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# Post-Harvest Losses of Vegetables Caused by Pests: A Review

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

Insect pests indeed present a major challenge to the storage and processing of vegetables, spices, and ornamentals. Insects, pests and diseases are the major biotic constraints to vegetable production. They not only degrade the quality of the products but also pose serious food safety risks and result in crop loss of about 10-30%. Some of the insect pest responsible for PHL in storage are cigarette beetle (*Lasioderma serricorne*), drug store beetle (*Stegobium panicum*), Potato Rubber Moth (*Phthorimaea operculetta*), sweet potato weevil *(Cylus formicarius)* red flour beetle *(Tribolium castaneum),* Indian meal moth, bean weevils (*Acantboscelides* spp.). The instant, pattern and causes of post-harvest loss specifically due to insect pests are studied. The review revealed that yield losses occur due to major, invasive and emerging insect pests in vegetable crops. For instance, *Leucinodes orbonalis* cause 70–75% damage in brinjal. *Plutella xylostella* cause 52% damage, and *Pieris brassicae* causes 42% damage in cabbage. Furthermore, *Maruca vitrata* causes 36% flower and pod damage in cowpea. *Epilachna vigintioctopunctata* cause 13–88% leaf damage in cowpea. Again, *Eariasvitella, E. insulana is responsible for 35% damage in okra, Helicoverpa armigera* causes 50–80% damage in tomato, *Diaphinia indica* cause 23% damage in cucumber and lastly, *Thrips parvispinus* cause 22.8 % and *Polyphagotarsonemus latus* cause 50% damage in Chillie. The paper highlighted the importance of grain crops in the global food supply, emphasizing the need to understand grain crop losses and implement efficient management strategies. Additionally, it underscored the essential role of grains in the human diet and the severe consequences of grain loss on food and nutrition security. The study is expected to offer valuable insights into the complexities of agricultural product losses, their effects on food and nutrition security and the specific importance of addressing losses in grain crops.

*Keywords: Post harvest loss (PHL); vegetables; insect pest; storage.*

## 1. INTRODUCTION

The agriculture and allied sectors in India have been performing well in recent years, making a significant contribution to the country's overall growth and development (Pathak et al., 2022; Jasrotia et al., 2022). "In India, the contribution of vegetable production remains the highest (59-61%) in horticulture crop production over the last five years. But insects, pests and diseases are the major biotic constraints to vegetable production" (Krishna et al., 2022; Berhe et al., 2022; Adedeji et al., 2020; Debebe, 2022). "Insect pests attack vegetables at various stages of growth, resulting in significant reductions in production and quality. The majority of insects and mites attack tropical crops such as brinjal, tomatoes, chilies, okra and cucurbits" (Ambethgar et al., 2024). "The crop losses in the country due to various pests range on an average from 10-30 per cent. As per the World Bank study, post-harvest losses of foodgrains in India are 7-10 per cent of the total production from farm to market level and 4-5 percent at market and distribution level" (Kumar et al., 2022). "Many new emerging pests have occurred in India during the last decade. Apart from invasive pests, many regular insects have also expanded their host horizon in the last decade" (Haider & Rai, 2021; Bharghavi et al., 2024). "Pests are notoriously difficult to manage due to their rapid reproduction and tolerance to conventional pesticides" (Nazeer et al., 2025; Dantata et al., 2023). "The major biotic constrains in vegetable production in India are tomato fruit borer (*Helicoverpa armigera*), brinjal shoot and fruit borer (*Leucinodes orbonalis*), chilli thrips (*Scirtothrips dorsalis*), fruit and shoot borer (*earias spp*.) on okra, diamond back moth (*plutella xylostella*) on cole crops, fruit fly (*bactrocera cucurbitae*) on cucurbits along with some other pests like serpentine tomato leaf miner, gall midge, okra stem fly and bitter gourd leafhopper and mites are gradually attaining the major pest status in different regions of the country" (Elik et al., 2019; Rajapaksha et al., 2021).

## 2. MATERIALS AND METHODS

Literature searches on fruit and vegetable postharvest losses were conducted in a wide range of databases, journals, and other sources (both published and unpublished), using parameters that included a long list of postharvest horticulture-related keywords. Online databases included SCOPUS, ResearchGate, and Google Scholar. This study is carried out based on literature available in different journals, book chapters and secondary data available in Government databases.

## 3. RESULTS

### 3.1 Post-Harvest Loss (PHL)

Postharvest loss (PHL) is defined as the measurable quantitative and qualitative loss of products at any point in the postharvest chain, from harvest to consumption (Kikulwe et al. 2018). Although fruits and vegetables have high return per unit of time and area but PHL results in significant loss (Chauvin et al. 2012). However, there is very little literature on the quantitative and qualitative information (Emana et al. 2017). Post harvest losses are caused by diseases, injuries like mechanical force, heat or freezing or chilling temperature and due to chemicals and other disorders like over packing or under packing at field or careless handling of marketing containers such as dropping or throwing or walking on produce and packed containers during the process of grading, transport or marketing. Postharvest losses may occur at different levels during the supply chain viz., injuries and pressure damage during harvest; chemicals, bruises and wax damage during packing; chilling injuries, decay, peel disorders, pest infestation at storage; bruising, deformation, decay during transportation; decay, softening, wilting and losses at retail and the consumers.

### 3.2 Types of Post-Harvest Loss by Insect

Losses caused by insects after harvest may be direct or indirect. A direct loss is the disappearance of the commodity as a result of insect feeding, whereas an indirect loss is the lowering of the quality of the commodity to the extent that it attracts a lower price or is rejected completely. It is usual to describe post-harvest losses in terms of a loss in weight, but sometimes it is more helpful to consider the loss in economic terms, as a loss of nutritional units or as a loss of seed. Post-harvest losses are difficult to categorize, but the following categories are generally recognized:

a. **Loss of Weight:** A reduction in the weight of a commodity is usually obvious, but it may not always indicate a loss. It may simply be due to a reduced moisture content. Moisture changes can also lead to an increase in weight, and in some cases, production of water by an insect infestation may partly offset the loss caused by insect feeding. It is, therefore, customary to describe the weight losses on a dry-weight basis.

b. **Loss of Quality:** The quality of produce is assessed in different ways according to those factors considered important by the consumers or traders. Generally, quality is assessed and products graded on the basis of appearance, shape, size, etc.; the amount of foreign material (which may include insects and insect fragments); and damage, including insect damage. The higher the standard set by the consumer, the greater the potential for loss.

c. **Nutritional Loss:** Nutritional loss has been described as the product of quantitative and qualitative losses, but more specifically, it is the loss in terms of nutritional value to the population concerned. A weight loss of grain during storage is a measure of food loss, but the loss of nutrients may be proportionally greater due to selective feeding by insect pests. Some insect larvae, for example, feed preferentially on the germ of the grain, thus removing a large proportion of the protein and vitamin content. Weevils, on the other hand, feed mainly on the endosperm, reducing the carbohydrate content, whilst a bruchid infestation in beans can lead to a serious loss of protein.

d. **Loss of Seed Viability:** Loss of seed viability relates to loss in seed germination, which is important for its effect on future food supplies. Insects that selectively attack the germ will cause greater loss in germination than those feeding on the endosperm.

e. **Commercial Losses:** Commercial losses may occur as a direct consequence of any of the foregoing factors or indirectly as the cost of any preventative or remedial actions required. For example, a control measure that has to be used to ensure that a commodity remains saleable can be counted as an economic loss, and this is perhaps most easily accountable. Indirect consequences of loss may be encountered where measures have to be taken to prevent the loss of goodwill or to cover legal costs arising from the marketing of commodities which are unacceptable because of the presence of insects or insect-related damage.

**Table 1. Yield losses due to major, invasive and emerging insect pests in vegetable crops**

| Crop | Pest | Damage % | References |
|---|---|---|---|
| Brinjal | *Shoot and fruit borer (Leucinodes orbonalis)* | 70–75% | Dhandapani et al (2003) |
| Cabbage | Diamondback moth *(Plutella xylostella)* | 52% | Krishnamoorthy (2004) |
| | Cabbage butterfly *(Pieris brassicae)* | 40% | Ali & Rizvi (2007) |
| Cowpea | Spotted pod borer (*Maruca vitrata)* | 36% flower and pod damage | Singh and Allen (1980) and Phompanjai and Jamjanya (2000) |
| | Hadda beetle *Epilachna vigintioctopunctata* | 13–88% leaf damage | Haider and Rai (2021) |
| Okra | Shoot and fruit borer *Eariasvitella, E. insulana* | 35% | Krishnaiah (1980) |
| | Red spider mite, *Tetranychus spp* | 7–48% | Kumaran et al. (2007) |
| Tomato | *Tomato fruit borer, Helicoverpa armigera* | 50–80% | Dhandapani et al. (2003) |
| | *South American Pin Worm, Tuta absoluta* | 50–100% | Maneno et al.( 2016) |
| Cucumber | Cucumber moth, *Diaphinia indica* | 23% | Haider and Rai (2021) |
| Chillie | Black thrips *Thrips parvispinus* | 22.8 % | Sastrosiswojo (1991) |
| | Chili thrips, *Scirtothrips dorsalis* Hood and yellow mite, *Polyphagotarsonemus latus* | 50% | Kulkarni 1922 and Desai et al. (2007) |

*Source: Divekar* et al*. (2024)*

**Table 2. Some of the common pests that infest vegetables at the store are listed**

| | Insects/ pests | Hosts | Nature of Damage |
|---|---|---|---|
| 1 | Cigarette beetle *Lasioderma serricorne*(Anobiidae: Coleoptera) | Dried fruits and vegetables, spices, ginger, turmeric, black and red pepper, cocoa, etc. | Bore into grains. |
| 2 | Drug Store Beetle (*Stegobium panicum*) | Vegetables, spices, chocolates and dry fruits | Bore into products |
| 3 | Potato Rubber Moth (*Phthorimaea operculetta*) (*Gelechiidae Lepidoptera*) | Potato, tomato, brinjal (Pest of field and storage) | Larva tunnels into foliage, stem and tubers. Galleries are formed near tuber eyes. |
| 4 | Sweet potato weevil *(Cylus formicarius)* Apionidae : Coleoptera | Feeds on plants belonging to family Convolvulaceae, potato (pest of field and storage) | Bore into tubers |
| 5 | Red flour beetle *(Tribolium castaneum)* (Tenebrionidae : Coleoptera) | Pulses, dry fruits, and wheat flour | |
| 6 | Indian meal moths (*Plodia interpunctella*) Pyralidae | Dried fruits, nuts, dried roots, etc. | Larva causes damages by forming web of silken threads over a heap of grains. Adults fly and spread the infestation. |
| 7 | Bean weevils *Acantboscelides* spp. (Chrysomelidae: Coleoptera) | Beans, broad beans, lentils, chickpeas, soybean | Visible damage with tiny dot like entrance holes and larger, round exit holes and excavated seed . A large population may result stored seeds to dust. |

*(Anonymous, 2024a; Anonymous, 2024b; Anonymous, 2020)*

### 3.3 Stored Insect Pests

The stored insect pests are a major threat for agricultural commodities throughout the world, causing damage and loss to the economy and food security. They destroy dried fruits, grains, seeds, nuts, dried fruits, and processed foods, leading to spoilage, contamination, and a reduction in quality. Due to changes in cropping system and the rising use of high-yielding input-intensive hybrid varieties along with climate change, there is a different pattern of insect pest status in time and space and causing more damage worldwide. Some of them act as vectors in the transmission of viral and fungal diseases, causing greater problems. “Moreover, some exotic and invasive insect pests have been found in many parts of the country, e.g., South American pinworm *(Tuta absoluta (Meyrick*), Solenopsis mealy bug, (*Phenacoccus solenopsis Tinsley*) are few such insects. Others include mirid bugs *(Nesidiocoris cruentatus*) and *Metacanthuspulchellus Dallas*), melon weevil (*Acythopeus curvirostris*), white plume moth (*Sphenarches caffer (Zeller*), cucumber moth (*Diaphania indica*) and moringa fruit and seed borer (*Noorda blitealis Walker*), tortoise beetle (*Cassida circumdata Herbst*),” (Halder & Rai 2021; Etefa et al., 2022).

### 3.4 Pests of Stored Vegetables

It is seen from the literature review that about 500 species of insect pests have been associated with stored grain products, out of which almost 100 species of insect pests of stored products cause economic losses (Padmalatha & Balaji, 2024). Flour beetles, Indian meal moths and bean weevils are some of the major pests of stored and processed vegetables. Insect pests are a serious threat to agricultural commodities, causing damage and economic losses along with threats to food security.

### 3.5 Management of Insect Pests at Storage

A well-defined strategy involving a mixture of cultural, mechanical, biological and chemical control methods needs to be adopted. Integrated Pest Management suggests the use of nonchemical methods whenever possible and includes chemical control as part of a holistic pest management tactic (Daglish et al., 2018).

1. Proper sanitation including cleaning and disinfecting of storage facilities and infrastructure,
2. Proper temperature and humidity control as well as ventilation as many species of insect pests thrive in warm and humid conditions.
3. Early monitoring and detection for signs of infestation such as web development, grain damage, holes and bores may reduce the loss/ damage.
4. Use of natural enemies like parasitic wasps and predatory beetles can help to supress the infestation but with heavy infestation there may be requirement of pesticide application.
5. Innovation in packaging, like the use of eco-friendly material.

## 4. CONCLUSION

The study discusses the critical issue of food loss and its significant impact on food and nutrition security. It stresses the importance of minimizing losses to ensure that food reaches those who need it, thereby contributing to a food system that is more sustainable and secure. The study emphasizes the significance of grain crops in the world's food supply and the necessity of comprehending grain crop losses and putting effective management techniques into place. It also emphasizes how important grains are to a person's diet and how losing grains has serious repercussions for food and nutrition security. It is anticipated that the study will provide insightful information about the intricacies of agricultural product losses, their impact on the security of food and nutrition, and the significance of managing losses in grain crops in particular. It is expected that this all-encompassing strategy will contribute to the development of more effective techniques for assuring food and nutrition security and minimizing agricultural produce, particularly grain crop losses. Policy decisions and interventions aimed at minimizing food loss and enhancing food and nutrition security may be influenced by the studies described in the paper. The study's emphasis on the opportunities and problems associated with losses of agricultural products can help stakeholders make better decisions and allocate resources more effectively. Furthermore, the focus on grain crops emphasizes the need for targeted actions to safeguard these essential commodities and ensure their availability for the global food and nutrition supply. Overall, the findings of this study are likely to have wide-ranging implications for

initiatives to establish a more sustainable and resilient food system (Shahbazi et al., 2025).

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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