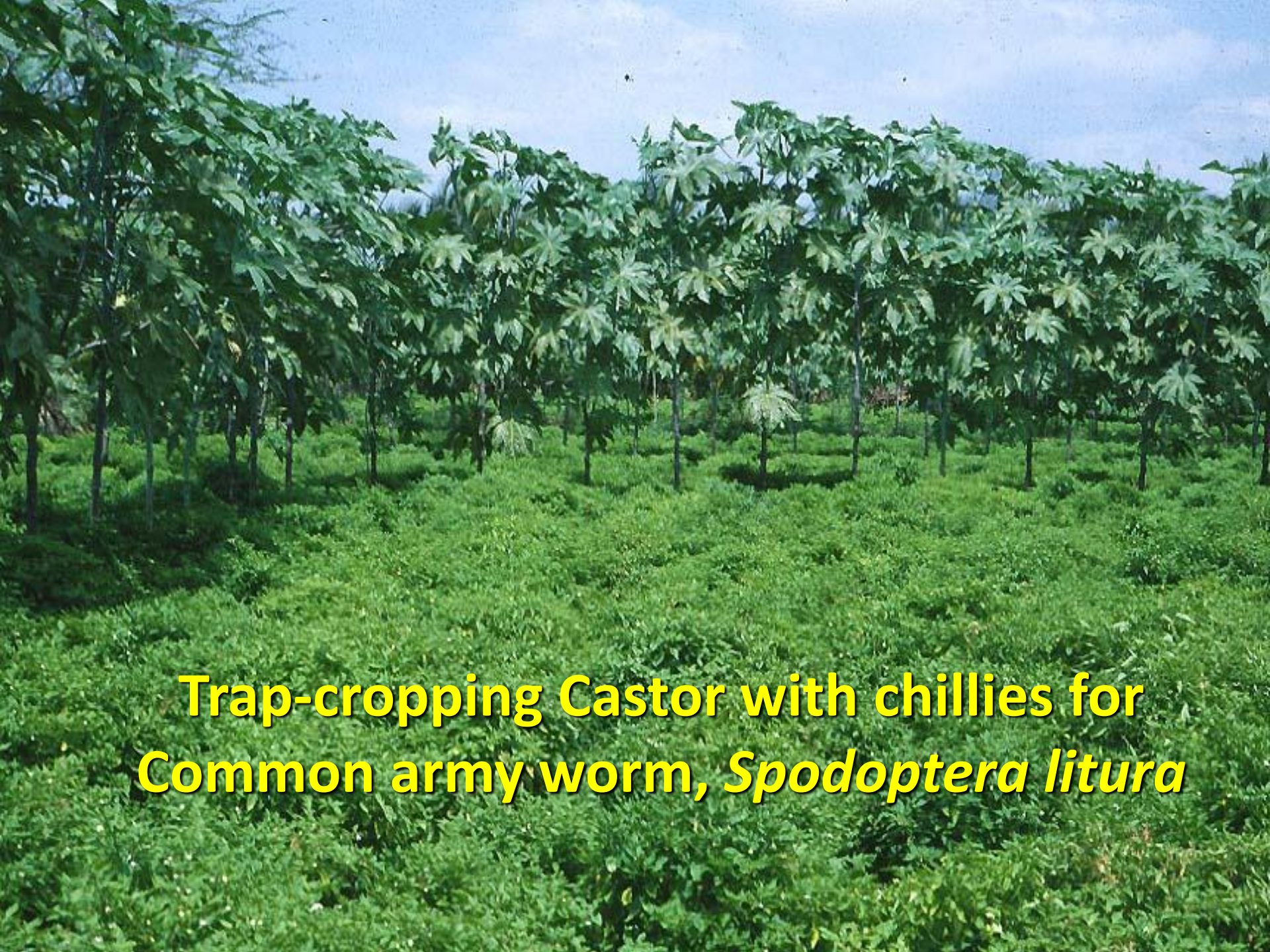
Indian Mustard (*Brassica juncea*) as a trap crop for Cabbage Head caterpillar and DBM


Trap-cropping Castor with chillies for
Common army worm, *Spodoptera litura*

Grow okra as a trap crop along borders of eggplant to trap the leafhoppers, and focus sprays on those trap plants

Inter-planting of tomato with trap crops such as cucumber may be useful for control of whitefly and TYLCV

French marigold (*Tagetes patula*) or African marigold (*T. erecta*) are very effective trap crops in lowering the root-knot nematode density in soil

Trap-cropping *Solanum viarum* with tomato for Tomato fruit worm, *Helicoverpa armigera*

Dead-End Trap-crop

- The trap crop attracts the insect pest, but do not support their survival. So, the pest insects fail to grow and die ultimately.

- ***Barbarea vulgaris*** **acts as a Dead-End Trap crop in cabbage for managing DBM**

Photo courtesy:
http://www.ct-botanical-society.org/galleries/barbareavulg.html

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Planting of taller crops such as corn around tomato and eggplant fields would reduce the incidences of whitefly and/or TYLCV

Removal of weed hosts

Trianthema portulacastrum

Amaranth leaf webber

Amaranth

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Avoid planting tomato near alternate hosts to prevent heavy infestations of *Helicoverpa armigera*


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Avoid planting cabbage near alternate hosts to prevent heavy infestations of *Helicoverpa armigera* and *Spodoptera litura*

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Avoid planting cauliflower near alternate hosts to prevent heavy infestations of *Helicoverpa armigera* and *Spodoptera litura*

Removal of borer infested fruits and shoots of eggplant at regular intervals and prompt destruction

Remove crop debris, weeds and other sources of thrips at the end of each crop

Plough and keep fields fallow for 3–4 weeks to allow thrips to emerge and disperse

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Biological Control - Predators

Predatory bugs can feed on caterpillar pests on various vegetables


Syrphid flies, an effective predator for controlling aphids
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Green lacewings controlling aphids, whiteflies, mites, etc.

Ladybird beetles controlling aphids, mites, etc.

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Biological Control - Parasitoids

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Diadegma semiclausum, a parasitoid of DBM, adopted to highlands

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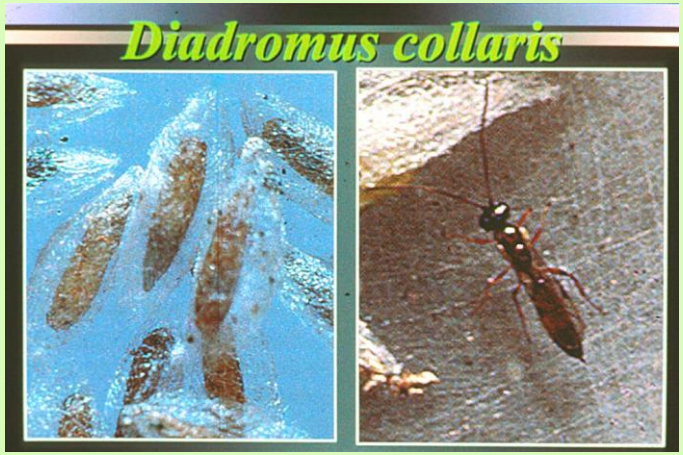
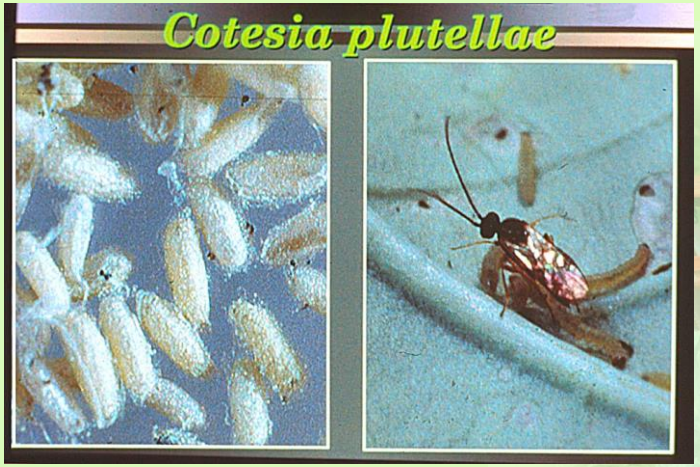
Other Parasitoids of DBM





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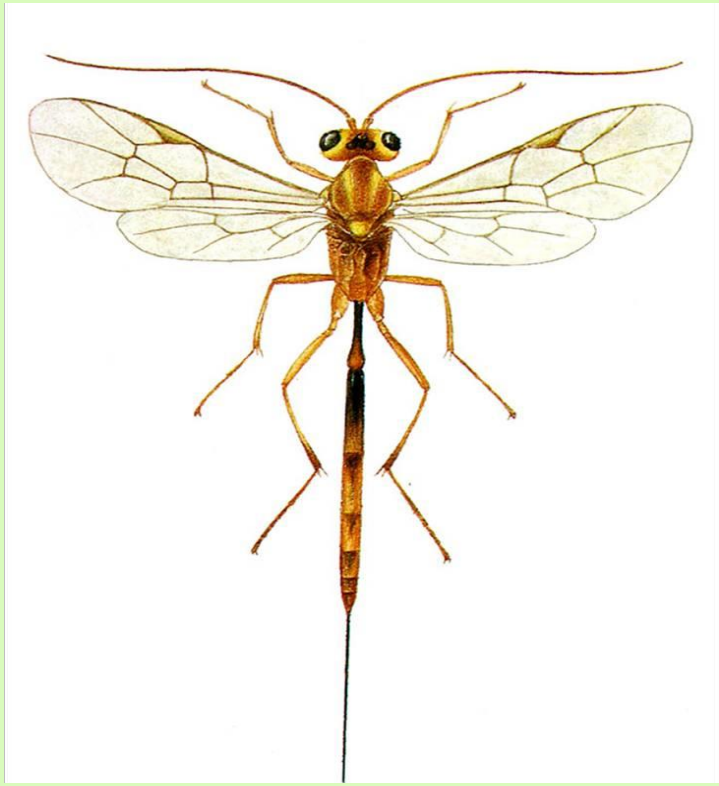
Trathala flavo-orbitalis, parasitoid of eggplant fruit and shoot borer



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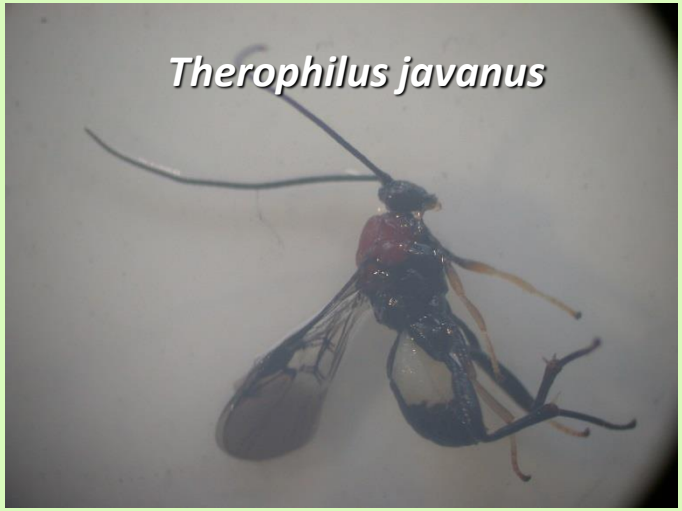
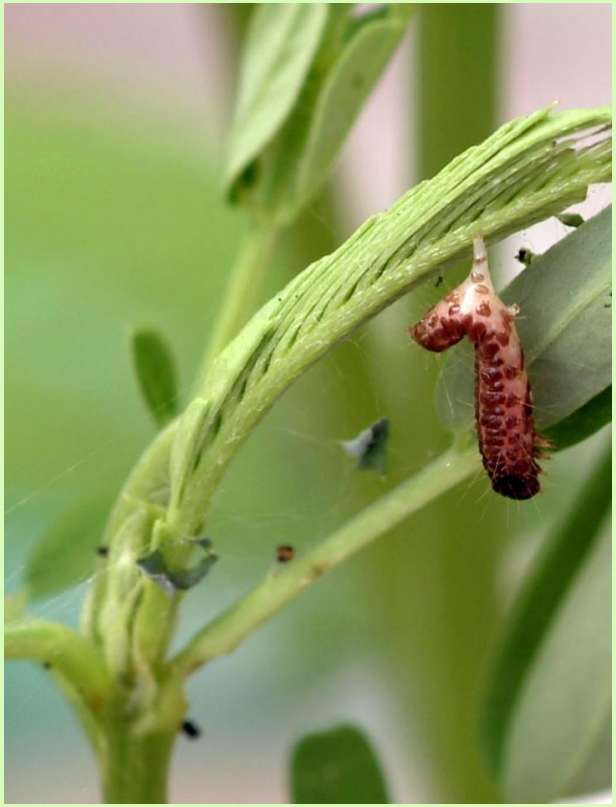
Parasitoids of legume pod borer, *Maruca vitrata*



Bio-pesticides



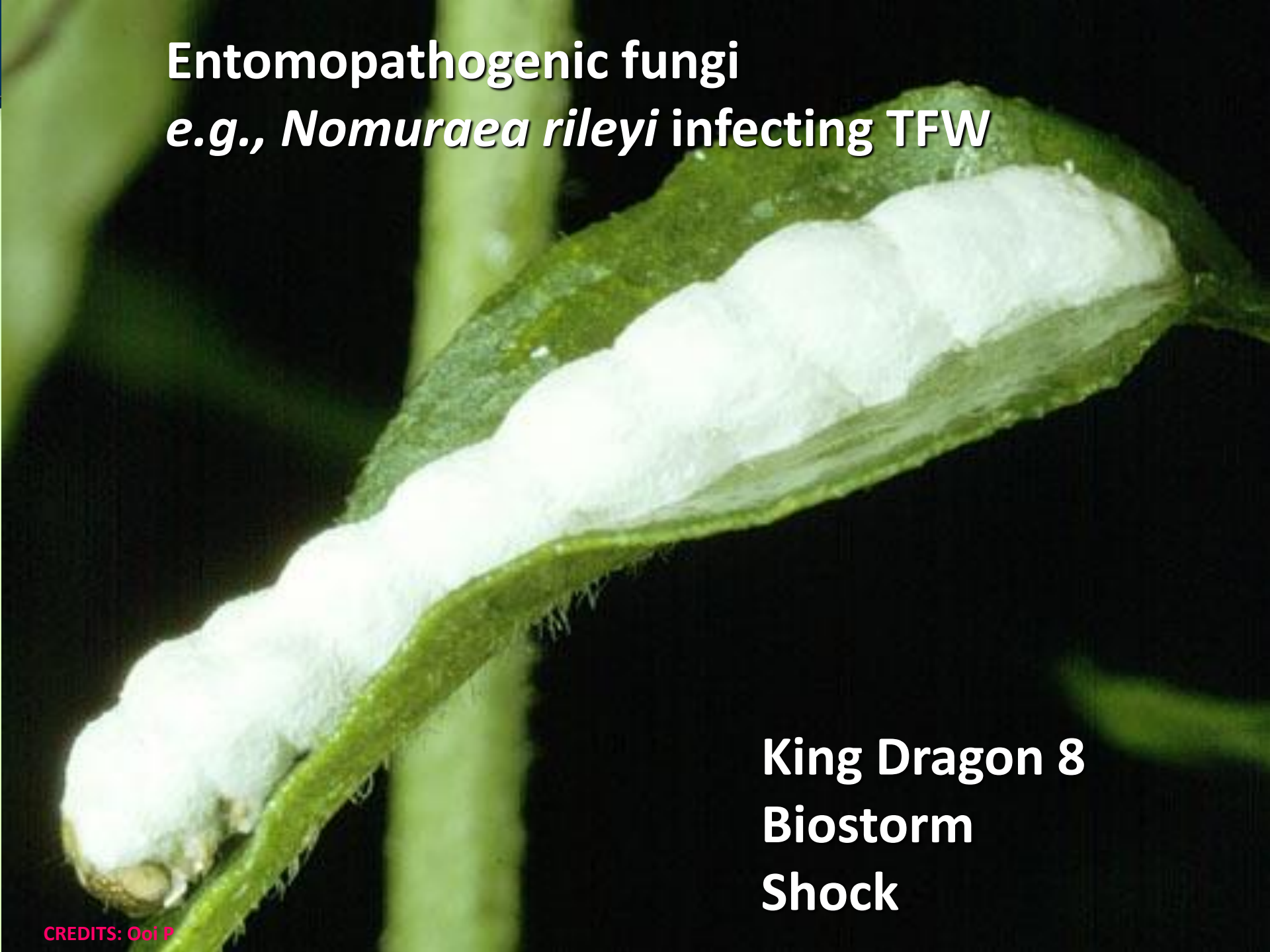
- **Nucleopolyhedrovirus (NPV)**

Tomato fruit borer (*H. armigera*)
Armyworms (*S. litura, S. exigua*)
Legume pod borer (*M. vitrata*)

- ***Bacillus thuringiensis*** **(Bt) formulations**

  P. xylostella, C. binotalis, H. undalis, P. rapae, H. armigera, S. litura, S. exigua, M. vitrata, L. orbonalis

- ***B. t. subsp. kurstaki*** **(Cry1A)**
- ***B. t. subsp. aizawai*** **(Cry1C)**
- **e.g., Xentari, Crymax**


Entomopathogenic fungi
e.g., Nomuraea rileyi infecting TFW
King Dragon 8
Biostorm
Shock
CREDITS: Ooi P


White muscardine fungi
e.g., Beauveria bassiana infecting
legume pod borer


Green muscardine fungi
e.g., Metarhizium anisopliae infecting
legume pod borer

Behavioral control

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Use of colored sticky traps

- Yellow sticky traps for whitefly, leaf miners, etc
- Blue sticky traps for Legume/Bean thrips

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Sex pheromone traps

Tomato fruit borer
Armyworms
Eggplant fruit and shoot borer

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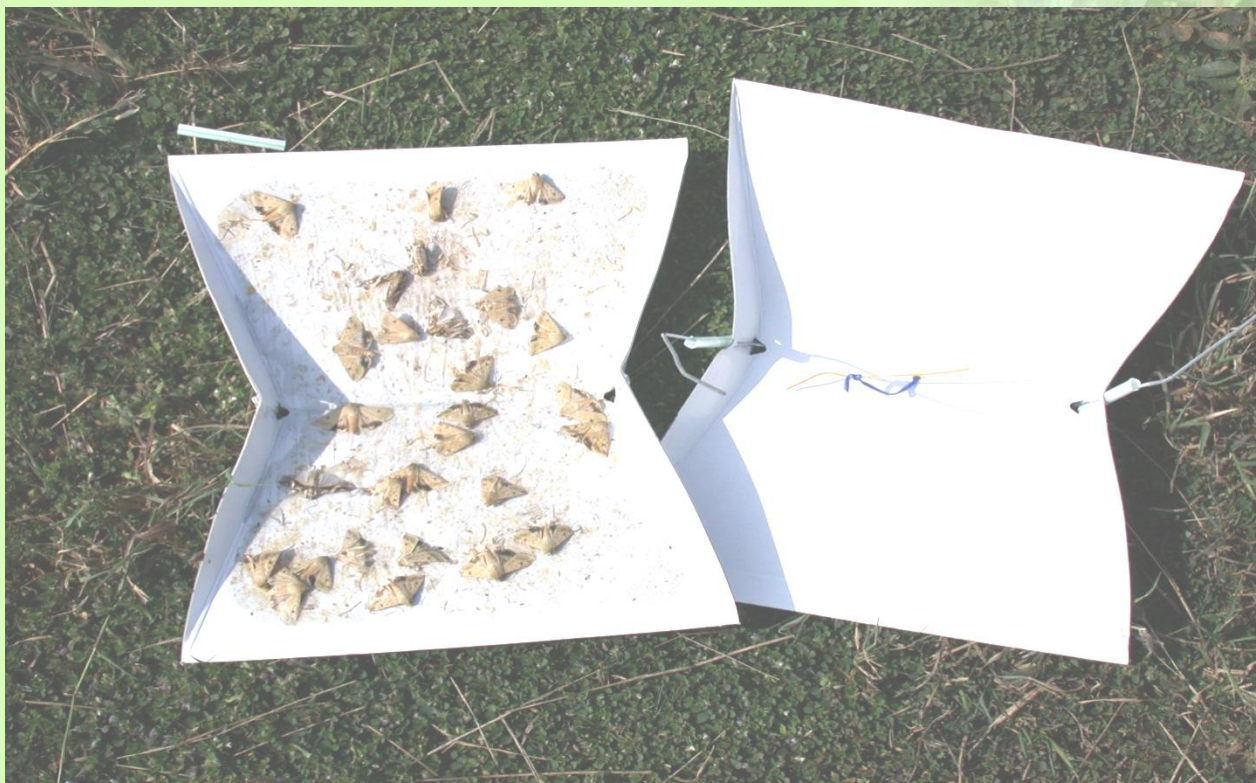
Sex Pheromone traps for *Helicoverpa armigera*

- **Widely used to monitor the male moths**



Sex Pheromone traps for *Spodoptera litura*

- **Widely used to monitor the male moths**

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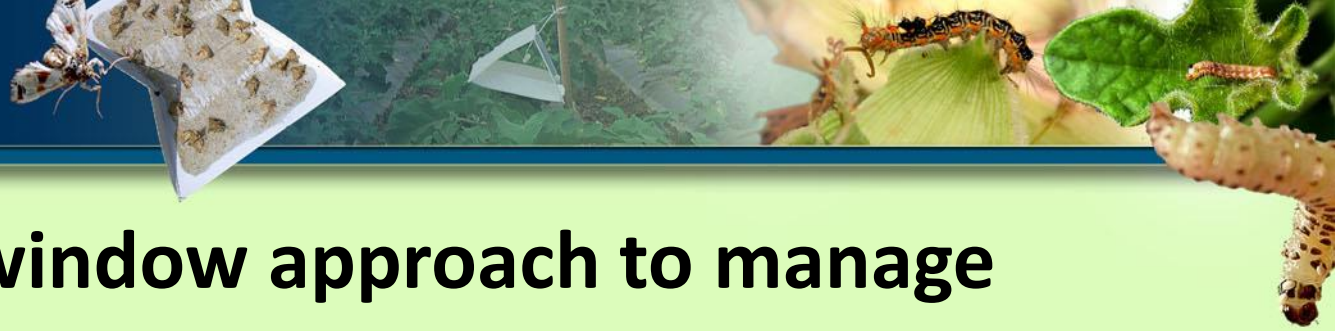
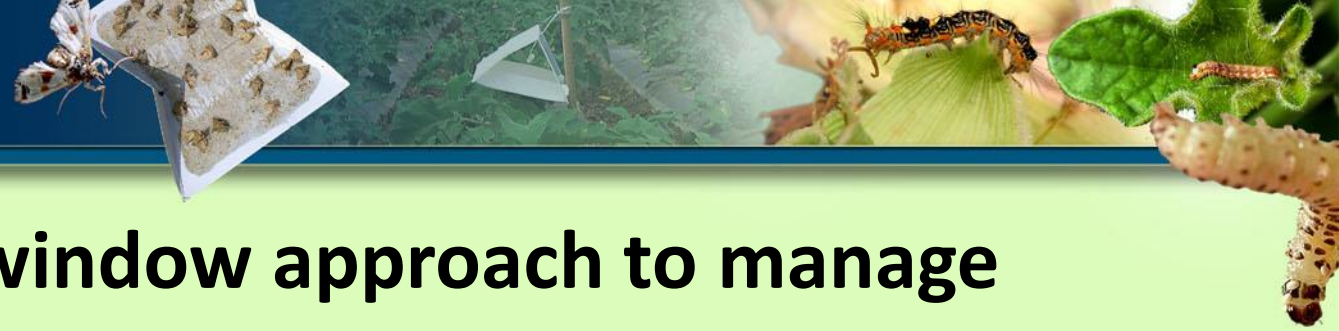
Sex pheromone lure is an imperative component in eggplant fruit and shoot borer IPM in South Asia



Pesticide window approach to manage DBM on brassicas in Australia

Window 1 (1 February - 15 June): fipronil, emamectin benzoate, chlorantraniliprole and flubendiamide.

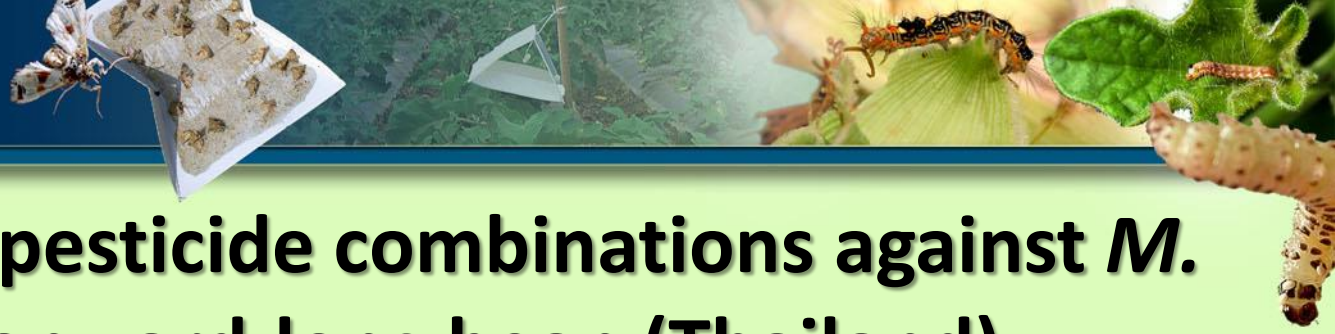
Window 2 (16 June - 31 October): chlorfenapyr, spinosad, indoxacarb



Pesticide window approach to manage DBM on brassicas in Taiwan

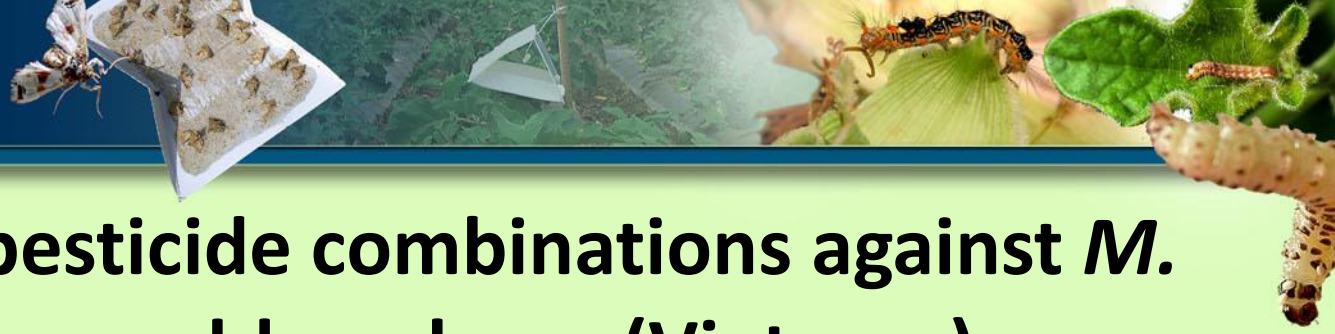
Window 1 (spring): spinetoram, chlorfenapyr, indoxacarb and *B. thuringiensis* subsp. *kurstaki*

Window 2 (autumn): emamectin, fipronil, chlorantraniliprole and *B. thuringiensis* subsp. *aizawai*



Different bio-pesticide combinations against *M. vitrata* on yard-long bean (Thailand)

Bacillus thuringiensis subsp. *aizawai* – *B. thuringiensis* subsp. *kurstaki* - cypermethrin – *B. thuringiensis* subsp. *aizawai*
B. thuringiensis subsp. *kurstaki* – *B. thuringiensis* subsp. *aizawai* - cypermethrin – *B. thuringiensis* subsp. *kurstaki*



Different bio-pesticide combinations against *M. vitrata* on yard-long bean (Vietnam)

Cypermethrin + *Bacillus thuringiensis* subsp. *aizawai* + *B. thuringiensis* subsp. *kurstaki* + cypermethrin + *Bacillus thuringiensis* subsp. *aizawai* + *B. thuringiensis* subsp. *kurstaki*
Neem + *Bacillus thuringiensis* subsp. *aizawai* + *B. thuringiensis* subsp. *kurstaki* + cypermethrin + *Bacillus thuringiensis* subsp. *aizawai* + *B. thuringiensis* subsp. *kurstaki*

Different bio-pesticide combinations against *M. vitrata* on yard-long bean (Lao PDR)

Bacillus thuringiensis **subsp.** ***aizawai*** **+ neem + abamectin +** ***B. thuringiensis*** **subsp.** ***kurstaki*** **+ neem**
B. thuringiensis **subsp.** ***kurstaki*** **+ neem + abamectin +** ***Bacillus thuringiensis*** **subsp.** ***aizawai*** **+ neem**