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Asian Vegetable and Mango Integrated Pest Management Innovation Lab (AVMIPM-IL), iDE Nepal

IPM Recommendations for Management of *Tuta absoluta*

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iDE Nepal, Bakhundole, Lalitpur

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Major Highlights

Recommendations for Management of *Tuta absoluta*

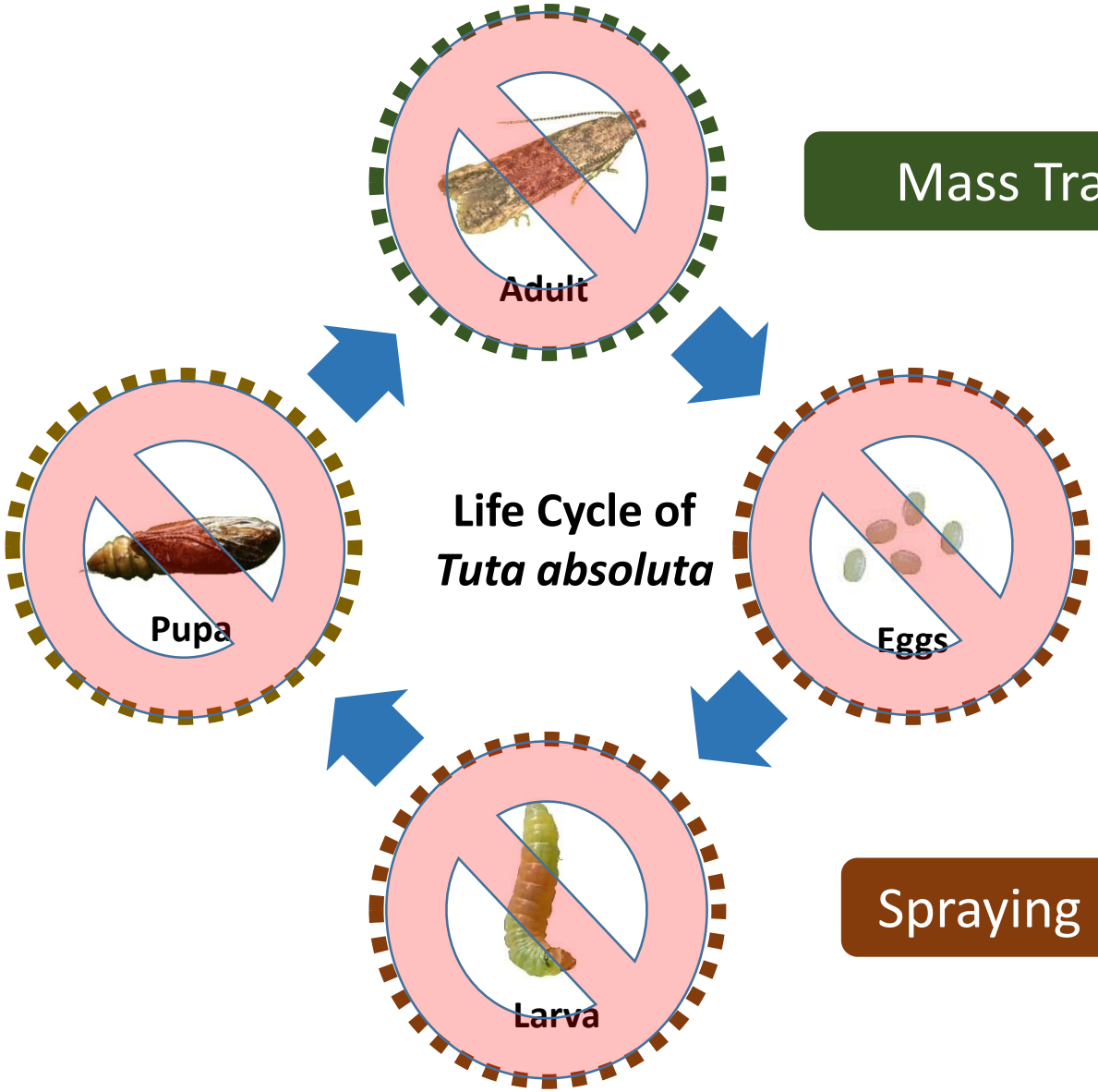
A.

For Green Houses with pest exclusion nets

B.

For Open Fields/Open Green Houses with no pest exclusion nets

Tuta management may require targeting each stage of the life cycle



Mass Trapping

Spraying pesticides

Sanitation or Tilling

A. For Green Houses with Pest Exclusion Nets (1mm mesh)

1. **Grow tomato seedlings inside a netted nursery.**
2. **Destroy previous crop residue right after the last harvest.**
3. **Do not grow other host crops around the farm and remove host weeds near the green house.**
4. **Destroy eggs, larvae and pupae in the field to be planted.**
5. **Best practice is to use plastic mulch to help identify and reduce pupation in the soil.**
6. **Check the seedlings before transplanting to ensure they are free of *Tuta* eggs and larvae.**
7. **Double check the net to make sure the green house does not have holes or gaps.**
8. **Perform mass trapping with pheromone and light traps seven (7) days before transplanting to trap *Tuta* moths in the green house.**
9. **Spray a neem based botanical pesticide or bio-pesticide (*Bt*) as soon as there are >5 *Tuta* moths trapped per day in any of the pheromone traps.**
10. **Make regular field inspections to look for new or further infestation.**
11. **Remove and destroy any infected leaves, shoots and fruit immediately.**
12. **To help ensure pollination use various methods such as hand pollination.**
13. **Make provision for ventilation at each end of the green house to remove hot air, especially during the hot summer.**
14. **Install a tight and secure door in the green house to prevent moths from entering.**
15. **Keep the traffic flow in the green house low.**

1. Grow tomato seedlings inside a netted nursery

- Tuta larva will attack tomato seedlings in a nursery.
- Best practice is to grow seedlings inside a netted nursery.

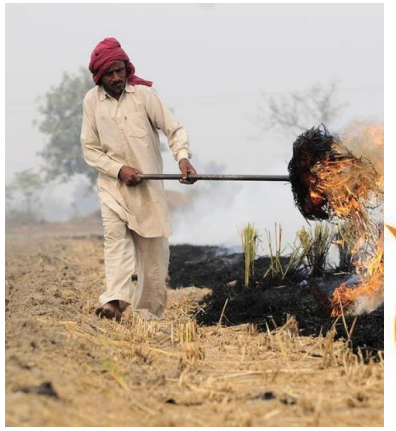
Best practice on how to grow healthy seedlings?

- Use a plastic tray with cocopeat and vermi-compost/Tricho-compost as a media.
- Make a two (2) foot high tunnel less than one (1) meter wide and length as required.
- Cover the tunnel with (1mm mesh size) nylon net.
- This will restrict insect pests such as *Tuta absoluta*, Whitefly and others. It also protects seedlings from birds and domestic animals.

2. Destroy previous crop residue right after the last harvest

a) Why to do this?

- Crop residue may contain larvae and pupae of *Tuta absoluta* which, if not destroyed, may continue its life cycle.
- **Do not mix previous crop residue into compost. Composting does not kill the larva and pupa.**



b) How to destroy?

- Burning (Collect crop residue in one place and burn)
- Burying (Collect crop residue and bury one (1) foot deep in a pit)

3. Do not grow host crops around the farm and remove host weeds

Major Host Crops for *Tuta absoluta*

Common Name	Scientific Name	Photo	Common Name	Scientific Name	Photo
Tomato	***Solanum lycopersicum***		Pepper	*Capsicum annum*	
Potato	*Solanum tuberosum*		Tobacco	*Nicotiana tabacum*	
Eggplant	*Solanum melongena*		Pepino Melon	*Solanum muricatum*	

- Move solanaceous crops or remove solanaceous weeds within 50m radius from the Tomato crop

Minor Host Crops and weeds for *Tuta absoluta*

Common Name	Scientific Name	Photo	Common Name	Scientific Name	Photo
Night shade	*Solanum nigrum*		Jimsonweed (Dathuro)	Datura stramonium	
Lamb's quarter (Bethe Saag)	*Chenopodium album*		Bindweed	Convulvulus arvensis	
Common cocklebur	Xanthium strumarium		Slender amaranth (Latte Saag)	*Amaranthus viridis*	

- Move solanaceous crops or remove solanaceous weeds within 50m radius from the Tomato crop

4. Destroy eggs, larvae and pupae in the field to be planted.

a) Apply bio-pesticide as a drenching

- Bio-pesticide: *Metarhizium anisopliae.*
- Effective against: Soil insects (*Tuta* Larvae, White grub and other insects in larval stage).
- Dosage: 2g per liter in water.
- Recommended only for soil application.
- This helps to kill the larvae and pupae residing in the soil.

b) Plough the entire field before transplanting to a depth of ten (10) centimeters

5. Plastic mulch can be used to help identify and reduce pupation in soil

- Pupation takes place in both soil and in dry leaves.
- Pupa in soil are difficult to detect due to their brown coloration. Using plastic mulch helps identify pupa on the mulch.
- It also reduce and prevents pupation in soil.
- Other benefits of mulching are weed control and the conservation of soil moisture and nutrients.

6. Check the seedlings to ensure they are free of *Tuta* eggs and larvae

- Use seedlings grown inside a netted nursery.
- Check the seedlings carefully from top to bottom before transplanting.
- Cull out any damaged or infested seedlings.

7. Double check the net to make sure the green house does not have holes and gaps

- Leaves of the Tomato plant produce a volatile signature (odor/scent) to which female *Tuta* moths are attracted to.
- The leaf scent helps female *Tuta* moths find tomato plants in which they lay eggs.
- Growers should check the netting to ensure the green house does not contain holes and gaps that create pathways for the moth to enter the green house.

8. Mass Trapping of *Tuta* moths

- Start mass trapping inside the green house seven (7) days before transplanting.
- Tools used for mass trapping
  - Light Trap (Blue LED bulb with 490nm light wavelength)
  - Water trap with Tomato Leaf Miner (TLM) pheromone Lure

<u>Trap density</u>

- For one (1) green house with pest exclusion netting (12x6m)
  - One (1) light trap
  - Two (2) water traps (Wota-T trap) with TLM pheromone lure (These lures should be replaced per manufacture's recommendation)
- Maximum trap height 40 cm above the ground

Time of day and light wavelength effectiveness comparison

Light wavelength

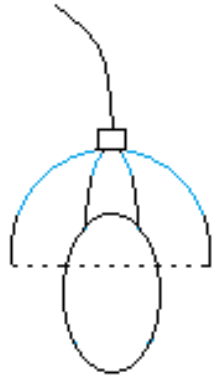
A. Violet (400nm)
B. Indigo (445nm)
C. (Blue 475nm)
D. (Green 510nm)
E. (Yellow 570nm)
F. (Orange 589nm)
G. (Red 650nm)

Trap	Time	6:00pm	12:00am	3:00am	6:00am	12:00pm	Total
White Light	Day 1	1	1	2	**110**	2	**116**
	Day 2	2	0	0	**103**	5	**110**
	Day 3	1	1	0	**95**	4	**101**
	Average	**1.3**	**0.7**	**0.7**	**102.7**	**3.7**	**109.0**
Green Light	Day 1	3	3	3	**130**	2	**141**
	Day 2	2	2	1	**123**	3	**131**
	Day 3	1	2	0	**105**	4	**112**
	Average	**2.0**	**2.3**	**1.3**	**119.3**	**3.0**	**128.0**
Blue Light	Day 1	2	5	5	**150**	5	**167**
	Day 2	1	3	4	**136**	3	**147**
	Day 3	1	2	2	**125**	8	**138**
	Average	**1.5**	**3.5**	**3.5**	**137.5**	**6.5**	**152.5**

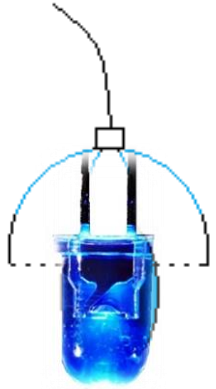
Source: https://www.google.com/patents/EP2308288A1?cl=en

- Blue light with wavelength of 490nm is found effective in attracting *Tuta* moth.

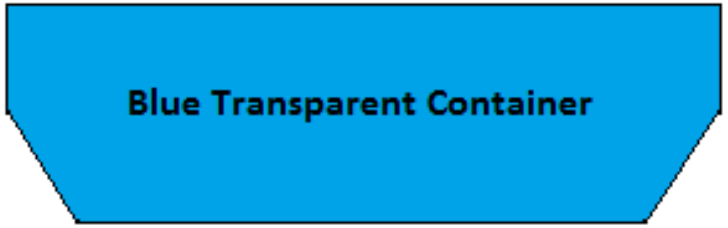
How to make a light trap?



White CFL or LED Bulb



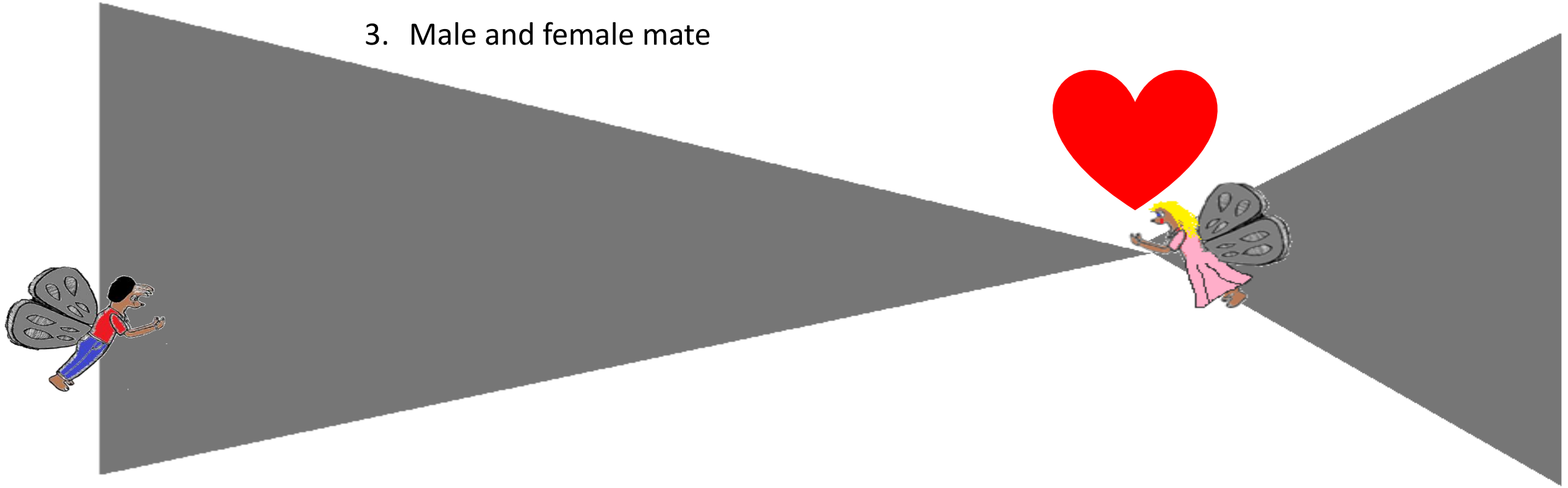
Blue CFL or LED Bulb



- Either use a white light with blue reflecting surface/container or use a blue light with white reflecting surface/container to attract the maximum number of moths.

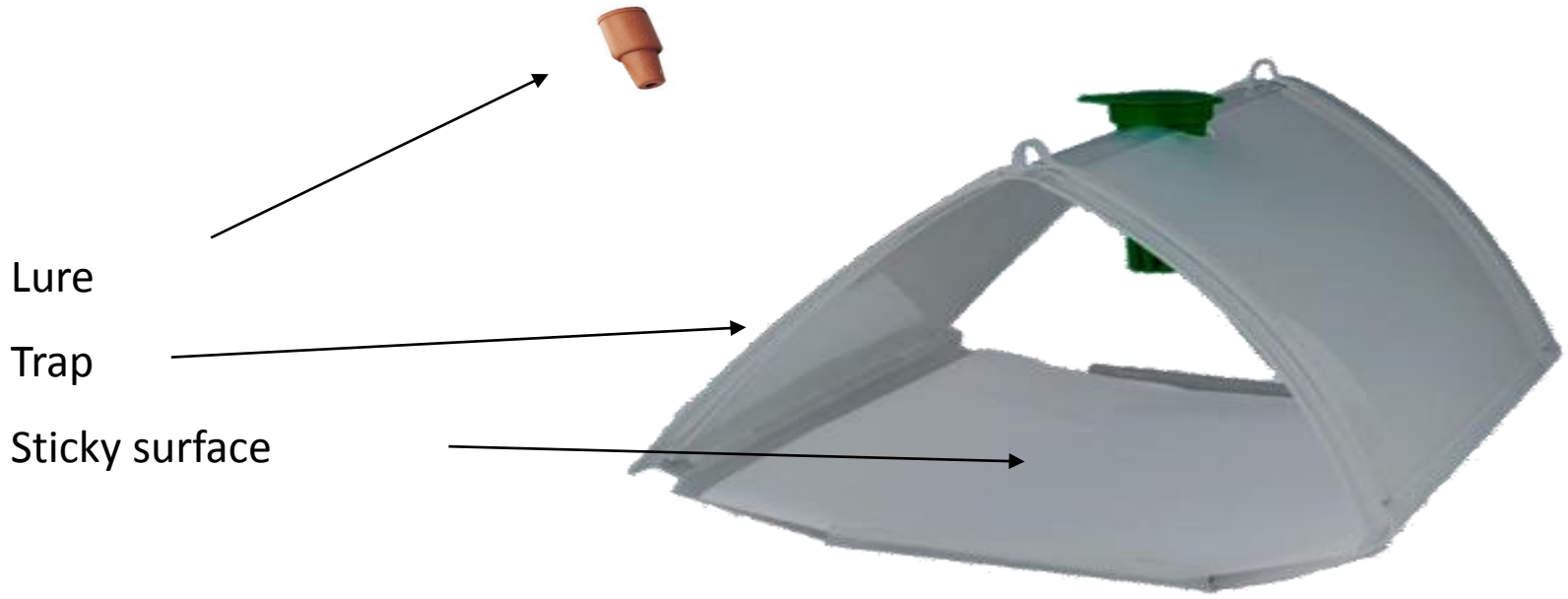
What are pheromones?

1. Female moth emits a chemical called “pheromones” when ready to mate
2. Male moth senses and follows pheromones
3. Male and female mate



How does a pheromone trap work?

1. Pheromone lure mimics the chemical released by the female moth
2. Male moth senses and follows pheromones
3. Male moth caught on sticky surface or water in case of water trap



9. Spray a neem based botanical pesticide or bio-pesticide (Bt) as soon there are >5 *Tuta* moths trapped per day in any of the pheromone traps

Neem based botanical pesticide

- Botanical: *Neem oil*
- Effective against: Soft bodied insects
- Dosage: 3ml per liter water
- Recommended for foliar application.
- Foliar spray in the standing crop as soon as there are >5 *Tuta* moths trapped per day in any of the installed pheromone traps.
- Azadirachtin functions both as a repellent and pesticide.

Or

Bio-pesticide

- Bio-pesticide: *Bacillus thuringiensis*
- Effective against: Soft bodied and larval insects
- Dosage: 2g per liter water
- Recommended for foliar application.
- Foliar spray in the standing crop as soon as there are >5 *Tuta* moths trapped per day in any of the installed pheromone traps.
- *Bacillus thuringiensis* infects and kills the young larva of *Tuta absoluta* when it comes in contact.

10. Make regular field inspections to look for new or further infestation

- Regular monitoring and inspection of fields is a critical activity for successful integrated pest management and is very important to effective management of *Tuta* .
- Growers should regularly monitor their fields to look for new infestations or further population development.
- Early detection provides time to adopt necessary management strategies.

11. Remove and destroy infested leaves, shoots and fruit immediately

- During regular monitoring of the field, remove and destroy infested leaves, shoots and fruit.
- Larva mine the leaves, fruit and shoots and can pupate in these infested parts, so it is important to immediately destroy or bury infested plant parts .

12. Pollination

- Using pest exclusion netting in a green house also restricts pollinators and predators.
- Pollination is necessary for fertilization and fruit set in tomatoes.
- Hand pollination can be used to help ensure pollination.
  - Gently brushing the flowers and shaking the staking ropes by hand is one method. The tomatoes should be staked on strings rather than bamboo for ease of shaking.
  - Using a tuning fork or vibrator near flowers to shake the flowers so that the pollen can reach the stigma is another method.

13. Green house design

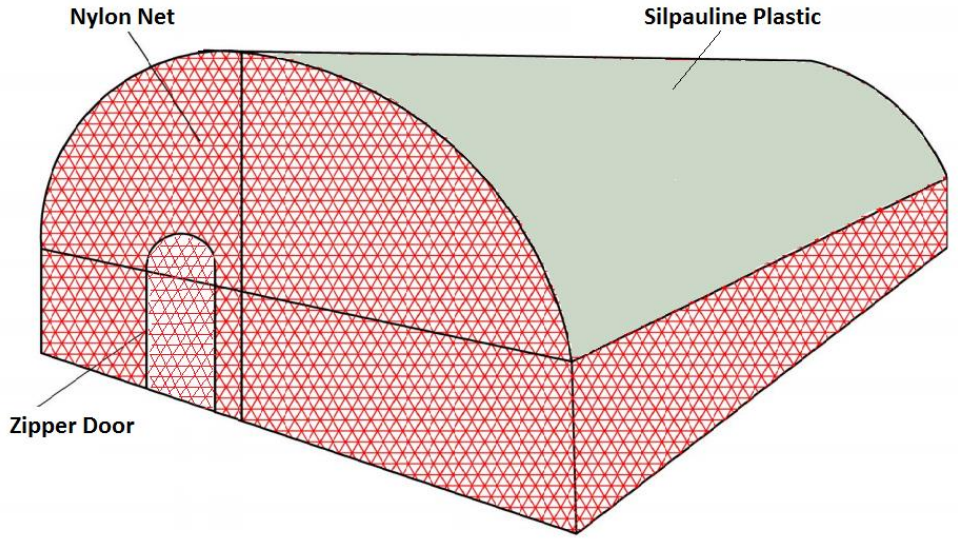
a) Mesh size for pest exclusion net should be 1mm

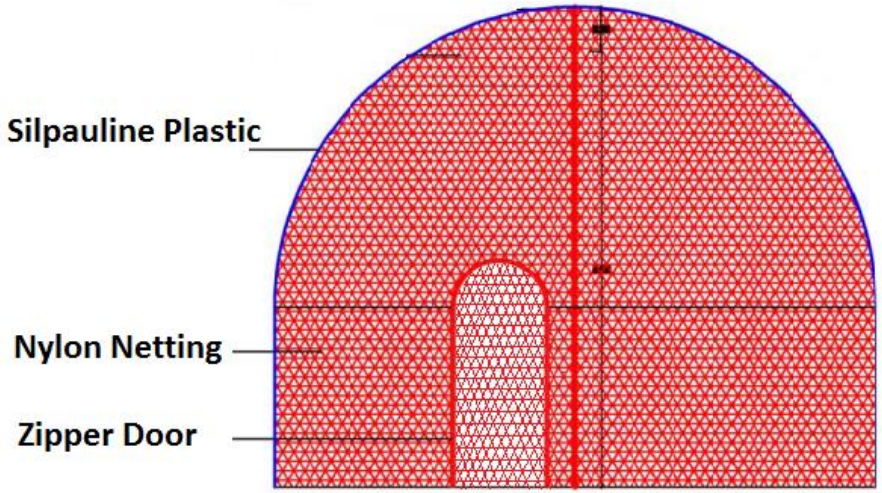
b) Ventilation

- Netting around the green house blocks air movement inside the green house.
- This causes an increase in temperature and humidity, especially during hot summer months.
- This type of environment favors the development of fungal diseases inside the green house.
- To help alleviate this concern:

  i. Provide ventilation at each end of the green house. (Also cover it with netting material)

  ii. Alternatively, use a shade net during summer months to block sunlight.





13. Green house design (Contd…)

c) Door system

- There should be a tight and secure door in the green house to prevent moths from entering.
- One should also be careful while opening and closing the door as insects may get inside if the door is left open.

Types of door systems:

i. Single door (Zipper) system:

- This system is cost friendly. It uses a zipper to make a door. Installing a zipper ensures there are no holes or gaps in the door. Check for insects entering the green house using the light and pheromone traps placed inside.

ii. Double door system:

- In a double door system there are two doors, an inside door and an outside door. Install a sticky trap with TLM lure in between the two doors to check for moths entering the green house.

13. Green house design (Contd…)

d) Keep traffic flow low

- Keep entry as low as possible.
- Do not allow visitors inside the netted green house.
- Irrigation drip drums should be installed and operated from outside the green house.

If these recommendations are followed in a green house with pest exclusion netting it is not anticipated that multiple applications of bio-pesticide or chemical pesticide will be necessary to control a *Tuta* infestation.

B. For Open Fields/Open Green Houses with No Pest Exclusion Net

1. Grow tomato seedlings inside a nylon net.
2. Destroy previous crop residue after the last harvest.
3. Do not grow other host crops around the farm and remove host weeds.
4. Destroy eggs, larvae and pupae in the field to be planted.
5. Best practice is to use plastic mulch to help identify and reduce pupation in the soil.
6. Check the seedlings before transplanting to ensure they are free of *Tuta* eggs and larvae.
7. **Perform mass trapping with pheromone and light traps seven (7) days before transplanting to trap *Tuta* moths in the main field.**
8. **Spray a neem oil or bio-pesticide (Bt) as soon as there are >5 *Tuta* moths trapped per day in any of the pheromone traps.**
9. **Alternate applications of botanical pesticides with bio-pesticides at seven (7) to ten (10) day intervals.**
10. **Make regular field inspections to look for new or further infestation.**
11. **Remove and destroy any infected leaves, shoots and fruit immediately.**
12. **Spray chemical pesticide as a last resort rescue operation.**

- ✓ 1. Grow tomato seedlings inside a netted nursery
- ✓ 2. Destroy previous crop residue after the last harvest
- ✓ 3. Do not grow host crops and remove host weeds around the farm
- ✓ 4. Destroy eggs, larvae and pupae in the field to be planted
- ✓ 5. Plastic mulch can be used to help identify and reduce pupation in soil
- ✓ 6. Check seedlings to ensure they are free of *Tuta* eggs and larvae

7. Mass trapping of Tuta moths

- Start mass trapping seven (7) days before transplanting seedlings in the main field.
- Tools used for mass trapping
  - Light Trap (Blue LED bulb with 490nm light wavelength)
  - Wota-T Trap with Tomato Leaf Miner (TLM) pheromone Lure

Trap density

Case 1: For farmers with one (1) or two (2) open green houses (12x6m)

- One (1) light trap in each green house
- Two (2) water traps (Wota-T trap) with TLM lure in each green house (TLM lures should be replaced per manufacture's recommendation)

Case2: For farmers with open continuous land (500m² or one (1) ropani)

- One (1) light trap
- Four (4) water trap (Wota-T trap) with TLM lure evenly distributed in the field (TLM lures should be replaced per manufacture's recommendation)

- **Mass trapping and other treatment activities described here should be done using a community based approach.**

9. Spray a neem based botanical pesticide or bio-pesticide (Bt) as soon as there are >5 *Tuta* moths trapped per day in any of the pheromone traps.

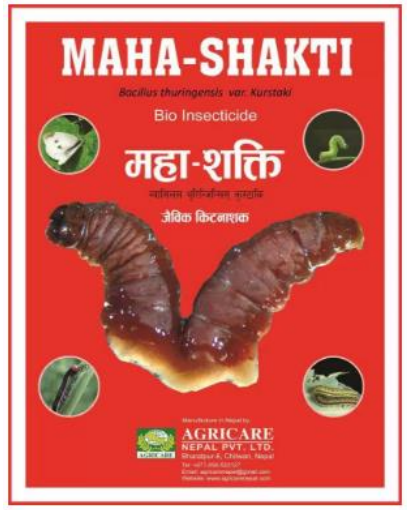
Neem based botanical pesticide

- Botanical: *Neem oil*
- Dosage: 3ml per liter water
- Azadirachtin functions both as a repellent and pesticide.

Or

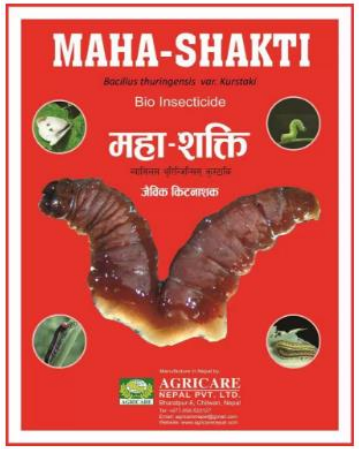
Bio-pesticide

- Bio-pesticide: *Bacillus thuringiensis*
- Dosage: 2g per liter water
- *Bacillus thuringiensis* infects and kills the young larva of *Tuta absoluta* when it comes in contact.



9. Alternating applications of botanical pesticides with bio-pesticides at 7-10 day interval.

- Alternate applications of botanical pesticides with bio-pesticides have been found effective in controlling *Tuta absoluta*.
- A botanical pesticide such as **neem oil (Azadirachtin @3ml/lit)** can be used alternately at 7-10 day intervals with a **biopesticide such as (*Bacillus thuringiensis* @2g/lit).**
- Do not depend on using only one type of pesticide for a long period as this may lead to development of insect resistance to a particular pesticide group.
- Do not mix neem oil with any bio-pesticide in a single application as neem can kill the bio-agents. Maintain at least a 7-10 day gap between alternate applications.



10. Make regular field inspections to look for new or further infestation

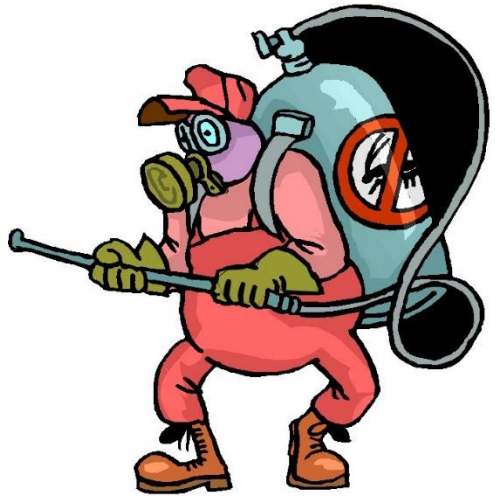
- Regular monitoring and inspection of fields is a critical activity for successful integrated pest management (IPM) and is very important to effective management of *Tuta* .
- Growers should regularly monitor their fields to look for new infestations or further population development.
- Early detection provides time to adopt necessary management strategies.

11. Remove and destroy infested leaves, shoots and fruit immediately

- During regular monitoring of the field, remove and destroy infested leaves, shoots and fruit.
- Larva mine the leaves, fruit and shoots and can pupate in these infested parts, so it is important to immediately destroy or bury infested plant parts .

12. Spray a chemical pesticide as a last resort 'rescue operation'

- If bio-pesticides and botanicals are not effective in controlling *Tuta absoluta,* as a last resort one can use chemical pesticides as a rescue operation.
- Always remember, chemical pesticides are broad spectrum and can harm human health, non-target insects and domestic animals.
- Follow appropriate safety precautions before spraying any pesticides. A few basic precautions are:
  - Cover skin with gloves, mask, hat and long sleeved clothing.
  - Cover eyes with goggles.
  - Use appropriate tools to spray the pesticide.
  - Do not spray in windy weather or scorching sunshine.
  - Always eat something before getting ready to spray pesticide.
  - Do not spray chemical pesticides unnecessarily.



- **Recommended chemical pesticides to use against *Tuta absoluta***

SN	Common Name	Trade Name	Dose	Waiting Period	Remarks
1	Chlorantraniliprole 18.5% SC	Coragen, Alcora	3ml/10 lit	7 days	Registered: PPD KISAN PERSUAP PAHAL PERSUAP
2	Spinosad 45% SC	Tracer	1ml/3 lit	7 days	Registered: PPD PAHAL PERSUAP

Cost comparison

Green house (12x6m) with pest exclusion net

SN	Particular	Rate	Quantity per 8 months	Total (NRs.) Yr 1	Total (NRs.) Yr 2	Total (NRs.) Yr 3	Total (NRs.) in 3 yrs	Remarks
1	Neem oil (100ml)	100	1	100	100	100	300	Neem oil@3ml/lit. 2-3 sprays
2	Pheromone Lures	100	10	1000	1000	1000	3000	Field viability of 1 lure is 50-60 days
3	Wota-T trap	160	2	320	0	0	320	Can be reused for 3 years
4	Light trap	1000	1	1000	0	0	1000	Can be used for 3 years if handled properly
5	Pest exclusion net (42m length 2m breadth) Approximate cost	150	42	6300	0	0	6300	Can be used for 3 years if handled properly
Total				**8,720**	**1,100**	**1,100**	**10,920**	

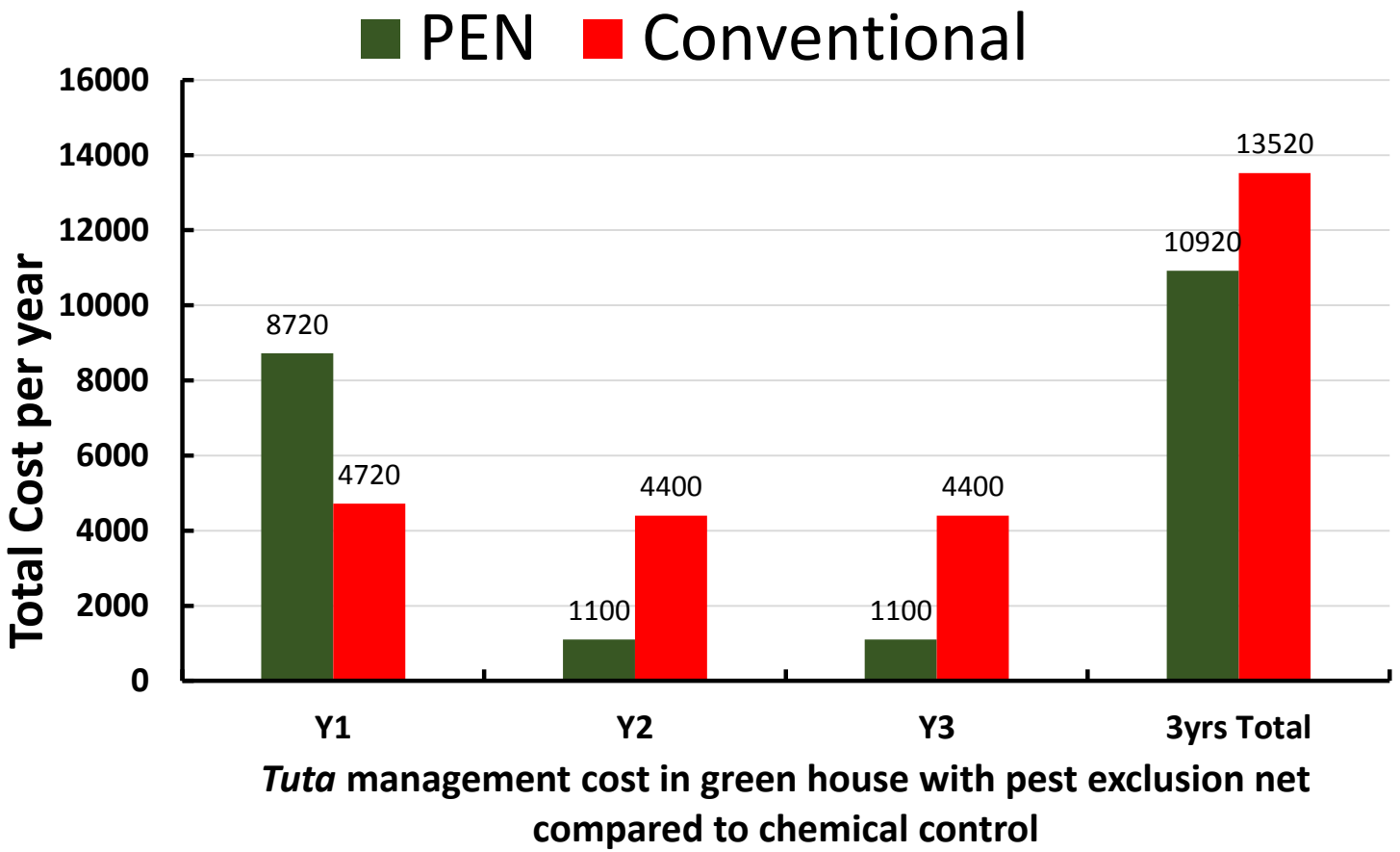
Note: *This is only the extra cost needed for Tuta management. Other costs such as plastic house construction, seeds, fertilizer, labor, etc. were not added here.*

Cost comparison

Conventional control method (For 12x6m area)

SN	Particular	Rate	Quantity per 8 months	Total (NRs.) Yr 1	Total (NRs.) Yr 2	Total (NRs.) Yr 3	Total (NRs.) in 3 yrs	Remarks
1	Chlorantraniliprole (10ml) Trade name: Alcora	280	10	2800	2800	2800	8400	Dosage 3ml/10lit. 14-16 sprays in a year
2	Neem oil (100ml)	100	6	600	600	600	1800	Dosage 3ml/lit. 14-16 sprays in a year
3	Pheromone lures	100	10	1000	1000	1000	1000	Field viability of 1 lure is 50-60 days
4	Wota-T trap	160	2	320	0	0	320	Can be reused for 3 years
Total				**4720**	**4400**	**4400**	**13,520**	

Note: *This is only the extra cost needed for Tuta management. Other costs such as plastic house construction, seeds, fertilizer, labor, etc. were not added here.*



***Tuta* management cost in green house with pest exclusion net compared to chemical control**

Average gross income from a tomato green house (12x6m) per season = Rs.20,000 to 25,000

Advantages of Pest Exclusion Net compared to conventional control:

- Lower or no pesticide use
- Likelihood of higher prices
- No risk of pesticide residue and rejection by testing lab
- Increased assurance of a good harvest
- Prevent development of pesticide resistance in *Tuta* and other pests

Researchable Issues for *Tuta absoluta*

- Distribution and extent of damage
- Nepal specific biology and host range
- Effectiveness of various natural enemies and local control approaches
- Varietal resistance
- Impact of cropping pattern
- Altitude effects on pest occurrence
- Verification of the effectiveness of approved chemical pesticides
- Effective monitoring of parasitoids and predators in collaboration with DoA, NARC and other stakeholders

Any questions or comments?

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Thank You!