



## A REVIEW OF DIFFERENT INSECTS ASSOCIATED WITH THE NEEM TREE, *AZADIRACHTA INDICA* (MELIACEAE)

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### ABSTRACT

*Azadirachta indica*, also known as Neem, has gained widespread attention in recent years due to its diverse medical and insecticidal benefits. Neem has been widely utilized in various medicinal fields like Ayurvedic, Unani, and Homeopathy. Neem produces a varied range of physiologically active chemicals that are both chemically and structurally complex. Many insects have been reported on Neem so far causing damage and destruction. This review summarises the various insects associated with the neem along with their nature of damage.

**Keywords:** *Azadirachta indica*, Neem, insect, pest, damage, infestation.

### INTRODUCTION

*Azadirachta indica* A. Juss, also known as “Neem” is a resourceful tree of the family Meliaceae (Figure 1). The family Meliaceae is distinguished by the constant occurrence of characteristic compounds called meliacins or limonoids (Das et al. 1984). Neem has also been named as *A. indica*, which is derived from the Persian language and means “the free tree of India” (Kumar and Navaratnam, 2013). It is native to upper Burma and other parts of south India (Roxburgh 1874). The center of origin of *Azadirachta indica* A. Juss is in the forests of Karnataka or the dried inland forest of Myanmar (Gamble 1902). In Africa, neem was introduced from India. Some old trees were also found on the island of Gran Canaria in Las Palmas (Schmutterer 1995). Isolated compounds from the neem have medicinal and therapeutic properties to combat various diseases (Biswas et al. 2002), and owing to its multifaceted properties neem is rightly called the

‘Village pharmacy’ or ‘doctor tree’ or ‘Wonder tree of India’ or ‘The bitter gem’ (Girish and Shankara 2008). Various parts of the neem tree are known to contain over 40 bitter principles belonging to the diterpenoid, triterpenoid, limonoid, and flavonoid groups of natural products (Thakur et al. 1981). The products obtained from neem provide many benefits to human health (Kumar and Navaratnam 2013) as well as livestock health (Esch 2012).

### A Neem Tree, *Azadirachta indica*

Despite the presence of various phytochemicals responsible for insecticidal properties, there were numerous insects have been recorded to cause damage to the plant (Boa 1995; Ciesla, 1993; Council 2002; Kiyanthi and Mikunthan 2009; Schmutterer 1998; Sharma 2016). There were many insects reported on Neem belonging to different orders are described below:

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S.No.	Order	Family	Name of insect	Damage causing stage	Nature of damage	References
1	Lepidoptera	Geometridae	<i>Cleora cornaria</i> Guenee	Larvae	Voracious feeder of leaves	(Mishra and Omkar, 2012; Sabo et al., 2018)
2	Lepidoptera	Geometridae	<i>Ascotis selenaria</i> (Denis & Schiffermuller, 1775)	Larvae	Defoliators of tenders leaves and shoots	(Chander and Singh, 2017)
3	Lepidoptera	Geometridae	<i>Macaria notata</i> (Linnaeus, 1758)	Larvae	Defoliators of leaves leaving the midrib	(Kiyanthy and Mikunthan 2009)
4	Lepidoptera	Geometridae	<i>Boarmia variegata</i> Moore	Larvae	Leaf feeders and defoliators of nurseries	(Rishi et al. 2013; Tewari, 1992)
5	Lepidoptera	Erebidae	<i>Leptocneria reducta</i> Walker	Larvae	Defoliators of leaves and fresh shoots	(Erskine 2014)
6	Lepidoptera	Tortricidae	<i>Loboschiza koenigiana</i> (Fabricius, 1775)	Larvae	Borers of seedlings and young plants. Also they roll up the leaves for shelter	(Kiyanthy and Mikunthan, 2009)
7	Coleoptera	Scarabaeidae	<i>Holotrichia serrata</i> (Fabricius)	Grubs	Defoliators of young seedlings and feeders of roots	(Theurkar et al. 2013; Tippannavar 2013)
8	Coleoptera	Curculionidae	<i>Myllocerus viridis</i> , <i>M. discolor</i> , <i>M. Subfaciatus</i> , and <i>M. maculosus myllocerus tenuicornis</i> Faust	Adults  Larvae	Consumers of leaves except midrib  Create tunnels inside the roots for attacking seedlings and other parts	(Kiyanthy and Mkunthan 2009)
9	Coleoptera	Bostrichidae	<i>Apate terebrans</i>	Adults & larvae	Create tunnels and feed on wood	(de Souza et al. 2009)



			(Pallas			
10	Coleoptera	Anthribidae	<i>Araecerus fasciculatus</i> de geer	Larvae Adults	Defoliators of seeds Create holes to come out	(Beeson 1941; Biosci et al. 2014)
11	Coleoptera	Silvanidae	<i>Oryzaephilus acuminatus</i> Halstead	Larvae	Defoliators and consumers of seeds	(Thomas and Woodruff, 2011)
12	Heteroptera	Miridae	<i>Helopeltis antonii</i> Signoret	Adults	Drying symptoms including exudation of gum	(Sundararaju & Sundara babu 1998)
14	Homoptera	Coccidae	<i>Pulvinaria maxima</i> Green	Nymphs and adults	Infest whole tree and suck sap	(Schmutterer 1999)
15	Homoptera	Coccidae	<i>Macropulvinaria jacksoni</i>	Nymphs and adults	Sap-sucking and causes yellowing of leaves	(Hodges 1992)
16	Homoptera	Coccidae	<i>Ceroplastes ceriferus</i> (Fabricius)	Nymphs and adults	Drying and yellowing	(Muniappan et al. 2002)
17	Homoptera	Coccidae	<i>Pseudococcus</i>	Nymphs and adults	Cause severe damage to seedlings by sucking sap	(Sharma 2016)
18	Homoptera	Coccidae	<i>Paracoccus marginatus</i> (Williams and Granara de Willink)	-	Yellowing and wilting of leaves but plant normally survived	(Sakthivel et al. 2012)
19	Homoptera	Cydnidae	<i>Scaptocoris castanea</i> Perty	Adults	Cause damage to seedlings by attacking radicles Symptoms include yellowing, wilting and drying	(Matias et al., 2011)

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20	Homoptera	Diaspididae	<i>Aonidiella orientalis</i> (Newstead)	Adults and nymphs	Yellowing, retarded growth and death of tree	(Ensaf et al. 2016; Lale 1998; Schmutterer, 1990a, 1998)
21	Orthoptera	Acrididae	<i>Orthacris simulans</i>	Adults and nymphs	Defoliation of leaves	(Sharma 2016)
22	Orthoptera	Tettigoniidae	<i>Microcentrum retinerve</i> (Burmeister, H., 1838)	Adults	Defoliation of leaves	(Chockalingam and Noorjahan 1984)
23	Hymenoptera	Formicidae	<i>Acromyrmex</i> species	Adults	Defoliation by cutting of leaves	(Schmutterer 1990a)
24	Isoptera	Termitidae	<i>Microtermes mycophagus</i> (Desneux, 1906)	Adults	Fungus growing termite causes deterioration of wood	(Iqbal et al. 2015)
25	Isoptera	Termitidae	<i>Microtermes naidensis</i> Harris	Adults	Infest and cause big tunnels inside the wood	(Al-Ghamdi et al. 2009)
26	Isoptera	Termitidae	<i>Coptotermes frenchi</i> (Hill)	Adults	Infest and cause big tunnels inside the wood	(Suganthy and Pretheepkumar, 2019)
27	Isoptera	Termitidae	<i>Coptotermes formosanus</i> Shiraki	Adults	Severe infestation in trunk and branches	(Delate and Grace, 1995)



Table 1. List of different insect pest of Neem and their nature of the damage



Figure 1. A Neem tree, *Azadirachta indica* (© Photographed by Barish E. James)

**Order-Lepidoptera**

**Family-Geometridae**

***Cleora cornaria* Guenee**

Larvae of this semi-looper moth are voracious feeders and cause damage to the neem tree by chewing the young leaves of the plant in a semi-circular manner. Adults are creamish with brown patterns on the wings. Newly hatched larvae are bright green and are the most active feeders of the leaves. They show semi-looper movements but as they reach to pre-pupal stage they become sluggish (Mishra & Omkar, 2012; Sabo et al., 2018).

***Ascotis selenaria* (Denis & Schiffermuller, 1775)**

These are the giant looper moths and their larvae are polyphagous. Larvae are the ones that defoliate the plant by feeding on the young tender leaves and shoots of *Melia azedarach* which leads to the loss of growth and defoliation of the plant (Beeson, 1941; Browne, 1968). Also, an outbreak of this moth is observed on Neem (*Azadirachta indica*) and Bakain (*Melia azedarach*) in Haryana and Punjab in India causing harm to the trees (Chander and Singh 2017).

***Macaria notata* (Linnaeus, 1758)**

Peacock moth, *Macaria notata* were the defoliators of Neem. At first, larvae were green in color and became brown as they developed toward the later stage. They consumed the whole leaves from the margin except the midrib (Kiyanthy & Mikunthan, 2009).

***Boarmia variegata* Moore**

The looper larvae of this moth are the major pest of *Melia azedarach* in North East India cause defoliation while feeding on the leaves completely and leaving the midrib and some basal parts of the leaves (Board 2003; Rishi et al. 2013; Tewari 1992). This defoliating insect causes serious damage to nurseries in arid regions (Farooqi and Sreeramu 2004).

**Family-Erebidae**

***Leptocneria reducta* Walker**

Australian white cedar moth, *Leptocneria reducta* was found to be consuming the leaves and fresh shoots of the plant. The hairy caterpillars are voracious feeders and defoliators of *Melia azedarach* and feed on leaves at night and gather at the base of the tree during the day. Once they caused the infestation to one plant they invaded other plants for further defoliation (Erskine 2014).

**Family-Tortricidae**

***Loboschiza koenigiana* (Fabricius, 1775)**

The tortricid moth, *Loboschiza koenigiana* causes damage to seedlings and young plants by boring into the terminals and then feeding on them. Larva of this

moth lives inside the leafy shelter made on its own, by rolling the leaves of their host plant and joining it together with silk where it gets pupated and grows well (Kiyanthy and Mikunthan 2009).

**Order- Thysanoptera**

Adults and nymphs feed on the sap of neem flowers. The insects' feeding causes ovarian abortion. The flowers fade and drop prematurely, and no fruit develops in such flowers. Its life cycle takes 13-18 days to complete (Ananthakrishnan 1973).

**Order-Coleoptera**

**Family-Scarabaeidae**

***Holotrichia* sp.**

*Holotrichia* sp. is also known as Chaffer beetle or May-June beetle. Adults of *Holotrichia serrata* (Fabricius) were collected from the host plant (Neem) at the population site of Khed Taluka (Northern Western Ghats, India) are dull brown and about 22 mm in length and 14 mm in width. A heavy infestation is found on the host plant in June-August (Theurkar et al. 2013). Their larvae are the white grubs feeding on roots and cause heavy damage to young seedlings. Adults feed on foliage at night (Srivastava et al. 1971; Tippannavar 2013).

**Family-Curculionidae**

***Myllocerus* sp.**

These beetles are generally polyphagous, but they have a limited host range. Adults are 2.5 mm to 6.2 mm long, with numerous blackish spots or lines on the thorax and elytra. The color ranges from yellowish-green to light to dark green, and grey to brown, which allows them to blend in with the color of the leaves, stems, and thorns and thus avoid predation (Kumar et al. 2016). The adults are the defoliators and consume the whole leaf except the midrib while the larvae damage the plant by feeding activity making the roots hollow by keep advancing upwards making tunnels and attacking seedlings and other parts of the plant (Paunekar 2015). Four species of *Myllocerus* such as *M. viridis*, *M. discolor*, *M. subfaciatus*, and *M. maculosus* cause damage to the



leaves (Kiyanthi and Mikunthan 2009). *Myllocerus tenuicornis* Faust is found to be infesting leaves of neem, *Azadirachta indica* in India.

#### Family-Bostrichidae

##### *Apate terebrans* (Pallas)

Adults of *Apate terebrans* (Pallas) are first found attacking a neem plantation in Brazil. The damage is identified as a hole in the trunk, from where the shot-hole-borer entered by constructing tunnels and feeding on the wood (de Souza et al. 2009).

#### Family-Anthribidae

##### *Araecerus fasciculatus* De Geer

It was reported for the first time on *Melia azedarach* in Iran. Larvae of the beetle cause damage to the plant by feeding on its seeds where they fed, developed, pupated and adults are only responsible for boring holes to come out of the seeds. No other part of the plant was attacked by this beetle (Biosci et al., 2014). It is also affecting the seeds of *Acacia nilotica*, *Aleurites fordii* and *Ficus glomerata* (Beeson, 1941).

#### Family-Silvanidae

##### *Oryzaephilus acuminatus* Halstead

It thrives well on stored dry neem seeds. Although these seeds were reported to have insecticidal properties, the chemicals do not appear harmful to them (Thomas and Woodruff, 2011)

#### Order- Hemiptera

#### Order- Heteroptera

##### Family Miridae-

##### *Helopeltis antonii* Signoret

It is known as the tea mosquito bug also widely spread in Asia and considered a serious pest of neem in India. It causes drying symptoms and it's sucking mouthparts

contribute to causing the tender shoots to exude a gum-like which on exposure to air becomes hardened (Pillai & Gopi, 1990; Sharma, 2016).

#### Family- Pentatomidae

##### *Halys dentatus* (Fabricius) 1775

*Halys dentatus*, commonly known as Neem bug is a phytosuccivorous bug infesting neem, *Azadirachta indica*. They tend to feed singly or in groups in the various plant including Neem. They show defensive behavior against their natural enemies such as camouflage, fake death, ejection of foul smell from the metathoracic scent gland, and yellow-colored excretory fluid from the anal part (Dhiman and Yadav, 2003). The first instar stage is a non-feeding stage and the rest of the stages include active feeders of tender as well as harder twigs and also the side branches of the tree (Dhiman et al. 2019).

#### Order-Homoptera

#### Family-Coccidae

##### *Pulvinaria maxima* (*Megapulvinaria maxima*) Green

This scale insect was found on neem in the Delhi region in India and is a serious pest of neem by infesting the tree and can be recognized by a thick coating of white mealy patches, the egg sacs on the foliage, shoots, and bark (Schmutterer 1999; Tyagi et al. 2014)

##### *Macropulvinaria jacksoni*

A large yellowish-brown scale of neem from Niger was identified as *Macropulvinaria jacksoni* by the International Institute of Entomology (IIE). Further, it was also collected from Maradi and Niamey. The symptoms are general yellowing of leaves due to severe infestation (Hodges 1992)

##### *Ceroplastes ceriferus* (Fabricius)

The Indian wax scale, *Ceroplastes ceriferus* is attacking neem plants, and their infestations were observed on the tender stems of the plant (Muniappan et al. 2002)

#### Family-Pseudococcidae

##### *Pseudococcus* spp.

It causes severe damage to the seedlings of Neem (Sharma 2016).

##### *Paracoccus marginatus* (Williams and Granara de Willink)

It is a serious pest of Papaya in Tamil Nadu, India. Apart from other plants and crops, the status of infestation is low in *Azadirachta indica* with less presence of all stages of mealybug. There are no adverse symptoms like leaf distortion observed. The infestation is moderate in *Melia dubia* as all stages of mealybug are present in large numbers. Symptoms observed are wilting and yellowing of plant leaves and the plants normally survived (Sakthivel et al. 2012).

##### *Rastrococcus invadens* Williams

It is a polyphagous pest and there is a low infestation recorded on neem besides other plants found in West Africa (Agoukéné et al. 1988).

#### Family-Cydnidae

##### *Scaptocoris castanea* Perty

*Scaptocoris* species are also known as Brown burrower bugs due to their burrowing habit and pattern of damaging the plant. It was found on *Azadirachta indica* in Brazil and causes damage to the seedlings by attacking the root system, especially the radicles. Symptoms observed are yellowing and wilting of the leaves, stem drying, and reduction in root size resulting in the death of the plant (Matias et al. 2011).

#### Family-Diaspididae

##### *Aonidiella orientalis* (Newstead)

*Aonidiella orientalis* (Newstead) is one of the dangerous species of scale on neem and infests neem trees in different countries including the Lake Chad

Basin, Brazil, Sudan, Kenya, and also some Asian countries like Sri Lanka, and India (Boa 1995; Costa et al. 2013; Ensaf et al. 2016; Lale 1998; Schmutterer 1998) due to its feeding activity the affected part of the leaflets turned yellowish (Kiyanthi and Mikunthan, 2009). *Aonidiella orientalis* attacks the whole neem tree and causes the yellowing of leaves, defoliation, retarded growth, and death of heavily infested seedlings and trees. Furthermore, heavy infestations are responsible for the reduced strength of the neem tree and lead to premature leaf fall and death of infested young shoots (Ensaf et al. 2016).

##### *Pinnaspis strachani* (Cooley)

*Pinnaspis strachani* is a scale insect that infests Neem trees in Asia, Africa, and Latin America (Tomar et al. 2008). In Brazil, it causes heavy infestation on the trunk which appears as a white paint and also they develop and reproduce by feeding solely on neem plants. Apart from the trunk, it also infests the stems and leaves of the plant (De Castro et al. 2020).

#### Order-Orthoptera

#### Family-Acrididae

##### *Orthacris simulans*

Greenish wingless grasshoppers are the defoliators and feed on mature leaves of neem (Sharma, 2016; Tyagi et al., 2014).

#### Family-Tettigoniidae

##### *Microcentrum retinerve* (Burmeister, H., 1838)

These are feeding on leaves of neem in the laboratory (Chockalingam & Noorjahan 1984).

#### Order- Hymenoptera

#### Family: Formicidae

##### *Solenopsis* species.

*Solenopsis* sp. causes damage to the neem plants of 3 to 6 years of age in Andhra Pradesh, India (Raghunath et al. 1982).



### **Acromyrmex species.**

These leaf-cutting ants cause defoliation of the neem leaves except the midribs and other strong veins (Schmutterer 1990b; Tomar et al. 2008)

### **Order- Isoptera**

#### **Family Termitidae :**

#### ***Microtermes mycophagus* (Desneux, 1906)**

A fungus-growing termite, *Microtermes mycophagus* shows a slightly superficial preference for neem wood apart from twenty other wood species (Iqbal et al. 2015).

#### ***Microtermes najdensis* Harris**

Najdian termite, *Microtermes najdensis* infests *Azadirachta indica* in Hada Al-Sham with other host plants including *Eucalyptus rostrata*, *Phoenix dactulifera*, *Tamarix nilotica*, *Ficus infectoria*, *Olea europea*, *Pithecellobium dulce*, *Conocarpus puselectus*, *Ziziphus spinachrista*, and *Simmondsia chinenses*. The diameters of the termite tunnels varied between 0.5 cm to 15 cm (Al-Ghamdi et al. 2009).

#### ***Odontotermes feae* (Wasmann)**

It is also known as a fungus-growing termite and belongs to the family Termitidae. This termite species infests live trees of *Melia dubia* in Tamil Nadu, India, and is identified as the South Asian wood-destroying termite (Suganthi and Pretheepkumar 2019).

#### **Family :Rhinotermitidae**

#### ***Coptotermes frenchi* (Hill)**

It is also known as the Australian Subterranean Termite and infests live trees of *Azadirachta indica* in Tamil Nadu, India (Suganthi and Pretheepkumar 2019).

#### ***Coptotermes formosanus* Shiraki**

The Formosan subterranean termite, *Coptotermes formosanus* Shir. is found on neem plants causing a severe infestation in the trunk and branches of the old neem tree (Delate and Grace 1995).

### **CONCLUSION**

Since the Neem tree and its products provide many benefits to human as well as livestock health so it is beneficial to conserve this valuable medicinal plant for the future. Studies and research should be done more on the insects found on this plant and the causes of deterioration of the plant parts whether related to feeding, egg-laying, boring into the stems, etc.

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Conceptualization, Sheetal Anand and Sheetal Anand and Barish E. James writing—revision, review and editing—Sheetal Anand. All authors have read and agreed to the published version of the manuscript.

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