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Eco Friendly IPM Approaches for Woolly Aphid in Apple Orchards

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INTRODUCTION

The woolly apple aphid, *Eriosoma lanigerum* Hausmann, is a damaging pest that affects apples grown globally (Blackman and Eastop, 2022; Jovicic, 2024). The aphid creates dense colonies with white, waxy secretions that can cause gall formation on tree roots and branches (Blackman and Eastop, 2022). Uncontrolled tree growth and vigor can lead to fruit contamination by wax-producing crawlers (Hoyt and Madsen, 1960), resulting in lower marketable output (Adhikari 2022; Bondesan *et al.,* 2023). *Eriosoma lanigerum* feeds on apple tree trunks, branches and shoots and reproduces primarily asexually (Barbagallo *et al.,* 1997), but there is evidence of sexual reproduction (Sandanayaka and Bus, 2005).

Eco-friendly woolly apple aphid management requires the combination of different solutions that are compatible with orchard ecosystem. Resistant rootstocks offer long-term protection by minimizing colonization in the canopy and roots. Natural suppressors of aphid populations include parasitoids (*Aphelinus mali*) and predators such as earwigs, lady beetles and lacewings. Mechanical treatments, including as trimming and sticky barriers, provide fast reduction when infestations increase. Organic sprays, such as neem, horticultural oils and biopestides are safe treatments that reduce harm to pollinators and beneficial insects. Continuous monitoring using traps, scouts and weather-based models ensures that interventions are timely, focused and minimum, protecting orchard biodiversity while lowering chemical dependence.

Figure 1: Infestation of woolly apple aphids in apple orchard in Kashmir

Integrated pest Management of Woolly Apple Aphid:

1. Cultural Practices

- **Resistant Rootstocks:**
  Geneva (G11, G202, G214) and Malling-Merton (MM 111, MM 106) series are rootstocks for resistance to woolly apple aphid. They reduce colonization both on roots and canopy, providing long-term orchard resilience (Webster & Wertheim, 2003; Fazio *et al.,* 2015; Sharma *et al.,* 2023; Choi *et al.,* 2021).
- **Pruning and Sanitation:**
  Regular removal of affected branches and suckers helps to avoid aphid spread. Destroy trimmed material to avoid reinfestation. (Sharma *et al.,* 2023).
- **Biodiversity Enhancement:**
  Flowering strips (buckwheat, mustard, clover) and hedgerows attract parasitoids and predators, resulting in a balanced orchard environment. (Herz *et al.,* 2019).

2. Biological Control

- **Parasitoid Conservation *(Aphelinus mali*):**
  This endoparasitoid parasitizes woolly aphids, resulting in colony collapse. To keep its populations safe, avoid using broad-spectrum insecticides (Shaw & Walker, 1996; Ateyyat *et al.,* 2012).
- **Predator Augmentation:**
  Effective aphid feeders include lady beetles (Coccinellidae), lacewings (Chrysopidae), earwigs (*Forficula auricularia*) and syrphid fly larvae. (Gontijo *et al.,* 2012).
- **Habitat Management:**
  Provide refugia such as corrugated cardboard shelters, mulch zones and undisturbed ground cover to support overwintering of beneficial insects.

3. Mechanical & Physical Methods

- **Sticky Bands:**
  Sticky bands are a simple yet effective mechanical barrier in integrated pest management. When wrapped around tree trunks, they prevent woolly apple aphid crawlers from migrating between canopy and roots. This disruption reduces reinfestation cycles and limits pest spread (Orpet *et al.,* 2019).
- **Root Pruning and Grafting:**
  Replace sutible scions with resistant ones to reduce root colonization.

4. Organic and Botanical Formulations

- **Neem-Based Products (*Azadirachtin*):**
  Neem-based treatments containing azadirachtin are particularly successful at controlling woolly aphid infestations. They act by disrupting woolly aphids eating and reproductive

cycles, gradually diminishing their number (Kumar *et al.,* 2019).

- **Horticultural Oils:** Suffocate colonies by penetrating waxy layers, with minimal ecological impact (Kelderer *et al.,* 2008).
- **Entomopathogenic fungi:** Entomopathogenic fungi like *Metarhizium robertsii*, *M. pinghaense*, *M. brunneum*, *Beauveria bassiana*, *Lecanicillium lecanii* and *Cordyceps fumosorosea* are effective biocontrol against woolly apple aphids. They infect the aphids by penetrating the cuticle, multiplying inside and ultimately killing the host (Fountain *et al.,* 2026).

5. Monitoring & Decision Support

- **Visual Scouting:** Regular inspection of shoots and roots helps track infestation levels.
- **Economic Thresholds**: Apply interventions only when aphid populations exceed damage thresholds, reducing unnecessary inputs.

CONCLUSION

Eco-friendly IPM strategies provide sustainable and effective solutions for woolly apple aphid management in apple orchards. Neem-based *Azadirachtin* formulations disrupt feeding and reproduction, reducing aphid populations significantly. Horticultural oils act as contact agents, suffocating colonies with minimal ecological impact. Entomopathogenic fungi such as *Beauveria bassiana*, *Metarhizium* spp., *Lecanicillium lecanii* and *Cordyceps fumosorosea* offer biological suppression under favourable conditions. Monitoring through scouting, sticky traps and rootstock checks ensures timely detection of infestations. Decision support systems integrate pest thresholds, weather conditions and natural enemy activity to guide interventions. Collectively, these eco-friendly approaches minimize chemical reliance, conserve biodiversity and strengthen orchard resilience for long-term sustainability.

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