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Pest Management in Protected Cultivation

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SUMMARY

Greenhouse crops worldwide face a significant threat from insect pests, which pose a primary challenge to production and productivity. The controlled environment of greenhouses, characterized by warm and humid conditions and ample food sources, creates a stable habitat for pest development. Unfortunately, the natural predators that typically keep these pests in check outdoors are often lacking within the protected confines of greenhouses. Consequently, pest issues tend to escalate more rapidly in indoor settings than in open fields.The extent of damage inflicted by arthropod pests upon greenhouse crops varies depending on the specific pest species and the prevailing season. Moreover, the tolerance level for such damage is closely tied to the type of crop being cultivated. To address these challenges, integrated pest management (IPM) offers a comprehensive and systematic approach. IPM integrates a diverse array of techniques and strategies aimed at reducing pest populations and mitigating their economic impact. This approach is tailored to the unique characteristics of each site and relies on accurate pest identification and a deep understanding of pest biology.

INTRODUCTION

Protected cultivation is the concept of growing potential crops in modified natural environment for ensuring optimum growth of the crop plants without any or least stress [1]. In other words, protected cultivation can also be defined as **controlled environment agriculture** (CEA) which is highly productive, conservative of water and land and protective of the environment. Greenhouses are being commercially used for production of exotic(non-native) and off-season vegetables, export-quality cut flowers and also for raising quality seedlings. Economic returns from the high value agricultural produce can be increased substantially when grown under greenhouse conditions.

Status of Protected Cultivation

In World

The estimated global protected agriculture area is **5,630,000 ha**. (13,912,000 ac.) [World Greenhouse Vegetable Statistics updated for 2019]

In India

India stands at **seventh position** (110,000 ha) worldwide while China stands first (2,760,000ha) in terms of fruit and vegetable crops in protected cultivation worldwide [3]. State wise crops grown under protected cultivation in India is presented in **Table 1**. Maharashtra is the leading state in India in protected cultivation, followed by Karnataka and Himachal Pradesh. Maharashtra and Gujarat cover 5,730.23 hectares and 4,720.72 hectares area under protected cultivation, respectively (Singh P, et al, 2020).

Table 1: Leading states and crops grown under protected cultivation

S. No.	State	Crops
1.	Maharashtra	Carnation, Gerbera, Rose, Capsicum
2.	Karnataka	Roses, Gerbera, Carnation, Vegetable seed production and nursery raising of Vegetables
3.	Himanchal Pradesh	Capsicum, Carnation, Gerbera, Tuberose
4.	Punjab	Vegetable Crops
5.	Uttarakhand	Gerbera, Capsicum
6.	Tamil Nadu	Floricultural Crops
7.	North Eastern States	Floriculture & Vegetable Crops
8.	Other States: Haryana, Up, Gujarat, Rajasthan, Jharkhand, J&K, Delhi, West Bengal, Odisha, Bihar, Madhya Pradesh	

Source-[ICAR-CIAH]

Insect-pests Scenario under Protected Environment in India

The most important insect pests of protected cultivation are whiteflies, aphids, leaf miners, thrips, and spider mites. These pests cause crop losses and can vector plant viruses to crops. The lists of major insect pests in protected cultivation and the main crops which they attack on is given below in **Table 2**.

Table 2: Major insect-pests under protected cultivation and their distribution (Sabir N., 2013)

Group	Insect and mite pests	Host	Distribution
Aphids	*Aphis gossypii*	Capsicum	Punjab, Delhi
	Macrosiphoniella sanborni	Chrysanthemum	Karnataka, HP
	Macrosiphum luteum	Orchid	Sikkim
	Myzus escalonicus	Strawberry	New Delhi
	Myzus persicae	Capsicum, Gerbera,	Punjab, Maharashtra
	Toxoptera aurantii	Orchid	Sikkim
Caterpillars	*Helicoverpa armigera*	Capsicum, tomato, carnation	Punjab, Uttarakhand, H.P.
	Spodoptera litura	Rose, tomato, capsicum, cucumber	Karnataka, Punjab, HP
Leaf-miner	*Liriomyza trifolii*	Tomato, cucumber, chrysanthemum, gerbera, and many ornamentals	Karnataka, H.P.
Mites	*Polyphagotarsonemus latus* (yellow mite)	Capsicum	Karnataka, Punjab, Delhi, H.P.
	Stenotarsonemus fragariae	Strawberry	New Delhi
	Tetranychus cinnabarinus	Carnation	Maharashtra
	Tetranychus neocalidonicus	Cucumber	New Delhi
	Tetranychus urticae (Spider mite)	Tomato, capsicum, cucumber, carnation, gerbera	H.P., Maharashtra
Thrips	*Scritothrips dorsalis*	Rose	Karnataka
	Thrips palmi	Gerbera	Karnataka
	Thrips tabaci	Gerbera	Maharashtra
Whiteflies	*Bemisia tabaci*	Gerbera, capsicum	Karnataka, Punjab
	Trialeurodes vaporariorum	Tomato, cucumber, capsicum, beans, gerbera, and more than 30 hosts	H.P. & Nilgiri hills (TN)

IPM strategies for protected cultivation:

It Includes Preventive measures, Scouting and early detection. Curative measures

Preventive Strategies

Preventive strategies involve the use of physical barriers & cultural practices.

Physical Barriers

a) Use of Insect-Proof Nets:

Screen mesh with holes less than 200 micrometers is needed for complete exclusion. The screen mesh sizes available for exclusion of major insect pests in greenhouse is given in **Table3**

Table 3: Screen mesh sizes needed to exclude major greenhouse pest species (Rathee M, et al,2018)

Insect-Pest	Hole size (micron)	esh (number of threads per linear inc
Leaf-miner (*L.trifoli)*	610	34
Cotton Whitefly (*B.tabaci)*	462	42
Aphid (*M. persicae)*	340	52
Greenhouse whitefly (*T. vaporiarum)*	290	58
Thrips (*Thrips spp.)*	192	76

b) Provision of double door- Double-door entry with a screened foyer helps to prevent wind-carried insect entry.

c) Use of Reflective or Metalized Mulches:

- These mulches have repelling effects on certain insects. Eg., Metalized mulch was effective in reducing silverleaf whitefly entrance by 90 %. The combination of screening and metalized mulch should be used together and will provide the greatest total reduction of whitefly entry [5].
- Combining screening with metalized mulch provides the best reduction of insect entry.
- Complete mulching of the greenhouse floor prevents weeds and acts as a mechanical barrier to some insect life stages (leaf-miners, thrips and other lepidopteran pests).

d) Ultra-Violet Radiation Absorbing Sheets:

- UV-absorbing films alter insect visual behaviour and reduce insect invasion.
- UV-blocking greenhouse cladding materials effectively prevent the immigration of various insect pests (e.g., whiteflies, aphids, thrips, and leaf-miners).
- UV-blocking plastic roofs are particularly effective against thrips

These preventive strategies collectively form an integrated approach to greenhouse pest management, focusing on excluding pests through physical barriers and visual deterrents.

Cultural Practices

a) **Pre-season Cleanup:** Remove pests and plant debris from the previous crop. Eliminate weeds in and around the greenhouse. Avoid growing other crops near the greenhouse. Consider monoculture over polyculture, or avoid staggered planting. Implement a fallow period of 2-4 weeks to reduce pest load. Use yellow sticky cards and indicator plants to monitor pests.

b) **Inspection upon Arrival:** Examine new plants closely for signs of pest infestation. Remove lower or damaged leaves to prevent pest spread. Make treatment decisions at the first sign of insect or mite symptoms. Manage pest infestations in small plants (seedlings) for easier control.

c) **Balanced Use of Fertilizer:** Follow a balanced nutrient-based fertilization schedule. Apply nitrogen only as needed for optimal growth to avoid excessive growth. Use potassium at desired levels to reduce insect-pest incidence.

d) **Pinching and Pruning:** Pinch off damaged plant parts, flowers, and infested leaves. Dispose of plant debris immediately in covered containers. This practice helps reduce pest populations. Prune lower leaves after harvesting lower fruit clusters to control leaf-miners and whiteflies.

e) **Trap Crop/Indicator Plants:** Use preferred host plants of target pests for early detection. Plant border rows of specific crops as trap crops. Example: *Portulaca oleracea* as a trap crop for tobacco caterpillars in rose cultivation. Onion can be used as a trap crop for vegetable crops as it emits allicin compounds which irritates the pests.

f) **Plant Quarantine:** Prevent the movement of plants with pests.. Avoid touching or moving infested plants near healthy ones. Ensure clean and healthy plants are handled separately by greenhouse workers.

These cultural practices are essential for effective greenhouse pest management, emphasizing prevention, early detection, and ecological approaches to minimize the need for chemical treatments.

Scouting and Early Detection

Monitoring or scouting is the regular, systematic inspection of the plants and exteriors to identify and asses pest problems.

Scouting Procedures:

- Visual observations provide pest population estimates in greenhouses.
- Pests are not evenly distributed in crops; scout the entire greenhouse uniformly.
- Inspect the whole plant, including soil surface, systematically.
- Start from the bottom and work upwards.
- Examine older leaves, young leaves, and flush growth.
- Young crops require thorough leaf checks as arthropod pests often prefer leaf undersides.
- Regularly scout the crop, inspecting at least 1-2% of total plants weekly.
- Use a field data sheet to record pest identification, location, severity, and treatment effectiveness

Monitoring:

- A relative method of estimating insect populations using attractant traps.
- Yellow sticky cards (4"x12" or 8"x12") are effective for whiteflies, aphids, thrips, and leaf-miner adults.
- Blue sticky traps can be used for thrips.
- Hang 1-2 yellow sticky cards per 100 square meters in a grid pattern.
- Increase trap numbers for mass trapping, if needed.
- Hang cards 4"-6" above plant canopy and adjust as crops grow.
- Record trap locations on a greenhouse map.
- Check cards during scouting visits (preferably twice a week) and record trapped insects.
- Replace cards when over 60-70% coverage by trapped insects.

Curative measures

It includes the use of biocontrol agents, chemicals, and botanicals.

Biocontrol Agents- BCAs play a crucial role in protected cultivation and are widely employed to combat numerous pests.

Table 4. Major BCAs of key pests of greenhouses

Pests	Predators	Parasitoides	Entomopathogens
Mites	*Phytoseiulis persimilis, Neoseiulis cucumeris, Orius laevigatus*	-	-
Whiteflies	*Orius laevigatus, Chrysoperla spp*	*Eretmocerus mundus, Encarsia formosa*	*Verticillium lecanii, Beauveria bassiana*
Thrips	*Orius laevigatus, Neoseiulis cucumeris*	-	-
Leaf Miners	-	*Diglyphus isaea, Dacnusa siberica*	*Bacillus thuringiensis*
Aphids	*Orius laevigatus, Chrysoperla spp., Apidoletes aphidomyza*	*Aphidus colemani, Aphidus matricarae*	-
Caterpillar (Spodoptera sp.)	*Chrysoperla carnea*	*Trichogramma spp*	*Bacillus thuringiensis, SlNPV, HaNPV*

Chemical Control- Insecticides, undoubtedly, stand as the most potent tools in pest management. Their effectiveness is unparalleled, offering swift curative action. But it is always recommended that insecticides should be applied in a judicious manner due to its adverse effect on the environment.

Table 5. Some of the important chemical formulations used against greenhouse insect-pest

Target pests	Chemicals
Mites	Diafenthiuron, Fenpyroximate, Abamectin @0.5ml/L
Thrips, Whitefly, Aphids	Imidacloprid @ 0.4g/L, Acephate @ 1g/L or Acetamprid @ 0.2g/L, Abamectin @ 0.5g/L, Phosphomidon 0.2mL
Leafminer	Spinosad @ 0.3ml/L, Abamectin @ 0.5ml/L
Caterpillars	Spinosad, Chlorantraniliprole @ 0.3ml/L, Flubendiamide @ 0.1 ml/L

CONCLUSION

The insights gleaned from existing literature underscore the paramount importance of adopting an integrated approach for effectively managing greenhouse pests. In the context of Indian greenhouse production, it is imperative for growers to implement a multitude of IPM exclusion strategies to ward off insect-pests. Once these pests breach the greenhouse defences, the available options for managing them become quite limited. Therefore, the primary focus should be on preventing pests from infiltrating the greenhouse environment.

By prioritizing prevention and employing a multifaceted strategy, greenhouse producers can enhance the sustainability and resilience of their pest management efforts.

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