



Introduction to Woolly Apple Aphid, *Eriosoma lanigerum* (Hausmann): A Perennial Pest of Apple

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Apple (*Malus domestica* Borkh.) is an important fruit crop in temperate region and the third most produced fruit in the world. It is originated in central Asia. In India, Captain Lee introduced apples for the first time in the Kullu Valley of Himachal Pradesh in 1865. Later, Satyanand Stokes introduced varieties of red-colored Delicious apples at Kotgarh in Shimla district in 1917. Currently, India is the fifth-largest producer of apples around the globe. Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh, and Nagaland are the leading apple-producing states/union territory of India. Apple fruit production provides a primary source of income to apple farmers and also contributes to the economy of India.

The production of apples is affected by a number of insect pests. The woolly apple aphid (*Eriosoma lanigerum* Hausmann) is one of them and can cause qualitative as well as quantitative yield loss. This insect pest was originated in eastern North America. *Eriosoma lanigerum* is commonly known as woolly apple aphid. This pest spreads to other apple-growing regions mainly through nursery stocks. In India, this pest was introduced during the 18th century with apple rootstocks imported from China. For the first time, it was observed in Conoor, Tamil Nadu (1889), then in Kumaon Hills, Uttarakhand (1909), and Shimla, Himachal Pradesh (1910). Now it is distributed in most of the apple-growing regions of India. In their native place, they feed on elm (*Ulmus americana*), but in the absence of their primary host, they feed on apples, pear, hawthorn, mountain ash, cotoneaster, and quince trees. They suck sap predominantly from the aerial and subterranean parts of apple trees by frequently moving up and down in summers and winters, respectively. The aerial and edaphic colonies of woolly apple aphids are present year-round on the apple trees, which makes their management difficult.

Morphological characteristics

The woolly apple aphids form colonies densely covered with white waxy filamentous secretions produced by specialized dermal glands (Figure 1). Such characters protect them from their own honey dew, frost, water, predators, parasitoids, and chemical insecticides. The adults of WAAs are tiny (2 mm long), purple, red, or brown, and partially or completely coated with large quantities of waxy filamentous exudates, which give them the characteristic woolly appearance. A blood-red stain is left behind after the adults are crushed. The winged viviparous females have brown-black head and thorax and a brown abdomen. The tibiae are yellowish to slightly dusky brown, while their antennae are dark brown. The cornical pores are also small (0.06-0.07 mm).

Life cycle

The behavior and biology of the woolly apple aphid vary significantly in different apple-growing regions of the world due to the absence of its principle host, elm, and diverse environmental conditions. In its native place in North America, this pest reproduces sexually on its primary host elm and asexually on its secondary host, i.e., apple trees. In the absence of elm, this pest reproduces in an asexual mode only on apple trees. The sexual life cycle includes life stages like eggs, nymphs, and adults, while asexual life stages include only nymphs and adults.

1. **Egg:** The adult females lay overwintering small, shiny black eggs singly. The females lay eggs on suckers and crevices of bark closer to the ground on the elm. These eggs hatch into nymphs, which soon develop wings and migrate to apple trees.
2. **Nymphs:** In the absence of elm, adult females give birth to nymphs parthenogenetically. The nymphs are dark reddish brown and pass through four instars. The first instar nymphs are more active and are known as crawlers. The subsequent instars are sessile and suck sap from apple trees. The crawlers migrate towards the aerial parts of the apple tree during spring and initiate the formation of aerial colonies. During the fall, they move down from the aerial parts to infest roots and to protect themselves from the chilling temperatures.
3. **Adults:** Adults are wingless, but sometimes winged forms are developed, which could migrate to other apple trees or to elm. In the case of the sexual life cycle, adult males and females are produced. The migrated adult females lay a single egg on the elm and repeat the life cycle.

Damage and symptoms

The woolly apple aphids suck sap from the young twigs, branches, and roots. Their feeding causes stunted growth in young apple trees, a reduction in branch and crown length, and a loss of vigour. Their feeding may induce the formation of galls in roots and shoots. In severe cases, apple trees may have a sickly appearance and may die. The aerial colonies of woolly apple aphids produce honey dew, which serves as fertile ground for sooty mould, which can reduce the quality, marketability, and profitability of apple fruits. Also, the honeydew as well as the woolly coat of aerial colonies cause nuisance to apple pickers. The hypertrophic root galls formed by the feeding of edaphic colonies of woolly apple aphid reduce the ability of distal apple root sections to conduct water and minerals. This may cause reduced fruit setting, fruit weight, and an increase in fruit droppings. Sometimes, their colonies suck sap from the tree cankers and the pruning wounds. Moreover, they can transmit fungal pathogens of perennial canker (*Neofabraea perennans*) in apple trees.

Management

1. **Cultural management:** Cultural management strategies include regular agricultural operations that either eliminate pests or prevent them from causing serious economic damage. A variety of cultural management strategies, like the removal of water shoots and suckers from apple trees, sanitation, low nitrogen fertilization, host plant resistance, crop isolation, , avoiding plantation of infested planting material, avoiding the use of hail nets, and the removal of terminally affected branches, can be used to manage woolly apple aphid. The promotion of plantations of resistant apple varieties like Northern Spy, Robusta, Harmony and rootstocks like Geneva rootstocks (G.210, G.214, G.890, and G.969), and Malling Marton rootstocks (MM109 and MM111) can be employed to manage woolly apple aphid. Avoid planting susceptible rootstocks like M9, M26, P series, and B9.
2. **Mechanical management:** The mechanical methods directly influence the population of the pests. The use of sticky trap around the stem can check the migration between roots

and the aerial portion of the apple tree. ICAR-IARI regional station, Shimla (Himachal Pradesh) developed a jute cloth trap to restrict the migration of woolly apple aphids. Jute cloth trap dipped in linseed oil containing insecticide chlorpyrifos (2 ml/l) can be tied to apple stems after harvesting to restrict the movement of woolly apple aphids. This technique should be followed on community level. The colonies of woolly apple aphid should be manually cleaned with a scrubbing brush during May–June, when they are localised on the trunk, before spreading to young shoots.

- 3. Biological management:** Release *Aphelinus mali*, a parasitoid of woolly apple aphid (Figure 2), in apple orchards @ 1000–1500 adults or mummies per infested tree. Additionally, the release of seven spotted lady bird beetles (*Coccinella septumpunctata*) @ 15–30 per infested tree during July can complement the biological management of woolly apple aphids. The population of other predators like common earwigs (*Forficula auricularia*), hoverflies (*Heringia calcarata*), and others should be kept in check. Future focus should be on the utilization of entomopathogenic microbes to manage woolly apple aphid.
- 4. Chemical management:** The foliar spray of chlorpyrifos @ 2 ml/l is recommended after harvesting to manage woolly apple aphids. Also, after harvesting, drenching of chlorpyrifos @ 4 ml/l can be employed to control woolly apple aphids. Several other chemical insecticides, like 0.05%, Thiamethoxam 25 WG @ 0.025%, Ethion 50 EC @ 0.4 ml/l of water, and Dimethoate 30 EC @ 0.4 ml/l of water, are effective in suppressing the population of woolly apple aphids.

