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Integrated Pest and Disease Management in Acid Lime (*Citrus aurantifolia*)

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Acid lime (*Citrus aurantifolia*), widely cultivated in tropical and subtropical climates, is an important fruit crop known for its rich vitamin C content and refreshing acidic flavor. It plays a vital role in the livelihoods of small and marginal farmers due to its consistent market demand and wide use in fresh consumption, pickles, juices, and traditional medicines. However, maintaining healthy and productive lime orchards is a constant challenge. The crop is prone to attacks by several insect pests and diseases, which can severely reduce fruit yield and quality. Key pests such as the citrus leaf miner, psylla, blackfly, fruit-sucking moth, aphids, and mealybugs target leaves, shoots, and fruits, while diseases like citrus canker, tristeza virus (CTV), greening (HLB), gummosis, and anthracnose affect the tree's overall health and longevity.

Traditional pest control often involves frequent use of chemical pesticides, which may give quick results but also lead to serious problems:

- Pesticide resistance in pests,
- Killing of beneficial insects,
- Chemical residues in fruits,
- Environmental pollution, and
- Increased production costs.

To address these issues sustainably, the modern approach is **Integrated Pest and Disease Management (IPDM)**. This is a holistic strategy that combines multiple control methods in a coordinated way to keep pests and diseases below damaging levels without harming the environment.

IPDM relies on:

- **Cultural practices** like pruning, clean cultivation, and proper spacing,
- **Biological control** using natural enemies like parasitoids and predators,
- **Mechanical methods** such as traps and manual removal,
- **Botanical extracts** and bio-pesticides for eco-friendly control, and
- **Chemical pesticides** used only when needed and based on field scouting and threshold levels.

This article provides a practical guide to the **major pests and diseases of acid lime** and outlines effective, field-tested **IPDM strategies** that help ensure healthier trees, safer fruits, and higher profits for growers.

1. Major Pests & Their Management

A. Citrus Psylla (*Diaphorina citri*)

- The Asian citrus psyllid is a major pest as it vectors **huanglongbing (HLB)**, a devastating citrus disease (Qureshi et al., 2014).
- **Biological control** using the parasitoid *Tamarixia radiata* has been effective in reducing psyllid populations (National Horticulture Board [NHB], 2021).

- For chemical control, **imidacloprid (0.3 ml/L)** is recommended (Insecticide Resistance Action Committee [IRAC], 2023).

B. Citrus Leaf Miner (*Phyllocnistis citrella*)

- Leaf miners cause severe foliar damage, reducing photosynthesis.
- The parasitoid *Citrostichus phyllocnistoides* provides natural control (Urbaneja et al., 2008). When infestations exceed economic thresholds, **spinosad (0.3 ml/L)** can be applied (IRAC, 2023).

C. Fruit Fly (*Bactrocera dorsalis*)

- Fruit flies cause significant post-harvest losses. **Methyl eugenol traps (5/ha)** are effective for monitoring and mass trapping (Ekesi & Billah, 2006).
- Chemical control includes **malathion bait sprays (2 ml/L)** (Agricultural and Processed Food Products Export Development Authority [APEDA], 2020).

D. Aphids (*Toxoptera aurantii, Aphis gossypii*)

- Aphids excrete honeydew, leading to sooty mold. **Lacewings (Chrysoperla carnea)** are effective predators (Khan & Rao, 1973).
- If necessary, **imidacloprid (0.5 ml/L)** can be used (Food and Agriculture Organization [FAO], 2022).

2. Major Diseases & Their Management

A. Citrus Canker (*Xanthomonas axonopodis pv. citri*)

- Citrus canker causes necrotic lesions on leaves and fruits. **Copper oxychloride (3 g/L)** is commonly used for management (Gottwald, 2010).

B. Powdery Mildew (*Oidium citri*)

- Powdery mildew appears as white fungal growth on leaves.
- **Wettable sulfur (3 g/L)** is an effective treatment (University of California Statewide Integrated Pest Management Program [UC IPM], 2023).

C. Anthracnose (*Colletotrichum gloeosporioides*)

- Anthracnose leads to fruit rot and leaf spots. **Carbendazim (1 g/L)** is recommended for control (Agrios, 2005).

D. Citrus Greening (*Huanglongbing*, HLB)

- HLB causes yellow shoots and bitter fruits.
- Infected trees should be **removed immediately** to prevent spread (Bové, 2006).
- Antibiotic trunk injections (e.g., oxytetracycline) have limited efficacy (Zhang et al., 2019).

3. IPDM Strategies (With Scientific Support)

A. Cultural Methods

- Using **resistant rootstocks (e.g., Rangpur lime)** helps manage citrus tristeza virus (Castle, 2010).
- **Intercropping with marigold** reduces nematode infestations (Chavan et al., 2018).

B. Biological Control

- The fungus **Beauveria bassiana** effectively controls sucking pests (Lacey et al., 2015).
- **Trichoderma harzianum** suppresses soil-borne pathogens (Harman, 2006).

C. Chemical Control (Judicious Use)

- **Neem oil (5 ml/L)** is an organic alternative (Isman, 2006).
- Farmers should **rotate modes of action (MoA)** to prevent resistance (Fungicide Resistance Action Committee [FRAC], 2023).

Conclusion

The implementation of Integrated Pest and Disease Management (IPDM) in acid lime cultivation represents a paradigm shift from reactive pest control to proactive ecosystem management. This holistic approach, supported by extensive scientific research and field validation, offers multiple pathways for achieving sustainable citrus production while addressing contemporary challenges in agriculture.

Implementation Recommendations

For successful IPDM adoption, growers should:

1. Establish regular monitoring protocols using pheromone traps and visual scouting
2. Maintain habitat for natural enemies through flowering border crops
3. Implement record-keeping systems to track pest/disease trends and intervention outcomes
4. Participate in farmer field schools to share experiential knowledge
5. Gradually phase in IPDM components while reducing synthetic inputs

The transition to IPDM represents not merely a change in production techniques, but a fundamental reorientation toward agroecological principles. As global citrus systems face mounting pressures from climate change, trade regulations, and pest resistance, IPDM offers a scientifically grounded, practical pathway for maintaining productive and profitable acid lime cultivation while safeguarding environmental and human health. Continued research, adapted to regional contexts and evolving pest pressures, will further refine these strategies to meet future challenges.

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