

Insect Invasive Species: Threat Posed and Collaborative Efforts for Management

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Insects are a highly diverse group of organisms and their rich diversity is essential for ecosystem functioning. Insects have more influence on agriculture and most agricultural pests are invasive species that have been introduced into a new ecosystem. These invasive species have the capacity to compete, establish and displace the native species and therefore can be a threat to biodiversity. Introduction of such invasive species has increased with the increase in trade across the globe. Therefore, it is pertinent to strengthen the International cooperation and coordination between the affected countries and the country of native origin to identify the threat for the execution of different mitigation strategies. International Organization for Biological Control (IOBC), Centre for Agriculture and Bioscience International (CABI) and the Biotechnology and Biological Control Agency facilitate international collaboration and play a vital role in managing invasions by alien pests. In India, Directorate of Plant Protection, Quarantine and Storage (DPPQ&S), ICAR-NBPGR, ICAR-NBAIR and other crop-specific institutes of ICAR, Ministry of Agriculture and Farmers' Welfare, Government of India are the bodies engaged in monitoring of invasive insects/invasive alien species. Thus, international collaboration plays a key role in research on the prevention of future invasions, the development of more effective surveillance and eradication methods and the implementation of classical biological control.

Introduction

India is one of the mega biodiversity centres of the world constituting nearly 7% of the world's insect species. In India, the diversity of insects is known for 27 orders, and Coleoptera remains the most speciose insect order. Of the 27 orders, Coleoptera, Lepidoptera, Orthoptera, Diptera, Hemiptera, Hymenoptera, Odonata and Thysanoptera constitute about 94% of insect fauna and the remaining 21 orders represents 6% of insect species (ZSI, 2012). Worldwide, Coleoptera (3,87,000), Lepidoptera (1,57,000), Diptera (1,55,000) and Hymenoptera (1,17,000) are the most speciose insect orders (Stork, 2018).

Insects due to their rich diversity, ecological role, and influence on agricultural, human health and natural resources contribute more for ecosystem functioning (Scudder, 2017). Most major agricultural pests are non-native species that have been introduced into a new ecosystem and cause potential damage to crops. Agricultural intensification and climate change are rapidly decreasing the diversity of insects worldwide.

Additionally, the rise of invasive species also competes, displaces and changes the community structure of several native insect species in various habitats (Fortuna *et al.* 2022).

Threat to Biodiversity and Invasive Alien Insect Species

Invasive alien species are plants, animals, or any other organisms that are introduced unintentionally or deliberately into a new area that is outside their natural habitat (IUCN). These species have the capacity to establish and can become a threat to biodiversity, disrupt ecosystem services, human health, etc. With globalisation, came the dissolution of the natural barriers, and the tremendous boost to trade, tourism and transport have made it easy for many alien pests to enter and invade new habitats.

Once introduced, they engaged in competition for food and space and eliminate native species. Invasive alien species caused 40% of animal extinction since 17th century (CBD 2006). Invasive alien insect species

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cause direct damage to crops by feeding or indirectly by transmitting diseases and viruses to many crops and thus poses a serious threat to food security. In India, twenty-three species of insects have been reported until 2019 as invasive species (Naveena *et al.*, 2020). These species caused a huge loss in India. For ex., Papaya mealybug in India caused immense loss. Later importation of parasitoid, *Acerophagus papayae* Noyes and Schauff saved a crop loss of Rs. 435 crores (papaya, tapioca and mulberry) and input cost on pesticides to the tune of Rs. 244.5 crores annually in Tamil Nadu (AICRP-BC Annual Report).

There are many examples of invasive alien insects causing harm to native plants and associated fauna. In the Galapagos Islands, the invasion of *Icerya purchasi* Maskell adversely affected endangered plant *Darwiniothamnus tenuifolius* and significantly reduced the abundance of associated three species of Lepidoptera (Roque-Albelo, 2003). The harlequin ladybird, *Harmonia axyridis* (Pallas), a predator which was introduced to North America and Europe to protect crops is now a globally expanding invasive alien species and has spread to almost every continent (de Groot and Haelewaters, 2022). Arrival of this predator resulted in decline in population of two-spot ladybird, *Adalia bipunctata* (Linnaeus) by 30-40 % in Europe over 5 years (Roy *et al.*, 2012).

International Cooperation to Mitigate Invasive Species

Introduction of species has increased with the increase in trade across the globe. Therefore, it is pertinent to foster international cooperation and coordination between the affected countries and the country of native origin to identify the threat and execution of different management strategies. Management strategies for biological invasion can be accomplished by three strategies, by prevention of introduction, by eradication after establishment and by containment to prevent further spread. Information available on invasive species is very much required for prevention. The information on the potentially damaging species along with their management practices can be accessed through various websites like Global Plant Protection News (<https://iapps2010.me>), Centre for Agriculture and Bioscience International's (CABI) Invasive Species Compendium (<https://www.cabi.org/isc>) etc. Official pest reports are also released by the corresponding National Plant Protection Organizations

of countries of origin to conform to International Plant Protection Convention's (IPPC) Standard on Pest Reporting (ISPM-17) (Liebhold *et al.*, 2021).

International Plant Protection Convention (IPPC) has been identified by the World Trade Organization's Agreement on the Application of Sanitary and Phytosanitary Standards (SPS) as the international body responsible for putting in place standards for phytosanitary treatments and other plant quarantine activities (MacLeod *et al.*, 2010). Critical information necessary for implementing phytosanitary measures is generated by elucidating invasion pathways and helps in decision making to apply different prophylactic phytosanitary treatments (Hennessey *et al.*, 2014). International Organization for Biological Control (IOBC), CABI and the Biotechnology and Biological Control Agency facilitate international collaboration and play a vital role in managing invasions by alien pests. However, collaborative research on biological control must adhere to international treaties, one of which is the Convention on Biological Diversity (CBD) with broad objectives on biodiversity conservation; sustainable use of biodiversity; and on fair and equitable benefit sharing (Liebhold *et al.*, 2021).

In India, Directorate of Plant Protection, Quarantine and Storage (DPPQ&S), ICAR-NBPGR, ICAR-NBAIR and other crop-specific institutes of ICAR, Ministry of Agriculture and Farmers' Welfare, Government of India are the bodies engaged in monitoring Invasive insects/Invasive Alien species (Naveena *et al.*, 2020). DPPQ&S is the responsible body for intercepting invasive insects/weeds/pathogens to the country *via* international trade. Thus, international collaboration plays a key role in research on the prevention of future invasions, the development of more effective surveillance and eradication methods, the implementation of classical biological control, and effective coordination with foreign scientists so as to facilitate collaborative research and exchange of data.

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