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Invasive Pests and Their Potential Threats to Indian Agriculture

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Abstract

The Indian agriculture is vulnerable to biotic and abiotic factors mainly invasive pests. These are non-native and exotic which are introduced by humans unintentionally from one region to another. There are about 23 invasive insects recorded in India. They threaten the biodiversity, food security thus significant economic losses. Invasive insects have wide range of characteristics for their establishment and spread viz., wide host range, survival in varied climatic conditions, phenotypic plasticity, high dispersal potential, high fecundity, mutualistic facilitation with viruses and native insects. Climate change and global warming have increased the chances of invasive pests. Government of India have established quarantine stations for monitoring of Invasive Alien Species (IAS). Strict quarantine regulations of import, international trade at the entry points by using molecular diagnostics for early detection will ensure safeguard to India from invasive pest species. Biological control by introduction of natural enemies and chemical control is the last step for the management of the invasive pest.

1. Introduction

India is the seventh largest country in the world with a total area of 3.2 million square kilometres (Stanley et al., 2020). Insect pests are the major constraint for the Indian agriculture. Globally about 30% of yield losses are incurred by pests and diseases. Apart from these, invasive alien species became threat to the agriculture economy in India. According to International Union of Conservation of Nature (IUCN), an invasive alien species (IAS) is an "alien species which becomes established in natural or semi-natural ecosystems or habitats, is an agent of change, and threatens native biological diversity (www.iucn.org)."

The cultural heritage in India attracts many tourists every year and therefore there is a chance of entry of invasive pests through any transportation or through infested fruits or vegetables carried by tourists. The introduction of a single gravid female pest may create havoc and cause disastrous damage to the field crops.

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The establishment of these invasive pests may be due to decreased biotic resistance and increased resource availability. Out of 173 invasive species of agricultural ecosystem about 23 are insects.

2. About Invasive Pests

The invasive species quickly exploit new resources and have the ability to survive in wide range of environmental conditions, and other insect characteristics like short life cycle, high fecundity, wide host range, phenotypic plasticity, mutualistic facilitation with viruses and native insects etc. are all the factors responsible for introduction, establishment and spread of the invasive pests (Figure-1). The IAS also supplant native species, harm biodiversity, and alter ecosystems, resulting in significant economic losses (Kenis et al., 2009; Pratt et al., 2017; Rai and Singh, 2020; Fortuna et al., 2022). Global warming and climate change have favoured the establishment and spread of these pests. Once they establish and spread, they cause huge losses in the agriculture ecosystem. These insects feed, damage or transmit diseases to crops, leading to reduce yields, economic losses for farmers and also threaten food security. The fall army worm, *Spodoptera frugiperda* a destructive polyphagous pest having a wide host range of over 353 plants from 76 families, primarily from the Poaceae (106), Asteraceae (31), and Fabaceae (31) (Dumas et al., 2015; Montezano et al., 2018) caused 15-73% yield losses in maize growing areas. Another invasive pest is papaya mealy bug, *Paracoccus marginatus* which caused 117 billion US dollars loss in India in 2001(Anonymous, 2019). There are about 23 invasive alien pests introduced to India from several different countries (Table 1, Naveena et al., 2020).

Management of invasive pests includes management

Table 1: List of Insect pests introduced into India (Naveena et al., 2020)

Sl. No.	Crop	Common name	Scientific Name	Entry to India (Place)	From/Native
1.	Apple	San Jose scale	*Quadraspidiotus perniciosus* (Comstock) (Hemiptera: Diaspididae)	1879/(1921-Kashmir)	China
2.	Apple	Woolly apple aphid	*Eriosoma lanigerum* (Hausmann) (Hemiptera: Aphididae)	1889-Coonoor, Tamil Nadu/ 1909 Uttar Pradesh	China/America
3.	Potato	Potato tuber moth	*Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae)	1906-(East Bengal, Now in Bangladesh)	Italy
4.	Citrus	Cottony cushion scale	*Ivory pyralin* Maskell (Hemiptera: Margarodidae)	1920-Tamil Nadu	Australia
5.	Pine	Pine woolly aphid	*Pineus pini* (Macquart) (Hemiptera; Adelgidae)	1970-Nilgiris, Tamil Nadu	Western & Central Europe
6.	Subabul	Subabul psyllid	*Heteropsylla cubana* (Crawford) (Hemiptera: Psyllidae)	1988-Tamil Nadu & Bangalore	Central America
7.	Coffee	Coffee berry borer	*Hypothenemus hampei* (Ferrari) (Coleoptera: Curculionidae)	1990-Gudalur, Tamil Nadu	Northeast Africa
8.	Chrysanthemum	Serpentine leaf miner	*Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae)	1991-Hyderabad, Telangana	Florida (U.S.A.)
9.	Coconut	Spiralling white fly	*Aleurodicus disperses* (Russell) (Hemiptera: Aleyrodidae)	1993-Kerala	Central America
10.	Coconut	Coconut Eriophyid mite	*Aceria guerreronis* Keifer (Arachnida: Eriophyidae)	1997-Enakulam, Kerala	Mexico
11.	Eucalyptus	Eucalyptus gall wasp / Blue gum chalcid	*Leptocybe invasa* (Fisher & La) Salle (Hymenoptera: Eulophidae)	2001-Karnataka/Tamil Nadu	Australia

Sl. No.	Crop	Common name	Scientific Name	Entry to India (Place)	From/Native
12.	Erythrina	Erythrina gall wasp	*Quadrastichus erythrinae* (Kim) (Hymenoptera: Eulophidae)	2006-Kerala	Tanzania, East Africa
13.	Cotton	Cotton mealy bug	*Phenacoccus solenopsis*, (Hemiptera: Pseudococcidae)	2006-Gujarat	Central america
14.	Papaya	Papaya mealy bug	*Paracoccus marginatus* (Williams and Granara de Willink) (Hemiptera: Pseudococcidae)	2007-Coimbatore, Tamil Nadu	Mexico
15.	Banana	Jack Beardsley mealybug	*Pseudococcus jackbeardsleyi* (Gimpel and Miller) (Hemiptera: Pseudococcidae)	2012-Karnataka	America
16.	Hibiscus	Madeira mealybug (Hibiscus)	*Phenacoccus madeirensis* (Green) (Hemiptera: Pseudococcidae)	2012-Karnataka	Neotropical
17.	Tomato	South American tomato pinworm/ Tomato leaf minor	*Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae)	2014-Pune, Maharashtra	South America
18.	Coconut	Coconut Spindle infesting leaf beetle	*Wallacea* sp. (Coleoptera: Chrysomelidae)	2014/2015-Andaman Islands	Oriental region Australia -
19.	Coconut	Rugose spiraling whitefly	*Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae)	2016-Tamil Nadu	Central America
20.	Maize	Fall armyworm	*Spodoptera frugiperda* (JE Smith) (Lepidoptera: Noctuidae)	2018-Karnataka	America
21.	Coconut	Nesting whitefly	*Paraleyrodes minei* (Iaccarino) (Hemiptera: Aleyrodidae)	2018-Kerala	Syria
22.	Coconut	Bondar's Nesting Whitefly	*Paraleyrodes bondari* Peracchi (Hemiptera: Aleyrodidae)	2018-Kerala	Central America
23.	Coconut	Neotropical Whitefly	*Aleurotrachelus atratus* (Hempel) (Hemiptera: Aleyrodidae)	2019-Mandya/ Bangalore	Brazil

at three different stages of invasion of pest viz., PRA, quarantine and monitoring (Figure 1). Certain laws are laid by Government of India to cope up with invasive pests. Destructive Insects and Pests Act, 1914 came into effect to prevent the entry of invasive species. At present, thePlant Quarantine Order, 2003 in India provides new import polices which aim to restrict the importation of infested plants or plant products. The Directorate of Plant Protection, Quarantine and Storage (DPPQ&S), ICAR-NBPGR, ICAR-NBAIR and other crop-specific institutes of ICAR, Ministry of Agriculture and farmer's welfare, Government of India are the other regulatory bodies for the monitoring of IAS. Phytosanitary measures will be carried out by them by using the methods which are accepted by IPPC. Molecular diagnostic facilities are established across the quarantine station for easy and rapid detection of invasive pests.

The unavailability of natural enemy and unlimited food supply is a boon to the invasive pests (David et al., 2017). Biological control can reduce the invasive pests to below Economic Threshold Level (ETL) if the natural enemy is found and should be pre-analysed before the introduction of any natural enemy as sometimes it may cause negative impact. Chemical control is the last and quick acting step

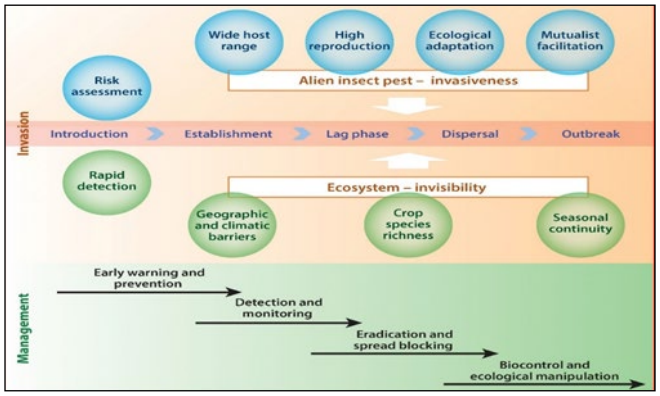

Figure.1: Framework of invasive alien species invasion and management (Wan and Yang, 2016)

and very efficient in controlling the invasive pests. But knowledge of insecticide, selectivity, its mode of action, residual effect is extremely important.

3. Future Perspective

One of the major constraints in India for the identification of the insect (at species level) is limited expertise in taxonomy. Therefore, there is a need to adopt the advanced technologies for early detection of insect pests. Sensory systems, DNA barcoding technology, electric conductance (identification of hidden infestation), Near-infrared spectroscopy (NIR) (quick method without sample preparation), E-nose technology can be used for rapid identification of invasive pests. Prioritising ecosystems based on their susceptibility to climate change and IAS helps to establish measures that will prevent IAS introduction. Continuous research on invasive species, their impact on ecosystems and development of early warning systems can helps us to take up the management strategies accordingly. Public awareness and educating the communities about the risks of invasive pests can lead to better prevent and management efforts. Taking up rigid, rigorous and stringent actions at quarantine stations will completely prevent the entry of IAS and thereby save the biodiversity, provide food security and increase the economy of the nation.

4. Conclusion

Invasive insect pests are non-native insects establish outside their natural habitat and have high dispersal potential. They cause threat to biodiversity, reduce yields and economic losses for farmers and also threaten food security. Mutual exchange of knowledge regarding the invasive pests and their natural enemies with international cooperation can help to minimise the entry and impacts of invasive pests. Early detection and integrated management through biological and chemical methods help in reducing or eradication of these insects.

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