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Invasive Insect Pests and their Management on Tapioca (*Manihot esculenta* Crantz*)* in India

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Abstract

Several insect pests have got introduced into India, and some of them were known to cause extensive damage to economically important crops in India. The present paper deals with the existing invasive insect pests and future pest threats of tapioca (cassava - *Manihot esculenta*)). Invasives include the spiralling whitefly *Aleurodicus dispersus* Russell, papaya mealybug *Paracoccus marginatus* Williams &Granara de Willink, Madeira mealybug *Phenacoccus madeirensis* Green, cassava mealybugs *Phenacoccus manihoti* Matile-Ferrero and *Phenacoccus herreni* Cox & Williams. *Aleurodicus dispersus*, native to Caribbean islands and Central America, was first reported to occur in 1993 in Kerala, and later in Tamil Nadu. Heavy incidence of spiralling whitefly caused yield reduction up to 54% in tapioca in India. The accidentally introduced parasitoids *Encarsia quadeloupae* Viggiani and *Encarsia* (?) *haitiensis* Dozier were able to suppress spiralling whitefly infesting tapioca in Tamil Nadu and Kerala. Papaya mealybug *Paracoccus marginatus*, native to Mexico, Central and North America was reported first on many agricultural and horticultural crops including cassava in July 2008 in Tamil Nadu.Tapioca yield was reduced considerably by the infestation of *P. marginatus* in Kerala and Tamil Nadu.The encyrtid parasitoid *Acerophagus papayae* Noyes and Schauff imported from Puerto Rico has given excellent control of *P. marginatus* infesting tapioca in peninsular India. *Phenacoccus manihoti*, the Neotropical species (South America), was accidentally introduced into Africa in the early 1970s, and it has spread fast to many Asian countries, *viz.*, Thailand, Vietnam, Lao PDR, Cambodia and Myanmar. It is an immediate threat to cassava industry in India. The encyrtid parasitoid *Apoanagyrus (= Epidinocarsis) lopezi* (DeSantis) had given excellent control of *P. manihoti* in several African countries. *Phenacoccus herreni* is known to cause yield losses in cassava in its native South America. It is a future threat to cassava in India. Three encyrtid parasitoids *Apoanagyrus diversicornis* (Howard), *Aenasiu vexans* Kerrich and *Acerophagus coccois* Smith, are used to control the cassava mealybug *P. herreni* in South America. If the mealy bug gets introduced into Asian countries, the above parasitoids can be imported to suppress *P. herreni.*

Key words: Invasive insects, spiralling whitefly, *Aleurodicus dispersus*, *Paracoccu marginatus, Phenacoccus madeirensis,* classical biological control, *Phenacoccus manihoti, Phenacoccus herreni,* cassava

Introduction

Invasive species are 'non-native species which threaten ecosystem besides habitats and species'. Invasive pests include insect pests of agricultural importance. Problems caused by such invasive species in agricultural ecosystems are manifold. These alien pests find the new habitat ideal and conducive for breeding and establishment without any restriction through regulating factors like natural enemies that keep the species under check in its native range. Several insect pests have got introduced into India, and some of them were known to cause extensive damage to the economically important crops in India. The present paper deals with the invasive insect pests - spiralling whitefly, *Aleurodicus dispersus* Russell; papaya mealybug *Paracoccus marginatus* Williams & Granara de Willink; Madeira mealybug- *Phenacoccus madeirensis* Green; cassava mealybugs, *Phenacoccus manihoti* Matile-Ferrero and

Phenacoccus herreni Cox & Williams. Managing such invasive species can be ideally attempted through biological methods including classical biological control and fortuitous biological control. The information on the above invasives will be useful whenever there is introduction of *P. manihoti* and *P. herreni/* outbreak of existing exotic *A.dispersus, P. marginatus* and *P. madeirensis* in tapioca growing areas of India.

Spiralling whitefly (*Aleurodicus dispersus*)

Bemesia tabaci (Genn.) was the only whitefly reported to cause damage to cassava in India up to 1993. Palaniswami et al. (1995) reported spiralling whitefly, *Aleurodicus dispersus* Russell for the first time in 1993 on cassava in Kerala.

Origin and distribution

Aleurodicus dispersus, native to Caribbean islands and Central America, is reported to occur in North America, South America, Asia, Africa, Australia and several Pacific islands. Besides Kerala, in 1993 it was observed in neighbouring states of Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, and Lakshadweep islands and subsequently in Rajasthan and New Delhi (Mani and Krishnamoorthy, 2007).

Biology

Eggs are laid in a typical spiral pattern from which the whitefly derives its common name. Female whitefly lays yellowish white eggs hatching in 5-8 days. Fecundity ranges from 51.8 to 64.06 eggs/female. There are four nymphal instars, which are greenish, white and oval. Fourth instar nymphs are covered with heavy wax material. The total nymphal period normally lasts for 12 to 14 days and pupal period lasts for 2 to 3 days. Development from egg to adult occupies about 20 days. Adults are much larger with dark reddish brown eyes and fore wings with characteristics dark spots. Adults live for 13 to 22 days (Geetha, 2000).

Ecology

In the absence of the parasitoids, weather factors significantly contributed for the variation in the population of spiralling whitefly. When the aphelinid parasitoids (*Encarsi*a spp.) are abundant, they dilute the effect of abiotic factors, and also play a major role in the regulation of *A. dispersus* population. Heavy sporadic rains and cool temperatures resulted in a temporary reduction in *A. dispersus* population. Palaniswami et al. (1995) reported the outbreaks during the post rainy dry season between November and April peaks in February in Kerala. According to Ranjith et al. (1996), the whitefly had increased drastically in summer and decreased after the pre-monsoon showers in Kerala. In Karnataka, the population of spiralling whitefly was found to be higher during March-June and the density of the white fly was positively correlated with maximum temperature and negatively correlated with relative humidity (Mani and Krishnamoorthy, 2000). In Tamil Nadu, the whitefly population was more during May- October (Geetha, 2000).

Damage

Aleurodicus dispersus is highly polyphagous known to attack about 500 plants in different countries and 280 in India alone. It was first collected on coconut in Florida. In India, the pest was first reported in 1993 on tapioca by Palaniswami et al. (1995). The spiralling whitefly *A.dispersus* is one of the serious polyphagous pest, posing a major threat to cassava cultivation in India. *Manihot esculenta* was one of the most highly preferred host plant by *A. dispersus* in India and also elsewhere. The infestation by spiralling whitefly was severe on improved cassava and perennial cassava were grown in Nigeria, Ghana, Kenya and Congo (D'Almeida et al.1998) *A. leurodicus dispersus* was also observed on cassava in Anuradhapura, Madampe and Sri Jayewardenepura in Sri Lanka (Wijesekara and Kudgamage, 1990). Besides cassava, the spiralling whitefly was also found damaging sweet potato in some countries.

Nymphs and adults congregate generally on the lower surface, but sometimes the upper surface leaves of all the host plants, and suck the sap. Yellow speckling, crinkling and curling of the leaves were noted when the infestation was severe on tapioca. The copious white, waxy flocculent material secreted by nymphs is readily spread elsewhere by wind and creates a very unsightly nuisance. Furthermore, much sticky honeydew is produced which serves as substrate for dense growth of sooty moulds, which interfere with photosynthesis. The sticky honeydew carried by wind on the flocculent wax adheres to windows and cars and causes considerable annoyances. Heavy incidence of spiralling whitefly caused yield reduction up to 55% in tapioca in India (Palaniswami et al. 1995; Geetha, 2000).

Management

Management of polyphagous invasive pests like spiralling whitefly becomes all the more difficult because of the multitude of host plants that grow wild in nature and support the build-up of the pests.

Physical control

Light trap is more appropriate tool for monitoring. A simple method for trapping large number of *A. dispersus* with light traps coated with vaseline was suggested (Srinivasan and Mohanasundaram, 1997). Fluorescent light smeared with castor oil attracted and trapped large number of adults (Asia Marium, 1999). Maximum adults were attracted and caught in yellow color sticky trap (Geetha, 2000).

Chemical control

Initial pesticide application may be necessary to control heavy infestations, Dichlorvos 0.08% was found toxic to various stages of spiralling whitefly. Triazophos 0.08%, clothianidin, imidacloprid and thiamethoxam were recommended for the control of spiralling whitefly. Rotation of insecticides from different groups may be effective in preventing the build of tolerance to the insecticides. Care should be taken to ensure that the insecticide used will not kill the naturally occurring parasitoids and predators of whiteflies. Only the use of selective insecticides is advised to manage the spiralling whitefly.

Setting up of sticky light traps initially and 15 days later spraying of ecofriendly insecticides had reduced the remaining population of the spiralling whitefly. Application of tobacco extract (4%,), neem oil 2%, and neem seed kernel extract 3%, fish oil rosin soap (4%) and detergent soap solution (5%) are known to reduce the whitefly population. Spraying the leaves using insecticidal soap / horticultural oil (made from petroleum), is another, environment friendly option. The spray will suppress the population enough to allow predator and parasitoid numbers to build up and start to control them (Geetha and Manickam, 2013; Mani and Krishnamoorthy, 2007).

Biological control

Application of chemicals to the lower surface of infested leaves thoroughly reduces the whitefly abundance but temporarily. Spraying with insecticides has little long-term impact on the pest; it usually makes the problem worse by destroying the biocontrol agents, prolonging the infestation, and promoting insecticide resistance in whitefly populations**.** Chemical control is impracticable because of abundance of host plants including extremely large size trees and wide spread distribution. Therefore, alternate methods such as biological control could help in the suppression of *A. dispersus*. As *A. dispersus* is an exotic pest in most of the countries, classical biological control is considered to be the best option for sustainable management (Mani and Krishnamoorthy, 2002).

Natural enemies

As many as 50 natural enemies (3 parasitoids, 45 predators and 2 pathogens) are known to attack the spiralling whitefly in different locations in India (Mani and Krishnamoorthy, 2007).

Parasitoids

Encarsia quadeloupae Viggiani and *Encarsia* (?) *haitiensis* Dozier are important parasitoids of spiralling whitefly. Adults of *Encarsia*(?) *haitiensis* are yellow coloured, while that of *Encarsia quadeloupae* are black in colour. Healthy nymphs are greenish, white and oval. The parasitised nymph turns black.

Predators

A total of 45 species of predators have been recorded in India. The major predators are coccinellids and chrysopids. *Cybocephalu*s sp. was observed in higher numbers on tapioca in and around Coimbatore. Among the coccinellids, *Anegleis cardoni* (Weise), *Anegleis perrotteti* (Mulsant), *Axinoscymnus puttarudriah* Kapur and Munshi, *Cheilomenes sexmaculata* (F), three species of *Jauravia* and *Cryptolaemus montrouzieri* Mulsant were commonly found in the spiralling whitefly colonies. The green lacewing *Mallada astur* (Banks) was frequently encountered on *A.dispersus* in several locations in south India (Mani and Krishnamoorthy, 2007).

Pathogens

Paecilomyces farinosis (Holms.) was known to infect the nymphs of spiralling whitefly in Bangalore. The nymphs were found infected with *Lecanicillium lecanii*Zimm. at Dharwad. The entomopathogenic fungi *Lecanicillium lecanii* and *Isaria fumosorosea* exhibited promising levels of control (> 70% mortality of the *A. dispersus* population) in Tamil Nadu. Application of *I. fumosorosea* was highly

pathogenic to *A. dispersus* in two seasons.Thus, entomopathogenic fungi have the potential to manage *A. dispersus* infestation of cassava (Mani and Krishnamoorthy, 2007).

Biological control attempts

The aphelinid parasitoids *Encarsia* (?) *haitiensis* and *Encarsia guadeloupae* have given excellent control of spiralling whitefly in several countries. When the parasitoids are not present, spiralling whiteflies multiply at a great rate, producing thousands of individuals on a single plant. However, when the parasitoid is present, there is excellent control of the whitefly, and it appears along with the appearance of spiralling whitefly but little later. In some cases, the parasitoid got introduced along with the whitefly, and in some other cases, it was deliberately introduced by government authorities.

Africa

Interestingly, the accidental introduction of *E.* (?)*haitiensis* into West Africa appeared to have occurred simultaneously with the introduction of the whitefly. *Encarsia*(?)*haitiensis* was found in all sampling sites in Benin as well as Ibadan in Nigeria and in Togo and Ghana. In early 1993, the spiralling whitefly was observed in Benin for the first time, inflicting damage to several crops including cassava. *Encarsia* (?) *haitiensis* Dozier and *E. guadeloupae* were observed in the second half of 1993. *Encarsia*(?) *haitiensis* was more abundant and widespread than *E. guadeloupae*. By 1995, *E. guadeloupae* was recovered from most (84%) of the infested localities (Neuenschwander, 1994; D'Almeida et al., 1998).

India

The survey in South India during January – July 2000 indicated that *E.* (?) *haitiensis* and *E.guadeloupae* were known to occur at several locations in Kerala , Karnataka, Maharashtra, Andhra Pradesh and Tamil Nadu (Mani et al., 2001). Both *E.* (?) *haitiensis* and *E.guadeloupae* have spread in many more areas resulting in remarkable reduction in the population of *A. dispersus* in India. *Encarsia guadeloupae* caused up to 77.11% parasitism on many crop plants in Bangalore and 78.88% in Thrissur. Periodic releases and recoveries of *Encarsia*(?)*haitiensis* were made around Coimbatore and parasitism of 20.92% was observed within a month after of release and later up to 70 percent (Geetha, 2000).Outbreak and heavy population of this whitefly (420 adults/ leaf) was recorded during dry summer periods in the years 2011 and 2012 in Salem, Erode and other adjoining districts in Tamil Nadu. As on 2016, the spiralling whitefly is no more a serious problem. It might be due to build up of *E. guadeloupae* on spiralling whitefly on cassava and other host plants over a period of time.

Competitive displacement of *Encarsia* spp.

Initially *E. guadeloupae* and *E.* (?) *haitiensis* were present on the spiralling whitefly. Subsequently, *E. guadeloupae* became dominant and displaced *E.* (?) *haitiensis* in India as witnessed in Tenerife, Benin and Taiwan (Mani et al. 2004).

Papaya mealy bug (*Paracoccus marginatus*)

Ferrisia virgata (Cockerell) and *Nipaecoccus viridis* (Newstead) (*Pseudococcus filamentosus* Ckll.) were known to attack cassava until 2010 in India. Muniappan *et al.*(2008) reported the incidence of *Paracoccus marginatus* Williams and Granara de Willink on a wide list of agricultural and horticultural crops including cassava in Tamil Nadu during 2008 (Muniappan et al., 2008)

Origin and distribution

Paracoccus marginatus is native to Mexico and/or Central and North America. Since its first description in 1992 from new tropical region, *P. marginatus* has spread to several Caribbean islands, central and south America, several African and Asian countries. In India, it was found causing serious damage to cassava in Tamil Nadu during 2008 and later in Kerala (Mani et al., 2016).

Biology

A single female lays about 400 eggs in an ovisac. Eggs are greenish yellow and egg hatching occurs in about 10 days. Males have four instars; first instar nymphs, are called as crawlers. Females have three instars. Adult female mealybug secretes large amounts of white wax. Males have longer development time (27-30 days) than females (24-26 days). Mean longevity of adult males and females was 2.3 and 21.2 days respectively.

Damage

Heavy clustering of mealybugs was seen under leaf surface giving the appearance of a thick mat with waxy secretion. The insect sucks the sap by inserting its stylets into the

epidermis of the leaf and stem. While feeding, it injects a toxic substance into the leaves resulting in curling, crinkling, rosetting, twisting and general leaf distortion. They excrete copious amount of honey dew that attracts ants and helps in development of black sooty mould which inhibits the plant's ability to manufacture food. Infestation at the initial stage is observed on the leaf, particularly on the ventral surface and petiole, and later it spreads to stems and branches. Heavy infestation causes leaf shedding and yield loss (Sakthivel and Qadri, 2010).The mealybug infestation varied from 50 to 90 per cent in cassava resulting in a monetary loss of rupees 220 crores in cassava alone in Tamil Nadu.

Ecology

Mealybug occurs throughout the year but active in warm dry weather. Prolonged drought with scanty rain fall and less number of rainy days favour the faster multiplication of the mealybug. During rainy season, papaya mealybug populations decreased drastically because heavy rain washed the insects off the plants. However, mealybugs sheltered within unopened leaves and other hiding places survived and built up their numbers again during the warm, dry weather. Heavy rains caused mortality of the mealybug especially of the crawler's stage.

Management

A comprehensive integrated pest management practices *viz*., early detection by timely monitoring, removal and destruction of affected plants and weeds, conserving natural enemies like predacious coccinellid beetles, lepidopteran predator *Spalgis epeus* Westwood and need based application of insecticides were developed. Even after adoption of IPM, the population of papaya mealybug was found to increase at a faster rate for want of efficient natural enemies since the pest is invasive and the chemical control is short lived and farmers have to spray once in a fortnight (Mani et al., 2012)

Severe infestation of *P.marginatus* was observed on cassava in several districts *viz*., Namakkal, Salem, Dharmapuri, Coimbatore,Karur, Erode,Thiruppur, Perambalur and Trichy in Tamil Nadu (Venkatesan et al., 2011). Since *Acerophagus papayae* Noyes and Schauff has given excellent control of *P. marginatus* in many countries, it was imported from Puerto Rico in June 2010, and releases were made in Tamil Nadu in 2010 (Mani et al., 2012).

Population density of papaya mealybug on cassava and percent parasitism on the mealybugs were recorded in the three sampling sites before and after release of parasitoids. Heavy population load @ 38.70, 43.85 and 41.21 numbers / $5cm^2$ was recorded in the districts of Salem, Dharmapuri and Namakkal respectively. No parasitism was observed in a pre-release survey in all the locations. Inoculative release of *A. papayae* @ 200 individuals per location was made in the tapioca gardens. The mealybug population had declined uniformly corresponding to gradual increase in percent parasitism. The parasitism by *A. Papayae* went up to 95% within six months of release. There was 94% suppression in the population of the mealybug in all the tapioca fields (Sakthivel, 2013). Similar control of the mealyug was achieved with the release of *A.papayae* in other districts namely Trichy, Erode (Divya, 2012) and Karur (Vijay, 2010) in Tamil Nadu, India. In Perambalur District in Tamil Nadu, *A.papayae* was releasesd in 100 farmers fields during 2010-11. A maximum of 100% parasitism was achieved within five months of parasitoid release, and there was also complete supppression of the mealybug (Sankar et al., 2012).

In Erode district, *P. marginatus* was reported on cassava on 07.07.2009. The incidence of mealybug was observed to be high (41 – 50% infestation) in Sithalanthur village. Before the introduction of the parasitoid, in Tamil Nadu, 84.7 % of the cassava area was affected by the papaya mealy bug. During 2010 -2011, the parasitoid *Acerophagous papayae* was released, and the farmers were convinced about the performance of the parasitoid in the suppression of mealybug (Venkatesan et al., 2011). In 2010-12, the mealybug, *P. marginatus* caused up to 80% loss in the tapioca growing areas in Salem region. Savings to the tune of ` 370 crores was realised due to mealybug control by the parasitoid release (Jonathan et al., 2011).

In Kerala, total area for tapioca cultivation is 75000 ha with the production 30 t ha^{-1}. The tuber yield was reduced considerably by the infestation of *P. marginatus*. Due to release of *A. papayae* in 2011, a net savings of 2.5 lakhs ha^{-1} and 1.8 crores/ year was realized in Kerala. The ICAR-Central Tuber Crop Research Institute, Trivandrum (ICAR-CTCRI) developed bioformulations "*Shreya*" and "*Nanma*" which are very effective against *P.marginatus*.

The Madeira mealybug (*Phenacoccus madeirensis*)

Phenacoccus madeirensis Green is of Neotropical origin, and is widespread in tropical South America, but was originally described from Madeira (Green, 1923). *P. madeirensis* is highly polyphagous, feeding on many herbaceous crops, fruit trees, and ornamentals. Shylesha et al., (2012) reported *P.madeirensis* first on *Cestrum nocturnam* in 2011, later on cotton, *Hibiscus rosasinensis*, *Lantana camera*, *Clerodendron viscosum*, brinjal, potato, acalypha, crossandra, tapioca and mulberry in many parts of Karnataka and Tamil Nadu. Four parasitoids namely *Allotropa* sp., *Anagyrus sinope* sp.nr., *Anagyrus quadrii* (Hayat, Alam & Agarwal) and *Anagyru sloeckii* Noyes & Menezes were recorded on *P.madeirensis*. Among them, *A.quadrii* was predominant. *Anagyrus amnestos* was also found to be potential parasitoid of Madeira mealybug. Besides the above parasitoids, *Cacoxenus persipicax* (Knab), *Cryptolaemus montrouzieri* Mulsant, *Scymnus* sp. and some undetermined cecidomyiids were found feeding on the Madeira mealybug (Shylesha et al., 2012). There is very good scope of utilising the above parasitoids for the suppression of the Madeira mealybug.

Cassava mealybugs

Phenacoccus manihoti

Phenacoccus manihoti, the Neotropical species (South America) was accidentally introduced into Africa in the early 1970s, and it has become naturalized throughout sub-Saharan Africa (Matile-Ferrero, 1978). Damage includes destruction of terminal shoots and expanded leaves by sucking of sap (and possibly by the injection of a salivary toxin) leading to short internodes, small leaves and sometimes die-back. The economic damage is partly from the loss of fresh leaves (which are edible) and partly from loss in root yield. The yield loss went up to 50% (Schulthess et al., 1991). In the absence of its natural enemies and other control measures, this damage can reduce yields by more than 80 per cent (Nwanze, 1982).

Phenacoccus manihoti remains a threat to the cassava areas of southern Asia. It is an immediate threat to cassava industry in India. *P. manihoti* was first detected in Thailand in 2008 (Winotai et al., 2010). There was a drop of about 25% in tuber yield in 2010 and economic losses resulting from mealybug damage were expected to be 2.8 billion Baht. With the appearance of the mealybug, the Department of Agriculture estimated losses of 40-50 per cent, adding up to more than US$150-200 million in crop damage in the first year alone. Further it was also detected at Vienam, Lao PDR, Cambodia, Myanmar, and threatens to engulf the cassava growing areas of southern China, Indonesia and Philippines (Muniappan et al., 2009; Wu and Wang, 2011).

The introduction of the parasitoid *Apoanagyrus (=Epidinocarsis) lopezi* (DeSantis) into Africa in 1980 reduced high infestations by 90%, becoming a highly-successful case of classical biological control. *Apoanagyrus lopezi* is an efficient biological control agent across several ecological zones of the African cassava (Neuenschwander and Hammond 1988; Hammond and Neuenschwander, 1990.).The wasp has been effective in bringing the mealybug under control and reduces yield loss by 2.5 tons per hectare. The successful control of the cassava mealybug problems has raised cassava yields and turned cassava into a cash crop that is now spreading throughout Africa. If the mealybug gets introduced into India, it can be tackled easily with the exotic parasitoid *Apoanagyrus lopezi*.

Phenacoccus herreni

Phenacoccus herreni is native of South America. It is a future threat to cassava industry in India. It is known to attack the young shoots and causing rosetting, stunting and shoot and stem malformations resulting yield loss in cassava in South America. The mealybugs are spread largely by wind and the movement of infested plant material (Bellotti, 1983). *Phenacoccus herreni* densities in Colombia were highest in the dry season. Mealybug densities had declined sharply with the onset of rains.Three encyrtid parasitoids *Apoanagyrus diversicornis* (Howard), *Aenasius vexans* Kerrich and *Acerophagus coccois* Smith, are used to control the cassava mealybug *P. herreni* in South America and several African countries (Driesche *et al.* 1990). If the mealy bug gets introduced into Asian Countries, the above parasitoids can be imported to suppress *Ph. herreni* in India.

Conclusion

Invasive insect pests of cassava include the spiralling whitefly *Aleurodicus dispersus* Russell, papaya mealybug *Paracoccus marginatus* Williams &Granara de Willink, Madeira mealybug *Phenacoccus madeirensis* Green, cassava

mealybugs *Phenacoccus manihoti* Matile-Ferrero and *Phenacoccus herreni* Cox & Williams. The accidentally introduced parasitoids *Encarsia quadeloupae* Viggiani and *Encarsia* (?) *haitiensis* Dozier were able to suppress spiralling whitefly infesting tapioca in Tamil Nadu and Kerala.The encyrtid parasitoid *Acerophagus papayae* Noyes and Schauff imported from Puerto Rico has given excellent control of *P.marginatus* infesting tapioca in peninsular India. *Phenacoccus manihoti*, the Neotropical species (South America), has spread fast to many Asian countries Thailand, Vietnam, Lao PDR, Cambodia and Myanmar. It is an immediate threat to cassava industry in India. *Phenacoccus herreni* is known to cause yield losses in cassava in its native South America , is a future threat to cassava in India. Three encyrtid parasitoids *Apoanagyrus diversicornis* (Howard), *Aenasiu vexans* Kerrich and *Acerophagus coccois* Smith, are used to control the cassava mealybug *Ph. herreni* in South America. If the mealybug *Ph. herreni* gets introduced into India, the encyrtid parasitoids *Apoanagyrus diversicornis* (Howard), *Aenasiu vexans* Kerrich and *Acerophagus coccois* Smith can be imported to suppress *Ph. herreni.*

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