Insects that Transmit Plant-Pathogenic Nematodes

Liqaa Hussein Mohammed[1] and Estabraq Mohammed Abdalreda[2]

[1]Al-Safwa University College / Department of Medical Laboratory Technology
[2]Karbala University / College of Agriculture / Department of Plant Protection

[1]Email: liqaa.husain@alsafwa.edu.iq
[2]Email: estabraq20162016@gmail.com

Abstract . Insects are the largest phylum belonging to the animal queen and constitute the most diverse group of living organisms on Earth. They contain more than one million species, and beetles alone amount to 360,000 species. Most types of insects cause heavy economic losses in various ways, including the transmission of other pathogens, especially nematodes, which is the second largest group After insects in number and variety, it does not have respiratory and circulatory systems but contains a pseudo-body cavity and is found in every ,The wet environments of the world and their parasitic species are invisible to the naked eye. However, the insect species that transmit nematodes do not form , More than 1% of the number of parasitic nematodes on plants. The search results show that ,The pine saw beetle *Monochamus titillator* and the coconut palm weevil *Rhynchophorus palmarum* transmit *Aphelenchoides xylophilus* nematodes and the coconut palm nematode *Rhadinaphelenchus cocophilus* on pine trees causing huge economic losses.

Keywords. Insect, Nematode

1 . First / Pine Saw Beetle *Monochamus Titillator* (Fabricius, 1775)

It belongs to the family of long-horned beetles and one of the most important types of beetles because of the great economic losses they cause to wood as they are distributed in all branches of pine trees in the cortical zone compared to other closely related species of beetles Its peak flight lasts for about 5 months, from late April to mid-October. The cut trees are unattractive at first and even after 5-7 days the females land and after mating, lay eggs on the lower part of the outer bark at a rate of 3-6 eggs and After a week, the eggs hatch into larvae and feed on the bark tissue for about three weeks It is believed that they have 3-6 phases, the larvae continue to feed and then enter the hole, and generation times take 7-10 weeks [1] .

1.1.Taxonomic Position of the Insect:-

Kingdom : Animalia (Animals)
Phylum :Arthropoda (Arthropods)
Subphylum : Hexapoda (Hexapods)
Class : Insecta (Insects)
Order : Coleoptera (Beetles)
Suborder : Polyphaga
Superfamily : Chrysomeloidea
Family : Cerambycidae
Subfamily : Lamiinae
Genus : *Monochamus*
Species : *titillator*

This insect plays an important role transporting the *Aphelenchoides xylophilus* nematode the one that causes wilting disease in pine trees, this nematode was first discovered on the long leaves pine wood in Louisiana, USA and it was named

ISSN 2072-3857

Aphelenchoides xylophilus by Steiner and Burher in 1943.

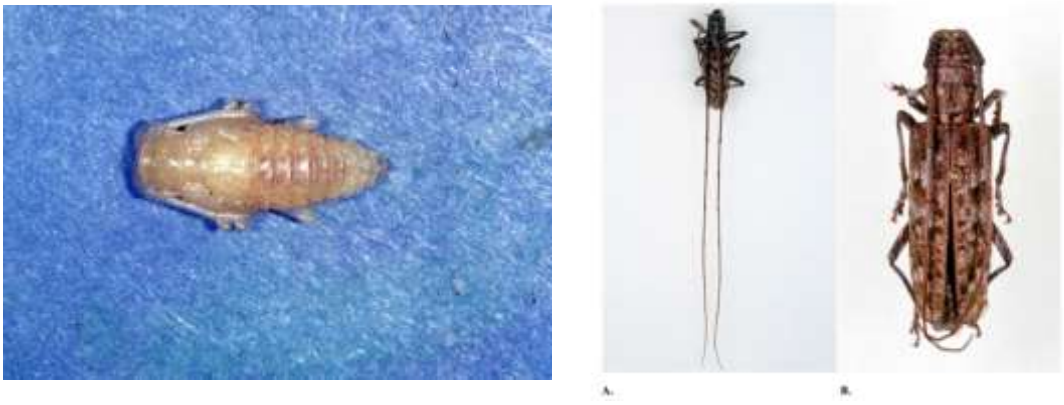
In 1972 the two scientists Kiyohara and Yasuharu Mamiya that nematodes were the main reason of death in pine and called it *Bursaphelenchus lignicolous* then reclassified in 1981 as the American type *Bursaphelenchus xylophilus*.

Number of Species belong to *Bursaphelenchus* genus is one hundred and most of them are feeding on conifers and few species feed on plants, Nematodes move from non-infected trees to infected trees by long-horned beetles *Monochamus*.

Pine wilting disease had spread in the European forests in 1999 and it's one of the complicated diseases as result of the interactions between the nematodes, hosting beetles and the fungi from the dead families.

This disease forms a large threat to the European forests (about 82 million Hectares) the risk of death is up to 50% in southern Europe. In the early twentieth century, it spread to the continent of Asia, and recently it was stressed on agricultural quarantine to prevent infected trees and to avoid the transfer of nematodes and their vectors of insects between countries due to the seriousness of the disease [2].

A- Egg B- Larva



C-Pupa D-Adult

Figure 1. insect's phases

ISSN 2072-3857

Figure 2. Places of distribution and spread of the insect

1.2. Symptoms of infection:-

Needle leaves wilt and as the disease progresses, yellowing appears, then turns brown, and trees die about 1-3 months from the onset of symptoms. Old trees are more sensitive to infection than young trees.

1.3.Nematode's life cycle:-

It's divided into two parts: reproductive cycle and proliferation cycle.

The reproductive cycle takes place in silver pine wood represented in 6 phases (egg phase +4 larval phases+ adult phase) and it takes 5 days under the proper environmental circumstances Where the first larval stage grows inside the egg to the second larval stage and after a short period it turns into the third larval stage, which has two different forms, the first turns into the fourth larval stage and then the adult stage and the last remains inside the infected trees. The second form of the third larval stage is called the non-trophic or dispersal stage and arises before the final death of trees and occurs only in the virgin pine sawfly beetle, and through the respiratory stomata, it enters the respiratory system of the insect and moves with it to the plant hosts [3].

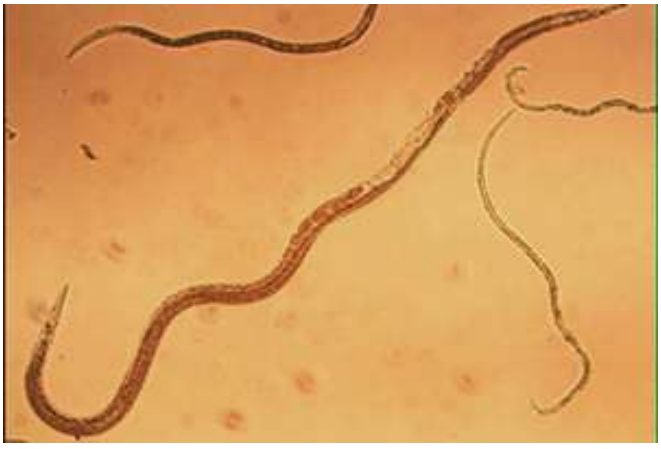


Figure 3. *Bursaphelenchus xylophilus* Nematode

2. Second / Coconut palm weevil *Rhynchophorus palmarum*

Large black beetles with a length of 4-5 cm and spread in South America, its range has recently expanded in Texas and California,

ISSN 2072-3857

and its most favorite secondary families are (sugar cane, citrus, cocoa, mango, avocado...) These insects are attracted to the volatile compounds produced by the coconut trees. The caterpillars penetrate the heart of the palm and lead to the death of the infected host or as a means of transmitting other diseases and attacking 35 different species. Females feed on living tissues, and their activity peaks between 7 and 11 am. During feeding, holes occur randomly to lay eggs individually inside the holes, and the egg settles vertically inside the hole and is covered with a waxy secretion by the female, as the female lays approximately 155± 245 eggs within 14-30 days Then the eggs hatch into larvae and the larvae feed on the tissues growing in the palm crown, where they destroy the apical growth area and Griffith stated that 30 larvae are enough to cause death in adult coconut palms It was not discovered until after the plant was damaged in addition to its active transfer of nematodes. The age of the larvae reaches 6-10 instars within 10-52 days, and the pre-pubescent stage lasts about 4-17 days, while the period of pupal transformation lasts from 8-23 days, the larvae make a cocoon. From plant fibers and adults remain inside the cocoon 4-7 days. Males live for 17-44 days, while females live 15-40 days, and the female can lay 718 eggs during her lifetime.

2.1. Taxonomic Position:-

Kingdom : Animalia (Animals)
Phylum :Arthropoda (Arthropods)
Subphylum: Uniramia
Class: Insecta
Order: Coleoptera
Family: Curculionidae
Genus: *Rhynchophorus*
Species: *palmarum*

A-Egg B-larva

C-Pupa D-Adult

Figure 4. insect's phases

ISSN 2072-3857

Figure 5. Places of distribution and spread of the insect

This insect plays an important role in transmitting coconut palm nematodes Rhadinaphelenchus cocophilus during feeding where the insect lays eggs inside the trees and when the eggs hatch they attach to the larvae of the nematode and remain inside the insect during metamorphosis. When they mature, they leave the palm to cause new infections, and in turn the larvae are transferred. African oil, ornamental palms and date palms, losses for coconut palms may reach more than 35%, and their life cycle takes 10 days, depending on climatic conditions, and it can live humid soils it may live for a long time inside the insect. The vector beetle lays the third larval stage of the nematode in the coconut palm, as it lays its eggs. In the place where it is placed inside the palm, the nematodes feed, develop and multiply. When the beetle eggs hatch, the larval stages of the nematode accompany the beetle larvae until the beetle reaches the full stage then the palm leaves with new groups of larvae of the third stage of nematodes, which in turn infect new palms, and the number of nematodes may reach more than 11,000 nematode stages/ gm of plant tissue [4].

Nematode damage results in reduced absorption and transfer of water and nutrients within the affected tissues. Old and young trees are more resistant to nematodes. Infected trees are often damaged and die within 2-3 months. Resistant trees live with small stunted leaves and short stems compared to healthy trees.

Symptoms differ from one variety to another in the nana variety and some of the panama variety and appear clearly on the edges of the old leaves. The nematode spends part of its life cycle externally until it reaches the appropriate host. It penetrates the tissues of the stem and begins feeding on the cells of the stem layers. A distinctive sign is when making a cross section in the affected stems A red ring appears at a distance of 5 cm from the outer circumference of the leg and 2-3 cm thick as in the attached figure [6] as in stunted and dead tissues on the lower parts of the stem with yellowing of the leaves and turning dark brown as a result of blockage of the woody vessels and the skin texture becomes spongy and changes color, these symptoms were described for the first time by Trinidad 1905 [5 ,6] .

ISSN 2072-3857

Figure 6. the red ring on the stem caused by the coconut palm nematode

References:

[1] Goodey, J. B. (1960). Rhadinaphelenchus cocophilus (Cobb, 1919) n. comb., the nematode associated with" red-ring" disease of coconut. Nematologica, 5(2), 98-102.

[2] RYSS, A., VIEIRA, P., & Mota, M. (2008). The history of expansion of the genus Bursaphelenchus (Nematoda: Aphelenchida: Parasitaphelenchidae).

[3] Tanaka, S. E., Dayi, M., Maeda, Y., Tsai, I. J., Tanaka, R., Bligh, M., ... & Kikuchi, T. (2019). Stage-specific transcriptome of Bursaphelenchus xylophilus reveals temporal regulation of effector genes and roles of the dauer-like stages in the lifecycle. Scientific reports, 9(1), 1-13.

[4] Blair, G. P., & Darling, H. M. (1968). Red ring disease of the coconut palm, inoculation studies and histopathology. Nematologica, 14(3), 395-403.

[5] Chinchilla-López, C. M., & Escobar-Carranza, R. (2007). Red ring and other diseases of the oil palm in Central and South America. El anillo rojo y otra enfermedades de la palma aceitera en Centro y Suramérica. ASD Oil Palm Papers., (30), 1-27.

[6] Brammer, A. S., & Crow, W. T. (2005). Red Ring Nematode, Bursaphelenchus cocophilus (Cobb) Baujard (Nematoda: Secernentea: Tylenchida: Aphelenchina: Aphelenchoidea: Bursaphelechina) formerly Rhadinaphelenchus cocophilus1.

ISSN 2072-3857