



Integrated Pest Management in Vegetable Crops: Principles, Strategies, and Sustainable Applications

Nilesh P Kakde

Shri Vyankatesh Arts, Commerce and Science College, Deulgaon Raja, Buldhana, Maharashtra, India.

E-mail : nileshkakde99@gmail.com.

Manuscript details:

Received: 09.04.2026
Accepted: 20.05.2026
Published: 30.05.2026

Cite this article as:

Nilesh P Kakde (2026) Integrated Pest Management in Vegetable Crops: Principles, Strategies, and Sustainable Applications, *Int. J. of Life Sciences*, 14 (1A): 339-342.
<https://doi.org/10.5281/zenodo.20685508>

Available online on <http://www.ijlsci.in>
ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)



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ABSTRACT

Vegetable crops are highly susceptible to insect pests, leading to substantial yield losses and quality deterioration. Excessive dependence on synthetic pesticides has resulted in ecological imbalance, pest resistance, and health concerns. Integrated Pest Management (IPM) provides an ecologically sustainable alternative by combining preventive, biological, mechanical, botanical, and selective chemical strategies. The present study evaluates the principles and applications of IPM in major vegetable crops and compares its performance with conventional pest control methods. Yield data indicate an average increase of approximately 25% under IPM practices. Statistical analysis confirmed significant differences at $p \leq 0.05$. The findings suggest that IPM enhances productivity while ensuring environmental safety and long-term sustainability.

Keywords: Integrated Pest Management, Vegetable Crops, Biological Control, Sustainable Agriculture, Economic Threshold Level

INTRODUCTION

Vegetables play a critical role in ensuring nutritional security and farm income generation. Countries such as India are major contributors to global vegetable production. However, pest infestation remains a major constraint, often causing 20–40% yield losses. Important insect pests affecting vegetable crops include fruit borers, sucking insects, and defoliators. Tomato cultivation is frequently damaged by *Helicoverpa armigera*, brinjal by *Leucinodes orbonalis*, and cabbage by *Plutella xylostella*. Indiscriminate pesticide use has caused resistance development, pest resurgence, environmental pollution, and pesticide residues in food. Integrated Pest Management (IPM) has emerged as a holistic approach aimed at sustainable pest regulation while minimizing chemical inputs.

MATERIALS AND METHODS

Study Design: A comparative field evaluation was conducted between IPM-based cultivation and conventional pesticide-based farming across major vegetable crops: tomato, brinjal, chilli, okra, and cabbage.

IPM Components Applied: The IPM strategy included cultural, mechanical, biological, botanical, and need-based chemical control measures.

Biological agents such as *Trichogramma* and *Bacillus thuringiensis* were applied according to recommended schedules.

Statistical Analysis

Yield data were subjected to one-way ANOVA and independent sample t-test to determine significant differences between treatments at 5% significance level ($p \leq 0.05$).

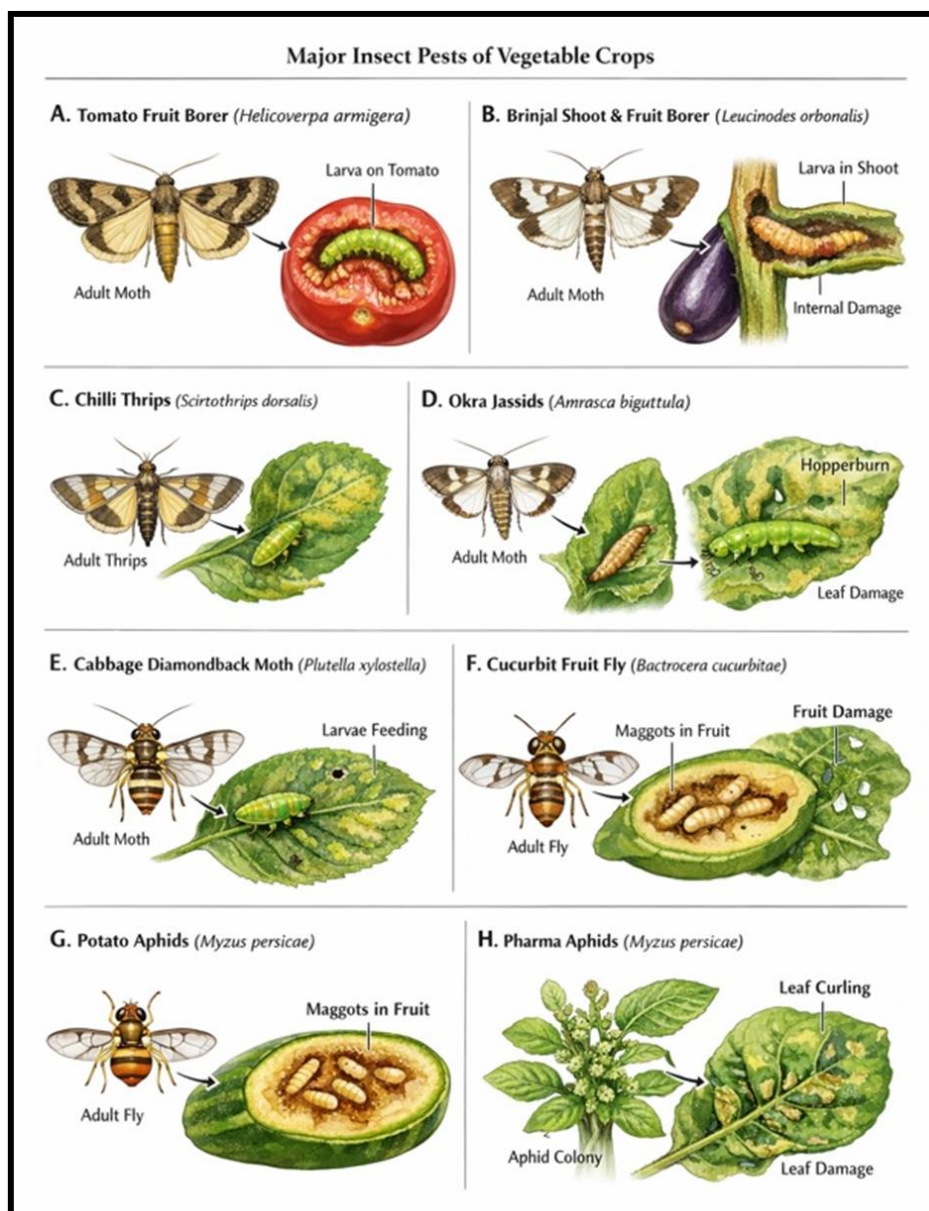


Table 1. Major Insect Pests of Vegetable Crops

Crop	Major Pest	Scientific Name	Damage Symptoms
Tomato	Fruit borer	<i>Helicoverpa armigera</i>	Fruit damage, larval feeding
Brinjal	Shoot & fruit borer	<i>Leucinodes orbonalis</i>	Shoot wilting, fruit damage
Chilli	Thrips	<i>Scirtothrips dorsalis</i>	Leaf curling, silvering
Okra	Jassids	<i>Amrasca biguttula</i>	Hopper burn, yellowing
Cabbage	Diamondback moth	<i>Plutella xylostella</i>	Leaf perforations

Table 2. Integrated Pest Management Practices

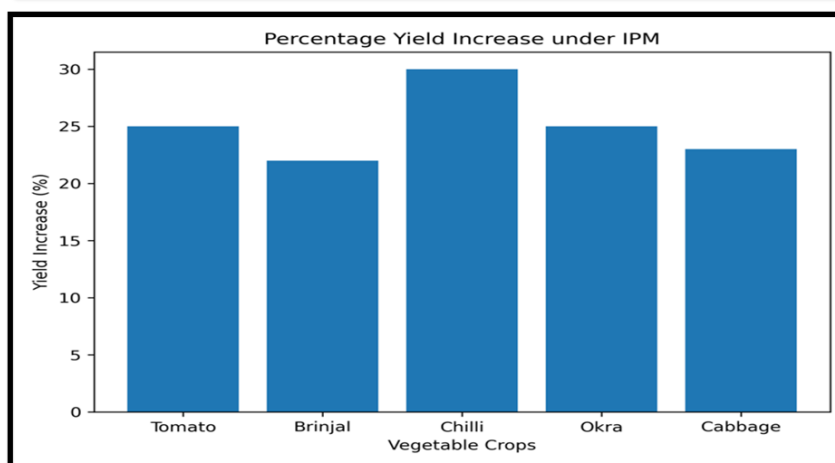
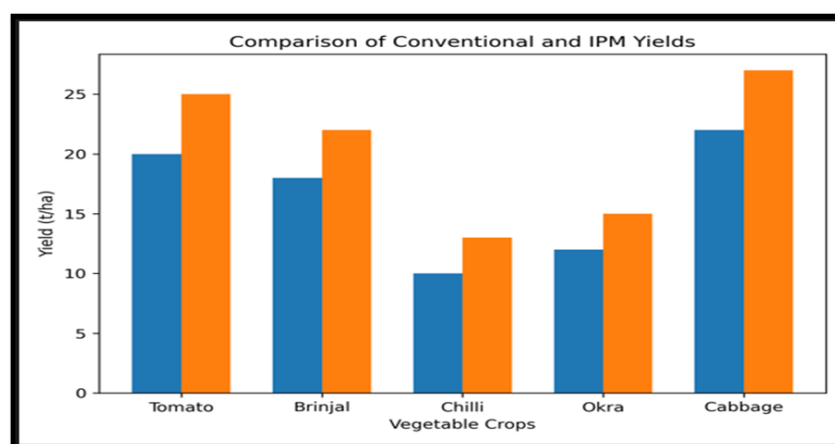
IPM Component	Practices	Target Pests
Cultural	Crop rotation, sanitation, resistant varieties	Borers, soil pests
Mechanical	Pheromone traps, sticky traps	Moths, flies
Biological	<i>Trichogramma</i> , <i>Chrysoperla</i> , <i>Coccinella</i>	Borers, aphids
Botanical	Neem formulations	Sucking pests
Microbial	<i>Bacillus thuringiensis</i> , <i>Beauveria bassiana</i>	Caterpillars
Chemical	Selective insecticides at ETL	Severe infestation

RESULTS

Yield Comparison IPM plots consistently recorded higher yields across all crops. Chilli exhibited the maximum improvement (30%), followed by tomato and okra (25%).

Table 3. Yield Performance under Conventional and IPM Practices

Crop	Conventional Yield (t/ha)	IPM Yield (t/ha)	Yield Increase (%)
Tomato	20	25	25
Brinjal	18	22	22
Chilli	10	13	30
Okra	12	15	25
Cabbage	22	27	23
Average	16.4	20.4	25



DISCUSSION

The results demonstrate that IPM practices significantly improve vegetable productivity. The integration of preventive cultural measures and biological control agents reduces pest pressure without disrupting ecological balance.

Natural enemies, including parasitoids and microbial agents, effectively suppressed pest populations. Reduced chemical intervention helped conserve beneficial insects and prevented resistance buildup.

The observed 25% average yield increase can be attributed to improved crop health, reduced pest damage, and enhanced ecosystem stability. These findings align with previous studies emphasizing the sustainability benefits of IPM.

CONCLUSION

Integrated Pest Management provides an environmentally responsible and economically viable solution for pest control in vegetable crops. By combining ecological principles with scientific pest monitoring, IPM enhances yield, reduces pesticide dependence, and promotes sustainable agriculture. The significant yield advantage observed in this study supports large-scale adoption of IPM practices.

Conflict of interest

The authors declare no competing interests.

Data Availability Statement: Not applicable.

Correspondence and requests for materials should be addressed to **Nilesh P Kakde**

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