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Managing sucking and chewing insect pest in Citrus

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Abstract: -

Citrus crops are vital for both human and animal nutrition; however, their productivity is greatly threatened by numerous harmful agents, including viruses, bacteria, fungi, and invertebrates. Among invertebrates, insects represent the most widespread group of citrus pests, either directly damaging plants or serving as vectors of serious diseases. This article highlights major insect pests of citrus with global distribution, such as the sap-sucking Asian citrus psyllid (*Diaphorina citri*), citrus mealybug (*Planococcus citri*), citrus whitefly (*Dialeurodes citri*), thrips species including Scirtothrips citri and *Pezothrips kellyanus*, as well as the chewing pests citrus leaf miner (*Phyllocnistis citrella*) and lemon butterfly (*Papilio demoleus*). These pests occur widely across Asia Pacific, the Americas, Africa, and Oceania. The article provides comprehensive insights into their biology, ecology, damage potential, and available management strategies. Since pest incidence and development are influenced by diverse biotic and abiotic factors, these interactions can be strategically exploited to disrupt pest life cycles. Accordingly, a range of integrated pest management (IPM) approaches cultural, physical, biological, and chemical are discussed to maintain pest populations below economic injury levels.

Introduction:

Citrus is among the most widely cultivated fruit crops across tropical and subtropical regions of the world, with major producers including Brazil, China, the USA, India, Pakistan, Italy, Spain, Australia, and Argentina. The genus *Citrus*, belonging to the family Rutaceae, encompasses several economically important species such as oranges, mandarins, grapefruits, limes, and lemons. However, citrus production is often constrained by both biotic factors primarily insect pests and pathogens and abiotic factors

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such as temperature, humidity, soil properties, and water availability. Among these, insect pests pose one of the greatest challenges to sustainable citrus cultivation. While nearly 250 insect species have been reported to attack citrus, only a limited number emerge as persistent pests causing significant yield losses, which may reach up to 50% in the absence of timely diagnosis and management. Citrus insect pests are broadly categorized into sucking and chewing types. Accurate pest identification and a thorough understanding of their biology and damage potential are essential for designing effective, eco-friendly, and economically viable pest management strategies that can safeguard and enhance citrus yield potential.

Sucking insects

Citrus whitefly

The citrus whitefly (CWF), scientifically named *Dialeurodes citri*, is an insect pest that belongs to the order Hemiptera and the family Aleyrodidae.

Management

Biological control

Biological control of the citrus whitefly (CWF) has received limited attention, with most efforts focusing on predatory insects. Among the key natural enemies, the coccinellid beetle *Serangium japonicum* Chapin (Coleoptera: Coccinellidae) is noteworthy, as it has been observed in pesticide-free orchards in Japan where it reduced CWF populations, particularly during population peaks in May and July. Similarly, the release of another ladybird beetle, *S. parcesotum* Sicard (Coleoptera: Coccinellidae), in the East Mediterranean region demonstrated successful orchard colonization and promising potential for CWF suppression.

Parasitoids also play an important role in biological regulation of this pest. Species such as *Encarsia lahorensis* (Howard) and *Eretmocerus debachi* (Hymenoptera: Aphelinidae) have shown effectiveness against CWF, although further optimization studies are needed. Likewise, pathogenic fungi have been tested with encouraging results. In China, several isolates of *Aschersonia placenta* (Hypocreales: Clavicipitaceae) were identified as effective against CWF, while *A. aleyrodis* Webber (Hypocreales: Clavicipitaceae) caused high mortality of *D. citri* in both Southern Alabama and China. Additionally, *Lecanicillium attenuatum* (Hypocreales) has been reported to kill CWF nymphs, highlighting its potential as a biological control agent.

Chemical control

Chemical management, including the use of inorganic compounds, botanicals, and synthetic insecticides, forms an important component of integrated pest management

(IPM) for citrus whitefly (CWF). However, such measures should be applied judiciously and only when necessary. Typically, two sprays of summer oil or white oil (petroleum emulsion) are recommended during the peak activity of CWF, though in cases of severe infestations, 3–4 applications may be required. Studies have reported that applying pyriproxyfen or buprofezin at 0.05% twice, at 45-day intervals, can effectively reduce CWF populations in citrus orchards.

Similarly, a combined application of the organophosphate insecticide triazophos with neem formulations, applied twice at 15 day intervals, has shown effective suppression of both nymphs and adults. In sweet orange orchards, the use of tree spray oil (0.5–1%) mixed with lime sulfur diluted in water has been found effective against CWF eggs. Additionally, spraying dimethoate or formothion at 0.03% has resulted in significant control of CWF nymphs. Nevertheless, overdependence on chemical methods should be avoided, as CWF populations can rapidly develop resistance to multiple pesticides, reducing their effectiveness and complicating management strategies.

Asian citrus psyllid

It is commonly referred to as citrus psylla, scientifically named *Diaphorina citri* Kuwayama. This insect belongs to the order Hemiptera and the family Liviidae.

Management

Biological control

Biological control involves managing insect pests through the use of predators and parasitoids, and its large scale adoption is essential to minimize the excessive reliance on chemical insecticides. In citrus crops, *Diaphorina citri* has several natural enemies. Generalist predators include syrphid flies, ladybird beetles, lacewings, predatory mites, and ants. Ants are known to attack the immature stages of *D. citri*. According to Husain and Nath and Batra, various species of coccinellid beetles prey on *D. citri*, such as the seven spotted ladybird *Coccinella septempunctata* Linnaeus, the transverse ladybird *C. repanda* Thunberg, the Malaysian ladybird *Chilocorus nigrita* (Fabricius), the zigzag ladybird *Cheilomenes sexmaculata* (Fabricius), and the three striped ladybird *Brumus suturalis* Fabricius. The larvae of syrphid flies (*Allograpta* spp.) also attack *D. citri* nymphs, as reported in Nepal and Réunion. Among parasitoids, *Tamarixia radiata* (Waterston) (Hymenoptera: Eulophidae) and *Diaphorencyrtus aligarhensis* (Shafee, Alam, and Agarwal) (Hymenoptera: Encyrtidae) are considered the most effective, being native to India and providing superior control compared to predators. Females of *T. radiata* prefer to parasitize the 3rd, 4th, and 5th instar nymphs of *D. citri*.

Chemical control

The use of insecticides against *Diaphorina citri* and citrus greening disease has increased significantly in recent years, with annual management costs ranging from US $240 to over US $1000, depending on the frequency of applications, type of insecticide, and method of application. Foliar applications of broad-spectrum insecticides are commonly recommended before flushing, to eliminate overwintering adults, and throughout the growing season. These include chlorpyrifos, dimethoate, fenpropathrin, bifenthrin, and zeta-cypermethrin, along with both foliar and soil applications of systemic neonicotinoids such as imidacloprid, thiamethoxam, and clothianidin. Imidacloprid has been shown to provide 50–90% control of adult psyllid populations in the field. Rotational sprays of imidacloprid with chlorpyrifos or cypermethrin at two-week intervals also reduce psyllid populations and the incidence and spread of huanglongbing (HLB) during the new flush stage of citrus growth. Globally, citrus growing regions remain vulnerable to citrus greening and its vector, and since no permanent cure exists, chemical control remains one of the most effective strategies to suppress pest populations and limit the spread of the disease.

Citrus leafminer

Management

Biological control

Biological control agents play a vital role in regulating the population of citrus leafminer (CLM) below the economic threshold. Reports indicate that natural enemies, including predators and parasitoids, can cause up to 60% mortality of CLM in Yuma. Among parasitoids, *Cirrospilus coachellae* Gates (Hymenoptera: Eulophidae) is particularly effective, appearing in late summer and early fall to suppress CLM populations. In addition, Yuma spider mites and *Tydeus* spp. have been documented as predators of CLM larvae. Studies by Browning et al. and Peña et al. in Florida during 1993–1994 identified several parasitoid species associated with CLM, including *Cirrospilus* sp., *Pnigalio minio*, *Sympiesis* sp., *Elasmus tischeriae*, *Closterocerus cinctipennis*, *Horismenus* sp., and *Zagrammosoma multilineatum*. Parasitism levels were found to vary, reaching up to 60%, with the lowest activity occurring in late winter and early spring. Furthermore, various predators such as *Chrysoperla rufilabris*, *Solenopsis invicta*, predatory thrips, and spiders have also been reported to prey on CLM.

Chemical control

Many growers resort to insecticide applications to reduce the impact of citrus leafminer (CLM) due to the visible foliar damage it causes. However, this approach is costly and usually ineffective, as most insecticides provide only short term suppression, typically lasting no more than two weeks. Relying on chemical control for CLM is generally considered inappropriate because of the high cost of repeated applications, the potential for resistance development in pest populations, and the risk of pesticide residues accumulating in fruit, groundwater, and the broader environment. Moreover, frequent spraying can negatively impact natural enemies, pose health risks to field workers, and disturb ecological balance. Resistance of CLM to pesticides has already been documented, with Tan and Huang confirming the development of resistance in this pest.

Lemon butterfly

The lemon butterfly (LBF), scientifically named *Papilio demoleus* Linnaeus, belongs to the order Lepidoptera and the family Papilionidae.

Management

Biological control

Winotai and Napompeth conducted a survey of natural enemies of the lemon butterfly (LBF) in Thailand. They found that *Ooencyrtus malayensis* and *Tetrastichus* sp. parasitize the egg stage. Several predators target the larval stage, including *Proxys punctulatus*, *Podalonia* sp., the bird *Oriolus steerii*, and the spider *Nephila* sp. Insect parasitoids reported to attack LBF larvae include *Erycia nymphalidophaga*, *Apanteles papilionis*, and *Bracon hebetor*. The pupal stage is affected by parasitoids such as *Brachymeria* sp. and *Pteromalus puparum*.

Mechanical control

Hand picking is an effective and practical method under certain conditions, such as when labor is inexpensive, egg masses are large and easily visible, insects are slow moving, exhibit congregating behavior, and are easily accessible. This technique is particularly efficient for controlling LBF larvae infestations in nurseries and home gardens.

Conclusion

Key characteristics of the major citrus pests have been highlighted. Currently, while numerous insect species attack citrus, only a few have been extensively studied, indicating a need for further research on other pest species. Investigations into the biology, ecology, and management of citrus pests are essential, particularly to generate data that can help reduce pest-related damage. Additionally, assessing the field efficacy of control measures and the adaptability of pests to different climatic conditions across major citrus growing regions is important for effective management. Efforts should also focus on developing environmentally friendly solutions, including new bioactive compounds, natural enemies, resistant cultivars, and innovative technological approaches.

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