Outline

- Why Protected Cultivation
- Major Issues under Protected Cultivation
- Insect Pests under Protected Cultivation and IPM
- Disease Management for Vegetables under Protected Cultivation
- Nematode Problem and Management
- World Vegetable Center’s Recent Work to Develop Low Cost Protected Cultivation of Vegetables
- Summary

Why Protected Cultivation

- Increased production
- Better quality produce
- Round the year cultivation.
- High-value crops with improved quality even under unfavourable and marginal environments.

Major Issues

- Slow adoption among small vegetable growers.
- Non-availability of reliable quality, clean and disease seed.
- Indiscriminate use of pesticide in protected cultivation.

Global Status

- Protective cultivation for off-season vegetable production under hot, wet climate in the tropics is becoming important and popular.

Insect Pests in Protected Cultivation

- Important pests under protected cultivation include thrips, whiteflies, mites, aphids, leaf miners, mealybugs, Tuta absoluta.
- **Thrips**: tiny insects, reproduce rapidly, very difficult to control under protected cultivation.
- Suck sap from flowers, leaves and shoots, deforming them, silvery streaking and flecking on expanded leaves, vectors of tospovirus.
**Insect pests in Protected Cultivation**

- **Whiteflies**: Serious pests, feeding on the lower sides of leaves, which dry-up prematurely, reducing yields, honeydew contamination.
- **Transmit geminiviruses**, lead to 100% yield loss, if left unprotected (Berlinger and Lebiush Mordechi 1996).

**Insect Pests in Protected Cultivation**

- **Aphids**: Infest most greenhouse crops. Suck plant sap from leaves, stem and flowers, multiply rapidly. The stem and leaves curl. They also secrete honeydew on which black sooty mold develops. Spread viral disease.

**Insect Pests in Protected Cultivation**

- **South American tomato leaf miner**: *Tuta absoluta* has recently emerged a major pest of tomato and other solanaceous crops such as chilli, potato and eggplant both in open field and under protected cultivation.
- **Cause losses of 80-100% on tomatoes in both protected cultivation and open fields** (Ilakwahhi and Srivastava 2017).

**Mites in Protected Cultivation**

- **Mites**: Spider mites form webs, pierce plant cells and remove their contents, resulting in a pale green mottling on leaves.
- **Mites** can be scouted by identification of the insects with a hand lens or by looking for signs of mite damage or webs.
- **Mites** are more prevalent in drip-irrigated greenhouses and can be reduced by washing off the surfaces of the plants.
- **Over-fertilization** of plants promote succulent new growth, favoured by mites.

**IPM in a Controlled Environment Different Than IPM in a Field**

- Once insects and diseases enter a greenhouse environment, they can multiply freely without predatory pressure. Are geographically contained and unable to leave.
- Management under protected cultivation is extremely difficult as population is isolated and easy to develop resistance.
- IPM is very important to reduce pests to acceptable levels.

**Successfully Implementing IPM**

**Depends on:**

- **Educating farmers about IPM based approaches**: Involve demonstrations, visits, discussions between farmers, online sharing of pest alerts, technical advice and success stories.
- **Promoting healthy seedling production**: Good insect control in polynet houses and in the field begins with healthy seed and seedlings, seed treatment plays an important role.
Successfully Implementing IPM Strategies

- **Using sticky traps in polynet houses:** A range of coloured sticky traps can provide very economical monitoring and control of insect pests right from just after germination through to fruiting and can keep sucking pests and leaf miners under control.

- **Netting and Plastic covers:**
  - Netting size-keep insects out
  - UV absorbing plastic roofing affect the suitability of the environment for pests.
  - Reflective mulches keep the insects away from the crops by disorienting them.

- **Enriched/Fortified/Suppressive compost:** Compost should be mixed with antagonist fungi such as *Trichoderma* or entomopathogenic fungi such as *Metarhizium anisopliae* or *Beauveria bassiana*, they suppress the development of soil-borne diseases and insect pests.

- **Polynet house Sanitation:** Clean area around polyhouses, free from weeds or other alternate host plants, and crops in vicinity reduce the sources of infestation.

- **Biological Control:** Natural enemies: predators, entomopathogens, and/or parasitoids to manage pest populations.

- **Biological control, a viable option for IPM under protected cultivation and can be more successful long-term than continuous chemical application.**

- **Use of pheromone traps for monitoring and mass trapping of insect pests:**
  - Pheromones traps for both monitoring and mass trapping of insect pests.
  - Using pheromone traps in nurseries and in field just after transplantation plays an important role in managing insect pests, especially *Tuta, Helicoverpa*.
  - Highly effective when used along with other control measures.

- **Mating disruption technique:** Involves high applications of pheromones to a limited area to prevent mating and is particularly suited for protected cultivation.
  - Many source points of pheromones are used to confuse the males.
  - Works well against brinjal shoot and fruit borer (egg plant) in and *Tuta* (tomato).
Management of South American Tomato Leaf Miner (Tuta absoluta) with SPLAT-Tuta

- Tuta absoluta an Exotic pest from South America.
- 100% Damage observed in Ranga Reddy and Medak Districts of Telangana, India.

SPAL Tuta Monitoring in Ranga Reddy and Medak Dist.

SPLAT Tuta evaluation studies in Ranga Reddy, Telangana

Management of Tomato leaf miner (Tuta absoluta) with SPLAT-Tuta

Application methodology
- Time of application: Just one day before transplanting & replications every 30 days. First application is done on pegs installed.
- Application rate: 2 Kg/ha. (500 g x 4 applications) Trail size: 1 ha
  - Dollop size: 1000-2000 source points/ha of 500-250 mg each

Traps for monitoring
- SPLAT-Tuta baited Delta traps / non-drying sticky covers/Water traps.
- Traps to be evaluated for moth catches and should be changed every 4 weeks (water traps: every week trap counts taken).

Damage Evaluations
- Damage assessments of the Tomato crop is assessed by leaf damage and randomly collected tomatoes from the treatments.

Bio-efficacy of SPLAT-Tuta from the Day of Transplantation

Application of SPLAT-Tuta on tomato plants

Trap catches on SPLAT-Tuta baited Yellow sticky traps and water traps
Number of Trap Catches on Treated Vs Control

Complete devastation of control field by *Tuta* infestation well before the crop period

Complete Control of *Tuta absoluta* in SPLAT-Tuta Treated Plots

*Tuta* infestation recorded in SPLAT-Tuta treated field in Bangalore

SPLAT-Tuta formulations could significantly reduce the damage over untreated control without any insecticidal applications

Management of Brinjal Fruit and Shoot borer (*Leucinodes orbonalis*) with SPLAT-BFSB

**Application methodology**
- **Time of application:** Just one day before transplanting & reapplication every 30 days. First application is done on pegs installed.
- **Application rate:** 500 g/ha (125 g/ha x 4 application) Trail size: 1 ha
- **Dollop size:** 250 source points/ac of 500 mg for each source point
- **Traps for monitoring:** SPLAT-BFSB baited Water traps.
- **Traps to be evaluated for moth catches three days once.**

**Damage Evaluations**
Damage assessments of the Brinjal crop is assessed by checking for dead heart in randomly selected 20 plants weekly. Later the fruit borers is assessed both from randomly selected plant harvest and total produce harvested.
**Application rate and treatment details**

T1: Farmers practice ie, control (3 water traps/acre)

T2: Mass Trapping – 40 water traps + Pesticide spray for BFSB (Farmers practice)

T3: 500 g/acre (125 g/acre x 4 application) + 20 water traps (250 source point)

T4: 1.0 Kg/acre (250 g/acre x 4 application) + 10 water traps (250 source point)

T5: 1.6 Kg/acre (400 g/acre x 4 application) + Pesticide spray for BFSB (400 source points) + 5 water traps

T6: 1.6 Kg/acre (400 g/acre x 4 application) + No Pesticide spray for BFSB (400 source points) + 5 water traps

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**Area-Wide Management of Brinjal Fruit and shoot borer (Leucinodes orbonalis) with SPLAT-BFSB in Keshavpally**

- Average monthly Moth catch/Water Trap
- Mean Monthly Shoot Damage (%)

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**Restoration of natural pollinators in treated plots**

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**Comparative study SPLAT-BFSB v/s Control for Brinjal**

- SPLAT Treated Plots have less than 5% damage with just 2 pesticide Sprays
- Untreated 40–60% Damage with 14 pesticide sprays

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**Field day program on management of BFSB using SPLAT technology at Keshavpally**
### Disease Management for Vegetables under Protected Cultivation
- The most common diseases in protected cultivation of Solanaceous vegetables are:
  - Bacterial leaf spot, damping off, bacterial wilt, blight, leaf curl, powdery mildew, anthracnose, downy mildew and Fusarium wilt.

### Integrated Disease Management (IDM)
- **Selection and promotion of resistant varieties:** Simplest and most effective solution.
- **Seed and seedling treatments and good seed bed and seedling nursery management:** Biological agents (e.g., Azotobacter, Pseudomonas fluorescens or Trichoderma harzianum) enhance the nutrient uptake and outcompete pathogens.
  - Seeds should be washed (e.g., 10% Trisodium phosphate) to remove surface contamination with pathogens.

### IDM
- **Grafting using pest resistant root-stocks:** Works best for controlling root diseases and root-knot nematodes, provides some systemic acquired resistance to some foliar pests and diseases.
  - WorldVeg has identified some resistant rootstock accessions for tomato and pepper grafting
- **Maintaining soil health:** Good pattern of crop rotation helps to prevent the build-up of soil-borne pathogens and nematodes.

### Root-Knot Nematodes
- **Root-knot nematode (Meloidogyne sp.)** is a serious pest under protected cultivation.
- **Symptoms:** Yellowing of foliage and wilting in patches.
  - Infested plants look pale, undernourished, water deficient and generally during daytime show wilting.
  - Under-sized and lower numbers of fruits.

### Nematode Management
- **Monitoring of root-knot nematode population,** as well as severity.
- **Soil samples should be analysed directly:** (extracting and counting eggs and juveniles) or root gall index on a trap crop.
- **Sanitation and good cultural practices:** Nematode free seedlings and planting material should be used.
  - Nematode free irrigation water.
  - Infested plants should be removed and burned.
  - Resistant rootstock through grafting technology.
Nematode Management

- **Soil application of peat, manure, and composts:** Increase water- and nutrient-holding capacity of the soil, lessen the effects of nematode injury.
- **Frequent irrigation helps reduce nematode damage.**
- **Soil solarisation and soil application** of bio-pesticides like neem seed cake, mustard oil cake, *Verticillium lecanii* and *Trichoderma* spp..
- Root dipping of seedlings in dimethoate before transplanting can reduce nematode infestation to some extent.

Postharvest Crop and Net House Care

- After crop harvest, plant debris should be removed from the net-house.
- Soil should be cleaned by flooding or sterilisation to reduce carry-over of pests and diseases.
- Area inside net house should be rototilled to loosen the soil.
- Pressurized water to clean the net from inside and outside the house removes dust and insect eggs, increases sunlight transmission.

Our Recent Work to Develop Low Cost Protected Cultivation of Vegetables

- Improved robust designs of low cost structures
- Construction of 20 test structures 250 – 500 m²
- Testing and selection of varieties for highest yields
- Implementing IPM technologies

Punjab Management Practices

- Alternative soil treatment methods for nematodes
- Testing net sizes for exclusion of major insect pests
- Refining IPM practices for major pests
- Training in construction and crop management

Work in Punjab 2008-2013

- Development and promotion of polynet houses
- Variety testing under protected cultivation
- Evaluation and promotion of trickle irrigation
- Pest and disease management under low tunnels (insect proof netting, drip fertigation systems, pheromone and sticky traps)
- Economics of leafy greens production in hot summers
- Vegetable value chains developed.

Work in Pakistan 2013-2016

- Postharvest Crop and Net House Care
- Our Recent Work to Develop Low Cost Protected Cultivation of Vegetables
- Punjab Management Practices
- Work in Punjab 2008-2013
- Work in Pakistan 2013-2016
Work in Bangladesh and Jharkhand 2014-2016
• Promotion of summer tomatoes under plastic covers
• Varietal evaluation for heat tolerance
• Evaluation of the economics of summer tomatoes
• IPM training and evaluation

Work in Karnataka 2014-2016
• Construction of 14 low cost structures
• IPM, mulching for tomatoes, cucumber and peppers
• Development and promotion of grafted tomato seedlings

Work in Tajikistan 2015-2017
• Low cost structures for seedlings and fresh produce
• Subsidizing construction of novel designs
• Assessing varieties and incomes for major crops
• Training and assess economics of protected cultivation

Work in Hyderabad 2015-2017
• Global review of tropical low cost protected cultivation
• IPM under protected cultivation (Tuta, fruit borer) (Mating disruption, pheromones traps)
• Introducing new types of tomato varieties
• Assess tomatoes in summer under different structures
• Microclimate testing and yields under different structures

Tomato Production in Open Field vs. 1m Low Tunnels

Towards a physically protected cultivation

Quantity and quality of products increased

Conclusion
• Protective structures provide protection to vegetable crops against biotic and abiotic stresses.
• Yield responses of other vegetables grown under protective structures vary depending on species, season and environmental conditions.
• Economic benefits from vegetable production under protective structures are not well defined and studied.
• However, there is a great challenge for more research to address the problems of vegetable production under protective structures, especially in IPM.
Thank You