

## **Invasive Alien Eucalyptus gall wasp, *Leptocybe invasa* (Fisher and Lasalle): A Threat to Eucalyptus Plantations in Tamilnadu (India)**

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**Abstract:** Survey was conducted in *Eucalyptus* nurseries and plantations of TAFCON at Karaikudi, Aranthangi, Pudukattai, Ariyalur and Sivagangai regions and TNPL farm forestry areas at Thiruvallur, Chengalpet, Mathuranthakam, Kanchipuram, Sriperumputhur, Madapuram, Akaram, Ulunthoorpettai, Thirunelveli, Sivagangai, Kovilpatti, Sattur, Ariyalur, Thiruvannamalai, Krishnagiri, Dharmapuri and Namakkal, covering five Agro-climatic zones of Tamil nadu viz., Cauvery Delta, North Eastern, Western and Southern Zones. Of the nineteen clones planted, clones like C10, C7, C271, T61 and C 283, were found infested with gall insect, *Leptocybe invasa*, ranging from 80-100%. Clone 413 was planted in all the agro-climatic zones surveyed and found free from gall. The most preferred clones C10, C3 and C7 were infested in all agro-climatic zones of Tamilnadu. Clone C283 and C271 were found to be most susceptible clones in southern, north eastern and north western zones, respectively. The present survey reveals that the pest invaded to the southern zone through Cauvery delta zone and correspondingly to western zone through North western zone. Clones C274, C226 and IFGTB clones were found to be free from gall insect exhibiting promising growth traits.

**Key words:** Eucalyptus gall • Eucalyptus clonal plantations and agro-climatic zones

### **INTRODUCTION**

Eucalyptus is one of the important plantation crops suitable for wasteland and degraded sites. It produces quality pulpwood for paper, newsprint and rayon industry. Some species of Eucalyptus are valuable timber, construction wood, as fodder for livestock. Commercial eucalyptus plantations are important global assets providing wood and wood fiber products to modern societies and offer a wide range of social, environmental and economic benefits to millions of people. Eucalyptus meets requirements of people, industries and has helped to reduce pressure on natural forests. More than 16 million hectares of eucalyptus is planted around the world for various purposes, including pulp for paper manufacture, solid wood and structural timbers and as woodlots for fuel. With an area of 8.0 million ha, India ranks first in area with a productivity of 146 t/ha [1, 2]. There is a high demand for the eucalyptus wood in India for various purposes like timber, pulp wood, fire wood and poles [3].

**Invasive Nature of Exotic Species:** Eucalyptus was introduced to India in 18<sup>th</sup> century (1790 by Tipu Sultan). As in the case of other exotic species, Eucalyptus is also encountered by several severe problems in India. Several plant and animal species of foreign origin have contributed a lot for India's food security. However, periodically some alien species have become 'exotic pests' which pose enormous threat to various ecosystems in India. These have invaded new areas due to either accidental or deliberate transport by humans. Increasing trends towards travel and import of plant products suggest that exotic species will continue to invade India in future with unprecedented consequences. Today, more species have become invasive than at any other time in the past. While most introduced species fail to become established, those that do, have become serious pests in agriculture, urban areas and natural landscapes. Annually, alien species cost crores of rupees in control measures and crop damage. They also threaten human health, displace native species or degrade environmental aesthetics.

**Insect Pests of Eucalyptus in India:** A number of pests such as stem borers, defoliators, sap suckers and gall forming insects attack eucalyptus. However, gall forming insects *viz.* *Ophelimus eucalypti* (Gahan) and *Ophelimus maskelli* (Ashmead) have emerged as the main production constraints in recent times in its native country, Australia. Since 2000, a new invasive pest is wreaking havoc on eucalyptus plantations throughout the world. First reported from northern and eastern Africa, the Middle East and Mediterranean countries, the pest has expanded its range like wild fire in every continent. Presumed to have originated from Australia, the pest was subsequently identified as a gall wasp new to science and named as *Leptocybe invasa* Fisher & La Salle (Hymenoptera: Eulophidae) [4].

**Nature and Extent of Gall Wasp Infestation:** Eucalyptus gall wasp, *L. invasa* has shown incredible natural dispersal ability throughout areas where it has been introduced. The pest causes galls on the midribs, petioles and stems of new shoots of *Eucalyptus*. Heavy infestation leads to deformed leaves, shoots and reduction in growth. Adult female size ranges from 1.1 to 1.4 mm. The adult wasps lay eggs inside tender leaves and stem and the larvae after hatching out of eggs remain in a cavity formed within the plant tissues and feed on the plant causing injury to plant tissues which results in formation of galls. The pest attack was observed mainly in nurseries, young plantations and coppiced areas. The affected seedlings show stunted growth and become unsuitable for planting [4]. On heavily attacked young trees the canopy hangs due to the weight of galls [5]. The practice of raising nursery for planting new areas coupled with coppicing provides large amounts of young leaf and shoot material ideal for *L. invasa* attack. This favors large population build-up and consequent higher levels of damage. First noticed in India during 2001 [6], the insect attack has assumed greater significance since its spread in many parts of the country. Initially the occurrence was restricted to a small area and attack was not observed to be serious [7]. Later, the insect attack assumed greater significance, since it had spread to other parts of the country causing large scale economic loss in clonal nurseries, clonal plantations and coppiced areas [8].

**Survey and Evaluation of Gall Incidence:** The Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore undertook extensive surveys in the eucalyptus plantations in Tamil Nadu during 2007 and 2009 to assess

the extent of infestation of the pest. Many paper companies and farmers planted high yielding clones such as C10, C3, C413, C7, C283 and C285 to enhance the productivity. Based on the survey, the clone C10 have been abandoned in Tamilnadu, since it was considered as the most susceptible clone, which farmers once preferred to grow for more biomass. Hence, further propagation and planting of C10 was stopped by TAF CORN, TNPL and many paper companies since 2009. Though there are indications that the outbreak level infestation of the gall wasp has subsidized, there are reports on the existence of gall wasp menace in Tamilnadu here and there in small pockets. To assess the present situation on the spread of the pest in Tamilnadu and the damage caused, survey was undertaken in different *Eucalyptus* growing areas of Tamilnadu from April, 2012 to March 2013.

## MATERIALS AND METHODS

**Study Sites:** The survey was conducted in eucalyptus nurseries and plantations of TAF CORN at Karaikudi, Aranthangi, Pudukkottai, Ariyalur and Sivagangai regions (Table 1) and TNPL farm forestry areas at Thiruvallur, Chengalpet, Mathuranthakam, Kanchipuram, Sriperamputhur, Madapuram, Akaram, Ulunthoorpettai, Thirunelveli, Sivagangai, Kovilpatti, Sattur, Ariyalur, Thiruvannamalai, Krishnagiri, Dharmapuri and Namakkal, covering five Agro-climatic zones of Tamilnadu *viz.*, Cauvery Delta, North Eastern, Western, North Western and Southern zones (Fig. 1).

**Methodology:** *Eucalyptus* nurseries and plantations of age 4 years and below, older coppiced plantations and seed origin plantations of Tamil Nadu Forest Plantation Corporation (TAF CORN), Tamil Nadu Newsprint and Papers Limited (TNPL) were selected for the survey. Clones such as C10, C3, C7, C274, C226, C413, C2045, C285, T61, T81, T113, T93, T97, KK5, C271, C283, C4, C217, C106 and provenances such as Laura, Kennedy River, Palmer River, Norman Bay and Emu Creck were planted in five Agro-climatic zones of Tamilnadu. In each plantation, quadrats of size 10m x 10m were marked randomly and the trees therein were visually assessed for presence or absence of gall insect attack. The intensity of infestation of each plot was arrived as VL = Very low infestation (VL- <10%); L = Low infestation (>10 -<25%) M= Medium infestation (>25-<50%) and S = High infestation (>50 %). The nursery plants were also examined for infestation and the percentage of infestation was worked out.

Table 1: Study sites under different Agro-climatic zones of Tamilnadu

Agroclimatic zone	Ownership of the plantation	Location of sites
North Eastern Zone	TNPL (Tamilnadu News Paper Limited) farm forestry areas	Thiruvallur, Chengalpet, Mathuranthakam, Kanchipuram, Madapuram, Melmaruvathur, Villupuram, Sriperamputhur, Ulunthoorpettai, Thiruvannamalai, Jayankaondam, Aandimadam and Meensuruti
Southern zones	TNPL farm forestry areas and TAFCON	Kalakadu, Thirunelveli, Kovilpatti, Sathur, Madurai, Manamadurai, Kalayarkovil, Karaikudi, Pudhukottai and Sivagangai.
North Western Zone	TNPL farm forestry	Namakkal, Thoppur, Harur, Uthangarai, Pennagaram and Hogenakkal.
Western Zone	IFGTB research plots	Coimbatore - Panampully, Karunya, Bharathiar University and IFGTB nursery
Cauvery Delta Zone	TAFCON (Tamilnadu Forest Development Corporation) areas	Aranthangi, Ariyalur and Thanjavur.



Fig. 1: Study sites in different Agroclimatic zones of Tamilnadu

### RESULTS AND DISCUSSION

The results of survey conducted in five Agroclimatic zones viz., Cauvery Delta, North Eastern, Western, North Western and Southern zones are as follows.

The provenances such as Kennedy River, Palmer River, Emu Creek and Norman Bay raised by TAFCON were found free from gall insect infestation. These provenances were imported by TAFCON from Australia. The clones such as C10, C3, C7, C274, C226, C413, C2045, C285, T61, T81, T113, T93, T97, KK5, C271, C283, C4,

C217, C106 IFGTB and provenances like Laura, Kennedy River, Palmer River, Emu Creek and Norman Bay were raised in their respective nurseries and planted in aforementioned study sites of both TAFCON and TNPL. Of the nineteen clones planted by TAFCON, fifteen clones viz., C10, C3, C7, C274, C226, C413, C285, T61, T81, T113, T93, T97, KK5, C271, C217 and provenances like Laura, Kennedy River, Palmer River, Emu Creek and Norman Bay Laura, Kennedy river, Palmer River, Norman Bay and Emu Greek were found in TAFCON regions. Of the fifteen clones studied, clones such as C10, C3 and C7, C271, T61 and KK5 were found infested by gall insect, *L. invasa* from 10 to 100 percent. Clones such as C3, C7, C413, C271, C4, C2045, C283, C106 were planted in TNPL farm forestry areas. Of the eight clones planted by TNPL, clones such as C283, C413, C3 and C7 were found infested with gall insect. C283 was found to be severely infested with 100 percent followed by C413 with 70-80 percent infestation. Clones such as C274, C226 and IFGTB clones were found free from gall insect with promising growth traits.

**Southern Zone:** Southern zone consists of clonal plantations and seed origin. The results of survey conducted are given in Table 2. It was noticed that clones such as C413, C226, C274, C106 and IFGTB are free from the infestation of gall wasp, while C3, C7 and KK5 had moderate infestation. Clone C283 had high infestation at Meenakshipuram near Madurai (Latitude: 9° 54' 21.412" N; Longitude: 78° 17' 03.231" E; Altitude: 128.5 (m) msl). In the present survey, the clone C413 is free from infestation of gall wasp unlike in our earlier observation during 2009 with heavy infestation. The recently introduced clone by TAFCON KK5 is found infested with gall wasp. The clones such as C226 and C274 are also free from gall wasp attack during our survey and reported with heavy infestation of gall insect earlier [9]. IFGTB clones are free from infestation of gall wasp.

Table 2: Gall insect incidence on various clones of Eucalyptus in Southern zone

Location	Planting agency	Name of the clone / Provenance	% of infestation
Karaikudi	TAFORN	C – 413	NIL
Virudhunagar, Kovilpatti	TNPL	C – 413	NIL
Pudukottai	TAFORN	C - 226	NIL
Pudukottai	TAFORN	C – 3	NIL
Sivagangai	TNPL	C – 3	25%
Sivagangai	TAFORN	C – 274	NIL
Karaikudi	TAFORN	C – 7	10%
Meenakshipuram (Madurai)	TNPL	C – 7	30%
Sivagangai	TAFORN	C – 10	80%
Sivagangai	TAFORN	C – 271	NIL
Manamadurai	TAFORN	KK - 5	25%
Manamadurai	TAFORN	Laura (S)	10%
Karaikudi	TAFORN (N)	Kennedy river (S)	NIL
Karaikudi	TAFORN (N)	Palmer river (S)	NIL
Karaikudi	TAFORN (N)	Emu greekl (S)	NIL
Karaikudi	TAFORN (N)	Normanbay (S)	NIL
Meenakshipuram (Madurai)	TNPL	C – 283	100%
Kalayarkovil	TNPL	C – 106 (C)	NIL
Kalayarkovil	TNPL	IFGTB	NIL

TAFORN – Tamilnadu Forest Plantation Corporation Limited, TNPL - Tamil Nadu Newsprint and Papers Limited

Table 3: Gall insect incidence on various clones of Eucalyptus in North Eastern zone

Location	Planting agency	Name of the clone / Provenance	% of infestation
Periyavalayam RF Jayankondam	TAFORN	C - 226	NIL
Vettiyarvetu RF - Jayankondam	TAFORN	C - 285	NIL
Melur -Aandimadam	TAFORN (N)	C - 285	10%
Melur –Aandimadam	TAFORN	C - 3	NIL
Aandimadam	TAFORN (N)	C - 3	NIL
Kattur agaram	TNPL	C – 3	10%
Melur –Aandimadam	TAFORN	C – 7	10%
Kattur agaram	TNPL	C – 7	NIL
Vettiyarvetu RF - Jayankondam	TAFORN	C – 274	NIL
Vettiyarvetu RF - Jayankondam	TAFORN	C – 413	NIL
Kundaveli	TNPL	C – 413	50%
Vettiyarvetu RF - Jayankondam	TAFORN	T – 81	NIL
Vettiyarvetu RF - Jayankondam	TAFORN	T – 113	NIL
Vettiyarvetu RF - Jayankondam	TAFORN	T – 93	NIL
Vettiyarvetu RF - Jayankondam	TAFORN	T – 97	NIL
Jayankondam	TAFORN	T – 61	20%
Vettiyarvetu	TAFORN	C - 271	60%
Sriperampudhur	TNPL	C – 271	NIL
Siluvachery RF - Aandimadam	TAFORN (N)	Laura	NIL
Kanchipuram- Vazhathur	TNPL	C - 4	NIL
Kanchipuram- Jaminperupakkam	TNPL	C - 2045	NIL

**North Eastern Zone:** Clones C226, C285, C3, C7, C413, T81, T113, T93, T97, T61, C271, C4, C10, C2045 and the provenance Laura are planted in this zone (Table 3). The clones such as C285, T61 and C271 raised by TAFORN are infested with the gall insect at Vettiyarvetu (Latitude: 11° 15' 15.283" N; Longitude: 79° 24' 30.741" E; Altitude: 54.9 (m) msl) near Jayankondam. The Clone 413 is widely planted in NE zone found infested with 70 percent. The newly introduced clone T61 is severely infested with gall insect. Clones C285 and C271

were the less infested clones during 2007-2009, but 60 percent infestation is noticed during the present survey.

**Cauvery Delta Zone:** Clonal plantation of C10, C7, C3, C413, C226, C274 and provenances like Emu Creck, Norman Bay and Kennedy River are surveyed in this zone. Clones such as C10, C3 and C7 had heavy infestation of *L. invasa* (Table 4). However, clones C3 and C7 were free from gall insect infestation during 2007 to 2009 [9].

Table 4: Gall insect incidence on various clones of Eucalyptus in Cauvery Delta zone

Location	Planting agency	Name of the clone / Provenance	% of infestation
Aranthangi	TAF CORN	C - 10	30%
Aranthangi	TAF CORN	C - 7	30%
Arimalam (Rayavaram range)	TAF CORN (N)	C - 7	NIL
Aranthangi	TAF CORN	C - 3	10%
Arimalam (Rayavaram range)	TAF CORN (N)	C - 3	NIL
Aranthangi	TAF CORN	C - 413	NIL
Arimalam (Rayavaram range)	TAF CORN (N)	C - 413	NIL
Aranthangi	TAF CORN	C - 226	NIL
Arimalam (Rayavaram range)	TAF CORN (N)	C - 226	NIL
Aranthangi	TAF CORN	C - 274	NIL
Arimalam (Rayavaram range)	TAF CORN (N)	C - 274	NIL
Aranthangi	TAF CORN	CTERA	NIL
Arimalam (Rayavaram range)	TAF CORN (N)	Emu greek (S)	NIL
Arimalam (Rayavaram range)	TAF CORN (N)	Norman bay (S)	NIL
Arimalam (Rayavaram range)	TAF CORN (N)	Kennedy river (S)	NIL

Table 5: Gall insect incidence on various clones of Eucalyptus in North western zone

Location	Planting agency	Name of the clone / Provenance	% of infestation
Namakkal	TNPL	C - 413	NIL
Thoppur	TNPL	C - 413	NIL
Harur	TNPL	C - 413	NIL
Pennagaram	TNPL	C - 413	NIL
Krishnagiri	TNPL	C - 413	80%
Uthankarai	TNPL	C - 413	NIL

Table 6: Zone wise clonal plantation available and corresponding gall insect infestation

Clone Name	Southern			North East			North West			Cauvery Delta			Western zone			Infestation % (Zone wise)				
	P	N	C	P	N	C	P	N	C	P	N	C	P	N	C	S	NE	NW	C	W
C - 413	+	+	-	+	-	-	+	-	-	+	+	-	-	-	-	-	50	40	-	-
C - 3	+	+	+	+	+	+	-	-	-	+	+	-	-	-	-	25	10	-	10	-
C -7	+	+	+	+	+	-	-	-	-	+	+	-	-	-	-	30	10	-	30	-
C -10	+	-	+	+	-	-	-	-	-	+	-	-	-	-	-	80	-	-	30	-
KK - 5	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	25	-	-	-	-
Laura	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-
C - 283	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	-	-	-	-
C - 285	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-
T - 61	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-
C - 271	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	60	-	-	-
C - 4	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C - 2045	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C - 274	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-
CTERA	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
C - 226	+	+	-	+	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-
C - 274	+	+	-	+	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-
C - 106	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IFGTB	+	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-
T - 81	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T -113	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T -93	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T -97	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kennedy river	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palmer river	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Norman bay	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emu greek	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

+ presence of clone/seed origin; - absence of clone. P- Plantation, N- Nursery, C-Coppice.



Fig. 2: Zone wise representation of number of clones infested with gall wasp

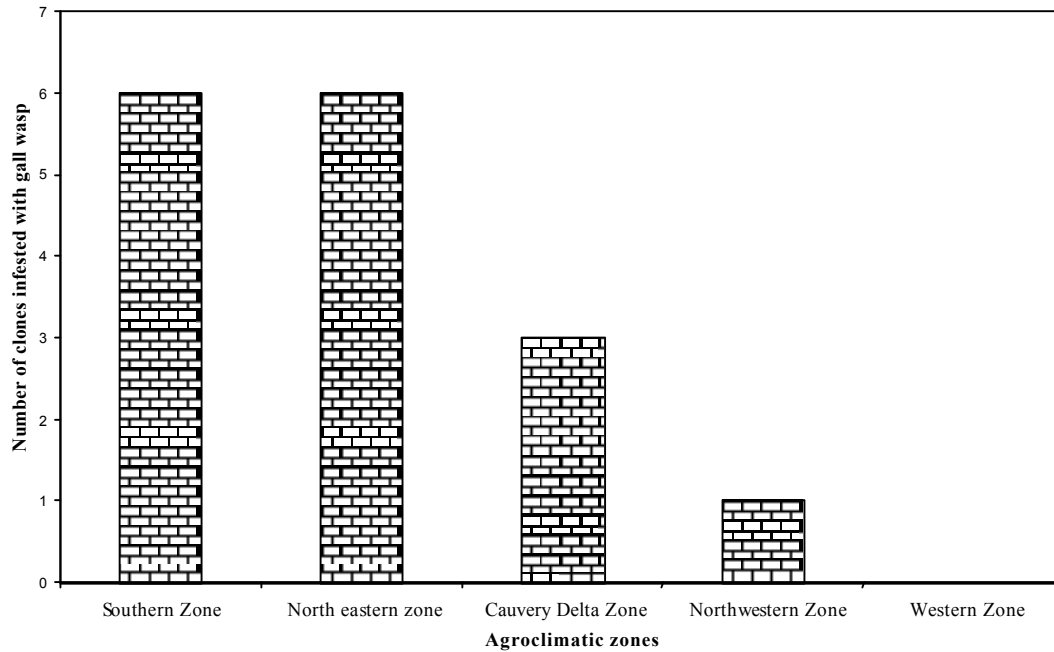


Fig. 3: Dispersion pattern of gall wasp in different Agroclimatic zones of Tamilnadu

**North Western Zone:** The widely planted and accepted clone in this region is C413. No incidence of gall wasp noticed in clonal plantations at Thoppur, Pennagaram, Harur and Uthankarai. However severe infestation of gall wasp on C413 is noticed at Pochampally near Krishnagiri (Table 5).

**Western Zone:** Survey was made on clonal plantations of IFGTB at Banampalli, Bharathiyar University campus, Karunya and IFGTB campus for the incidence of gall wasp. They are free from gall insect infestation (Fig. 2).

In brief, of the nineteen clones, clones such as C10, C3, C7, C271, T61, C283, C413 and KK5 (Table 6) were

found infested with gall insect, *L. invasa*. Clones C10, C283, C413 and C271 were severely infested with gall insect (80-100%). Clone 413 was planted in almost all the agro-climatic zones surveyed and found infested with gall insect in north western and north eastern zones only and free from gall infestation in rest of the zones. The most preferred clones such as C10, C3 and C7 were infested with gall insect in all agro-climatic zones of Tamilnadu. Clone C283, C271 and C413 were found to be most susceptible clones in southern zone, north eastern and north western zones, respectively. Gall insect was first noticed in Marakaanam district of Tamilnadu, Northeastern zone [8]. It is revealed from the present survey that it invaded to southern zone through Cauvery delta zone correspondingly to western zone through North western zone (Fig. 3). Clones such as C274, C226 and IFGTB clones were found free from gall insect with promising growth traits.

### CONCLUSION

The present study revealed that the gall incidence is not totally contained in the state, since some of the areas are still continued to be ravaged by the gall wasp. The suggested control measures include periodic monitoring of infested nurseries and plantation, mechanical removal, avoiding use of susceptible clones. When the pest incidence is low, selective pruning or plucking of leaves or shoots, application of systemic insecticides such as dimethoate or oxydemeton methyl (2 ml/l) or imidacloprid (1 ml/l) at fortnightly intervals. But application of chemical insecticides has to be judicious and may be practical only in nurseries. Two Eulophide parasitoids native to Israel namely *Quadrastichus mendeli* Kim and LaSalle and *Selitrichodes kryceri* Kim and LaSalle were introduced to India and released in gall wasp affected area. The results have been encouraging [10]. Continuous monitoring in both nurseries and young plantations for the incidence of the gall insect at regular intervals is very much essential in order to effectively manage the pest.

### ACKNOWLEDGEMENTS

We thank MoEF, GOI for funding support through project No. 5/2/2012-RE. We also thank TAF CORN and TNPL for permission granted to conduct the study. Thanks are also due to Dr. K.R. Sasidharan, Scientist, IFGTB for critically going through the manuscript.

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