Study on Control of Main Insect Pests in Kiwifruit

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Abstract To further enhance the yield and quality of kiwifruit and promote the sustainable development of the kiwifruit industry, this paper summarized the characteristics, damage sites, and control methods of major kiwifruit diseases and pests. It pointed out the main issues in current kiwifruit pest and disease management and proposed corresponding solutions. The prevention and control of kiwifruit pests should adhere to the principle of "prevention first, integrated management", and standardized planting modes should be implemented. In this process, priority should be given to agricultural, physical, and biological control methods to effectively reduce the use of chemical pesticides.

Key words Kiwifruit; Pest control; Pest species; Prevention and control

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Kiwifruit is a plant of the genus *Actinidia* in the family Actinidiaceae, also known as Yangtao, Maotao, and Tengli. It is a climbing deciduous vine fruit tree[1]. Renowned as the "King of Fruits", it is highly nutritious, rich in vitamin C, amino acids, dietary fiber, polysaccharides and other beneficial components, contributing to tumor prevention, anti-inflammatory effects and blood sugar reduction[2]. The fruit contains a large number of triterpenoids, flavonoids, polysaccharides, volatile oils, alkaloids, and over 20 types of amino acids[3-4]. It also includes 29 essential macro- and microelements for the human body. The fruit is not only highly nutritious, but also possesses medicinal and health-promoting effects[4-9]. It offers significant economic value and exhibits various benefits, such as anti-aging, antioxidant, anti-inflammatory, anti-allergic dermatitis, anti-fatigue, blood sugar-lowering, lipid-lowering, and anti-alcohol liver-protective effects[10].

China is the origin of kiwifruit and has abundant germplasm resources, making it a major producer of the fruit. However, New Zealand introduced kiwifruit cultivation, which was gradually adopted by other countries, elevating it to a leading position in global fruit production[11]. In China, kiwifruit is primarily cultivated in Shaanxi, Sichuan, Guizhou, Henan, and other regions along and north of the Yangtze River basin. The country ranks first in both production and cultivation area worldwide, and kiwifruit has become one of the dominant industries in many regions to boost poverty alleviation and industrial prosperity. In recent years, the kiwifruit industry has experienced rapid growth in import and export trade under the Belt and Road Initiative. However, due to varying local planting conditions, climate challenges, inadequate management, and continuous expansion of cultivation scale, pest infestation has frequently occurred. These issues have significantly reduced yield and fruit quality, causing substantial losses for growers. During the planting process, with the application of various pest control agents, kiwifruit pests have exhibited new characteristics. These include increased diversity of pest species, broader control ranges, and more frequent treatments, making pest management more challenging[12]. Consequently, the resulting damage and losses continue to escalate. According to reports[13], there are over 80 types of pests that damage kiwifruit, with the most severe being scarab beetles, *Lycorma delicatula*, stink bugs, leafhoppers, red spider mites, and various moths. This paper summarized the distribution and damage characteristics of pests and diseases affecting kiwifruit, aiming to provide reference insights for the development of the kiwifruit industry.

Major Diseases and Pests of Kiwifruit

In recent years, the continuous expansion of kiwifruit cultivation has been accompanied by frequent infestations of various pests, posing significant challenges to growers. Severe pest outbreaks can lead to nearly total crop loss. To address this issue, this paper reviewed the major pests, aiming to provide reference for early detection and timely intervention during cultivation, thereby ensuring both yield and quality of kiwifruit.

From sprouting to fruit harvesting, kiwifruit plants may suffer pest infestations at every growth stage. These pests can be broadly categorized into 10 groups: scale insects, leaf beetles, leafhoppers, longhorn beetles, aphids, moths, stink bugs, scarab beetles, and underground pests[14]. Specific pests include kiwifruit stink bugs, scarab beetles, *L. delicatula*, *Cortinicara gibbosa*, red spider mites, fruit borers, leafhoppers, planthoppers, peach borers, scale insects, whiteflies, crickets, leaf-eating moths, *Pseudaulacaspis pentagona* (Targioni Tozzetti), and *Erthesina fullo* (Thunberg)[15]. Based on their mouthparts, these pests can be classified into two major types: piercing-sucking and chewing pests. The infestation of kiwifruit pests will lead to dry leaves, poor fruit quality and rotten roots of plants. In severe cases, it can

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hinder the healthy growth of kiwifruit plants and even trigger the simultaneous occurrence of multiple types of pest damage. Ultimately, it results in decreased yield and lower fruit quality, ultimately causing economic losses for growers. Pests on kiwifruit plants primarily attack the roots, leaves, branches, vines, fruits, and flowers through bud and leaf chewing, boring, and sap-sucking, as shown in Table 1.

Erthesina fullo

Over 3 100 species of stink bugs have been recorded in China, many of which are major pests of agricultural crops. The primary harmful species include *Aelia nasuta*, *Dolycoris baccarum*, *E. fullo* (Thunberg), *Eurydema dominulus*, *Eurydema gebleri*, *Halyomorpha halys*, *Eysarcoris guttiger*, *Tropidothorax elegans*, and *Acanthocoris scaber*[16]. *E. fullo*, belonging to the Pentatomidae family, is also known as Huangbanchun or Huangshuangchun[17]. It primarily damages kiwifruit trees by piercing and sucking on their branches, stems, leaves, and fruits. When the plants are infested by *E. fullo*, they show signs of withering. Brownish-yellow spots appear on the stems and leaves, which can lead to premature leaf drop and, in severe cases, wilting and death of the kiwifruit plants[18]. Infested fruits become hardened, inconvenient to store, and suffer from reduced quality.

P. pentagona

P. pentagona (Targioni Tozzetti), belonging to the family Diaspididae, is an extremely common species of scale insect, also known as Sangdunjie or Tao scale insect. *P. pentagona* exhibits remarkable reproductive capacity, ranking among the highest of all pests, and spreads at a rapid rate. Once kiwifruit seedlings are introduced to a new region, *P. pentagona* can "hitchhike", rapidly spreading to various growing areas along with the circulation of the seedlings. When this pest infestation occurs, it primarily affects the fruit of the plant, resulting in low usability of the harvested fruit, reduced yield, and significantly compromised fruit quality.

Adults and nymphs of *P. pentagona* tend to cluster on the surface of kiwifruit branches and trunks, piercing the epidermis with their needle-like mouthparts to extract sap. In severe infestations, these pests cover the branches with a layer of white scale or pupal shells, significantly impeding the plant's absorption of nutrients and water. This leads to loosening of kiwifruit trees' bark and may ultimately result in plant death[19]. This pest particularly favors branches and branching parts. Plants infested by *P. pentagona* exhibit varying degrees of damage, and in severe cases, they can lead to leaf wilting, complete plant death, and poor fruit development. They may also cause delayed sprouting and fruit drop in kiwifruit plants, resulting in significant economic losses for growers[20-21]. For mildly affected plants, their growth becomes weaker and slower, with impaired fruit development resulting in unfilled fruit and prolonged maturation compared with healthy plants. This ultimately leads to reduced yield and inferior fruit quality[22].

Scarab beetles

Scarab beetle is a general term for pests in the Scarabaeidae family, primarily including species such as *Holotrichia diomphalia*, *Holotrichia parallela*, *Anomala corpulenta*, and *Popillia quadriguttata*[23]. These pests mainly damage kiwifruit trees by targeting fruits, young buds, tender leaves, and flower buds. Infected seedlings often exhibit fruit rot, while the growth and development of young buds, leaves, and flower buds are affected to varying degrees. The larvae of scarab beetles primarily infest the roots[24], impairing the absorption and transport of water and nutrients from the soil. In severe cases, this can lead to premature decline and death of kiwifruit trees[25], causing leaves to turn yellow and fall prematurely, posing a significant threat to agricultural ecosystems[26]. The adult beetles mainly damage the leaves, flower buds, and new shoots of young kiwifruit trees. This results in uneven leaf growth and the appearance of small holes. In extreme cases, they may completely defoliate the plants, leaving only petioles and main veins of branches. These effects severely disrupt the normal growth and development of kiwifruit saplings[17, 24-25].

Fruit-piercing moths

Fruit-piercing moths belong to Noctuidae of Lepidoptera, with three main species infesting kiwifruit: *Oraesia excavata*, *Adris tyrannus*, and *Oraesia emarginata*. These pests frequently occur during the fruit ripening stage. The larvae cause irreversible damage to leaves and young shoots, resulting in notched or skeletonized leaves where only veins remain. The adult moths pierce and suck on fruits, causing irregular shriveling and sunken spots, severely damaging mature kiwifruits. The occurrence of fruit-piercing moth infestations varies depending on plant species and seasons. In southern regions, they primarily damage loquat, peach, pear, mango, lychee, longan, and citrus trees, typically appearing as mixed pest populations but dominated by *Oraesia* species. Once infested, kiwifruit trees suffer severe yield and quality degradation. Fruits attacked by these moths exude gum at feeding sites, developing large necrotic or water-soaked patches that lead to fruit rot and premature drop.

Spider mites

Spider mites, belonging to the Tetranychidae family, are herbivorous mites also known as red spiders. *Tetranychus truncatus* falls under the Tetranychidae family in Trombidiformes. These pests exhibit exceptionally strong reproductive capability, enabling them to rapidly multiply in large numbers under favorable environmental conditions. Consequently, they produce relatively numerous generations each year. This pest poses a threat to a variety of plants, with a wide host range that includes legumes, cucurbits, as well as fruit trees such as kiwifruit, ornamental plants, and forest trees[27-28]. It primarily infests the leaves and fruits of plants, with both adults and nymphs attacking the host plants. They typically settle on the undersides of leaves, sucking the cell sap and damaging the chloroplasts, which inhibits photosynthesis and disrupts normal growth and development. Meanwhile, they cause mechanical damage to plants[29]. Infected leaves typically exhibit discoloration or fine speckling. In severe cases, the leaves turn yellow or brown and shed extensively, significantly shortening the

fruiting period and reducing the quality of the fruit.

Root-knot nematodes

Root-knot nematodes (*Meloidogyne*) belong to the family Meloidogynidae in the order Tylenchida. They are highly-specialized polyphagous plant-parasitic nematodes of the genus *Meloidogyne* within the phylum Nematoda. The primary species harmful to kiwifruit are *Meloidogyne incognita*, *Meloidogyne arenaria* and *Meloidogyne javanica*, with their severity of damage in descending order[30-31].

In the process of planting kiwifruit saplings, the most severe damage is caused by *M. incognita*, which attacks the roots of the saplings. The early stages show no obvious symptoms, making it difficult to detect. Therefore, preparations must be made before planting, and the growth of the plants should be closely monitored. If symptoms such as stunted growth, short and thin new shoots, yellowing leaves and easy leaf falling appear, measures must be taken to prevent further deterioration. When the saplings show signs of withering or death, it is often found that their roots have been eroded by nematodes, disrupting the normal transport of water and nutrients. This severely restricts growth and can lead to direct plant death, limiting the development of the kiwifruit industry and causing significant economic losses for growers. Root-knot nematodes have a wide host range, primarily affecting solanaceous crops and legumes. Due to their strong reproductive capacity, infected plants suffer long-term damage. Once infested, the fruiting rate of the plants decreases, leading to reduced yields.

Scale insects

Scale insects, belonging to the family Coccidae in Homoptera, are among the most common and severe pests encountered during plant cultivation. The primary scale insects infesting kiwifruit saplings include *P. pentagona*, *Drosicha corpulenta*, *Aonidiella citrina*, *Aspidiotus destructor*, and *Ceroplastes rubens*[32-33]. These pests attach themselves to the branches, vines, and leaves of trees, feeding on their sap. This weakens the saplings by disrupting photosynthesis and respiration, resulting in significantly stunted growth compared to healthy plants. When infested by scale insects, kiwifruit trees typically exhibit poor growth and premature leaf drop. In severe cases, the trees may wither and eventually die.

Table 1 Primary insect pests and harm sites of kiwifruit

Family	Species	Harm sites
Pentatomidae	*E. fullo*, *H. halys*, *Dolycoris baccarum*	Adults and nymphs suck sap from young leaves, shoots, and fruit of kiwifruit plants.
Scarabaeida	Scarab beetles (*H. diomphalia*, *H. parallela*, *A. corpulenta*, and *P. quadriguttata*)	Larvae gnaw on the tender roots of kiwifruit, affecting water and nutrient absorption and transport. In severe cases, this leads to premature tree decline, yellowing leaves, and early leaf drop. Adults feed on young buds, tender leaves, and flower buds.
Rhabditidae	Root-knot nematodes	They harm kiwifruit roots
Latridiidae	*C. gibbosa*	After flowering, adults gnaw on the bark and fruit flesh, creating shallow needle-like holes, leading to deformed fruits.
Cicadellidae	*Cicadella viridis*, *Erythroneura apicalis*	They damage leaves, shoots, buds, and fruit by sucking sap, causing premature leaf drop and reducing photosynthesis. Adults feeding on branch and leaf sap can lead to severe dehydration and tree death.
Noctuidae	*Oraesia excavata*	Adults suck juice from fruit, causing them to rot.
Hepialidae	*Hepialus*	Larvae damage the base of the trunk and main vines, causing upper branches to wither or break.
Coccidae	*Pseudaulacaspis caspiscockerelli*, *D. corpulenta*, *Chrysomphalus aonidum*, *P. pentagona*, *C. rubens*	Scale insects (adults and nymphs) suck sap from branches and leaves, causing weakening or even death of the tree.
Hemiptera in Insecta	Stink bugs	They feed on fruit and plant shoot sap, leading to fruit drop or rot.
Fulgoridae	Planthoppers (*L. delicatula*, *Ricania speculum*)	Adults and nymphs suck sap from young leaves and branches, affecting normal growth, fruit quality, and photosynthesis.
Sesiidae	Clearwing moths	Larvae bore into the inner parts of stems of *Actinidia arguta*.
Tetranychidae	*Tetranychus truncatus*, spider mites	They suck cell sap from leaves, limiting photosynthesis and hindering normal growth and development.

Prevention and Control Methods

In recent years, rural revitalization and the concept that "lucid waters and lush mountains are invaluable assets" have transformed many villages. Some areas have even achieved the goal of working near home, and the people don't have to go out to work to support their families as before, thanks to the relocation-based poverty alleviation that made this possible. On the path to poverty alleviation, vigorously developing agricultural products remains a primary measure. Making full use of every piece of land, such as beekeeping, growing crops and cultivating fruits, has increased farmers' income through sales after production. Nowadays, regions across the country are promoting agricultural development, with some even leveraging live-streaming e-commerce to sell local products via express delivery. The introduction of national policies has

provided opportunities for the development of the kiwifruit industry. Guided by these policies, various regions have vigorously expanded kiwifruit cultivation, making it a key poverty alleviation industry in many areas. Kiwifruit is known as the "king of fruits" for its rich nutritional value, but kiwifruit trees are vulnerable to various pests and diseases during cultivation. To ensure both delicious and safe produce, growers adhere to the principle of "prevention first, integrated control", improving the growing environment and applying scientific management. They employ a combination of physical, eco-friendly, chemical, and other control methods for comprehensive pest management.

Agricultural control

If the kiwi plantation area consists of overly homogeneous varieties, it will accelerate pest infestation, leading to rapid spread and increasingly severe damage. To address this issue, appropriate introduction of other kiwi varieties during cultivation can be implemented to reduce the risk of pest infection due to monoculture. In this process, when selecting new kiwifruit varieties, it is essential to prioritize their resistance and tolerance, opting for seedlings with strong defensive capability and striving to cultivate disease-free saplings to minimize potential sources of pest infestation. During the planting of kiwifruit saplings, timely and appropriate management of water and nutrient supply is crucial. Meanwhile, it is necessary to regularly remove infected plants from the planting area, disinfect the orchards, and reduce the spread of pest infestations.

To prevent further expansion of pest infestation, during the planting process, in addition to introducing new kiwifruit saplings, plants such as clover and alfalfa can also be incorporated into the planting area. This not only reduces the risk of various pest infections but also minimizes the use of herbicides. For example, biological pesticides such as *Bacillus thuringiensis* and *Beauveria bassiana* can effectively control beetles. Meanwhile, natural predators of pests can be utilized to protect kiwifruit seedlings, leveraging the principle of interspecies antagonism. For instance, employing ladybugs (*Coccinella septempunctata*) and parasitic wasps to control aphids yields favorable results.

Physical control

In addition to utilizing natural predators for pest control in kiwifruit cultivation, physical methods can also be employed. These methods do not cause substantial harm to the kiwifruit seedlings. For pests such as stink bugs and beetles, manual removal or traps like insecticidal lamps and sticky boards can be used for capture and elimination[35]. In the case of *E. fullo* control, net trapping has been proven to be a relatively effective method[36]. For *P. pentagona*, they can be removed by scrubbing with tools such as bamboo brushes or cloths. Nobuyuki *et al.*[37] studied the attraction of monochromatic purple light, green light, and combinations of ultraviolet and green light to stink bugs in field conditions, based on the high sensitivity of Pentatomidae pests' compound eyes to ultraviolet and green light. Research has demonstrated that monochromatic green light has weak attractiveness to insects, while the combination of both lights enhanced attraction, with the effect increasing as the number of combined lights rose.

For areas with high nematode infestation, crop rotation can be implemented by planting other pest-resistant or pest-tolerant crops to reduce nematode occurrence in kiwifruit cultivation areas. Alternatively, without hindering the normal growth of kiwifruit seedlings, hot water treatment can be applied to their roots[38] to effectively prevent and control nematode damage. Based on the occurrence characteristics, patterns, and habits of kiwifruit pests, corresponding trapping and killing methods should be adopted, such as using lights and baits. Specifically, deploying solar-powered insecticidal lamps in kiwifruit planting areas can effectively eliminate adult pests like beetles, leaf rollers, and clearwing moths. Meanwhile, installing large-scale yellow sticky traps can help capture pests such as aphids, leafhoppers, and mosquitoes. The wider the installation coverage, the greater the reduction in pest infestation probability. For moths, beetles, and similar pests, sugar-vinegar solution can also be used as an effective trapping method. The trapping and killing method should be combined with other approaches to enhance pest control effectiveness. For instance, when using solar-powered lamps or sugar-vinegar solutions, bagging the fruit on kiwifruit trees with light-yellow kraft paper can protect the fruit. This method avoids mechanical damage while shielding the fruit from pests and pesticide exposure, improving safety and reducing pesticide residue. Additionally, applying white paint to the tree trunks can prevent pest attacks on the seedlings, and this method can kill bacteria and insects.

Chemical control

Throughout the growth process of kiwifruit seedlings to fruit-bearing, green control methods primarily serve a preventive role, reducing the probability of infestations by various pests. To ensure the safety and reliability of the fruit, a series of physical control methods such as natural predators, crop rotation and trapping are often applied in the pest control process. However, while implementing green control methods, chemical control remains essential as some pests show low susceptibility to eco-friendly approaches. In such cases, kiwifruit growers need to apply targeted chemical pesticides to ensure normal growth of seedlings and enhance yield potential.

During the application of pesticides, it is essential to strictly control the time and dosage. For example, directing at the larval stage of *E. fullo*, diluted solutions of 25% deltamethrin emulsifiable concentrate, 10% cypermethrin emulsifiable concentrate, or 40% phoxim emulsifiable concentrate can be sprayed on kiwi plants to effectively prevent their occurrence[39]. Additionally, alternating the use of diluted solutions of 5% beta-cypermethrin emulsifiable concentrate or 5% acetamiprid emulsifiable concentrate can also achieve good control results[40-41].

Diluted solutions, including clay-diesel oil emulsion with oil content of 0.2%, dichlorvos emulsion, and dimethacarb emulsion, can be sprayed directly on kiwi seedlings to control the nymphs of *P. pentagona*. Additionally, spirotetramat has shown good efficacy in controlling this pest[42-43]. During the egg-laying period of *P. pentagona*, applying matrine · nicotine aqueous agent to kiwi seedlings can help prevent infestations[44].

Spraying kiwi plants with an 80% diluted dichlorvos solution in the evening can effectively control large-scale damage caused by adult scarab beetles, while the chemical pesticide Bordeaux

mixture can repel the adults. Alternatively, during the early stages of infection, kiwi plants can be treated with a diluted 40% omethoate emulsifiable concentrate for eradication[45]. For the larvae, the pesticide can be sprayed onto the ground and then turned into the soil for control.

Spraying a diluted mixture of abamectin, difenoconazole and chlorpyrifos on the surface of kiwi plants can effectively control mite infestations. The decision to apply chemical pesticides should be based on the pest infestation situation in the plantation. If necessary, appropriate chemical pesticides should be purchased. Otherwise, green control methods should be primarily adopted. For example, to control spider mite infestations, options include spraying 3 – 5 Be lime sulfur, 20% hexythiazox emulsifiable concentrate (3 000 – 4 000 × times dilution), 20% pyridaben emulsifiable concentrate (3 000 – 4 000 × times dilution), or 5% fenpyroximate suspension concentrate (3 000 – 5 000 × times dilution). Other cases should be handled according to the specific pest conditions[46-47].

Biological control

To ensure food safety and reliability, the cultivation of kiwifruit should primarily adopt green prevention and control methods, supplemented by chemical control. Environmentally friendly and human/livestock-safe biological control approaches should be employed to prevent pest infestations and reduce the risk of damage to kiwifruit plants. In the production of green food, it is essential to prioritize long-lasting and plant-friendly pest control methods. Among them, biological control strategies mainly include utilizing natural enemies of pests, applying microbial agents, and implementing biological sterilization techniques. Specifically, the introduction and utilization of parasitic or predatory natural enemies can prevent pest infestations. For example, ladybugs, hoverflies and parasitic wasps can be employed to control aphid populations. Meanwhile, natural enemies such as *Trichogramma*, *Orius similis* Zheng, spiders and ladybugs can be used to manage mites, aphids, scale insects, and other pests[46]. These methods aim to achieve effective pest control while ensuring healthy plant growth. Biological metabolites can be utilized for pest management, such as employing insectivorous animals including beneficial birds and poultry for biological control. Additionally, the "using insects to control insects" approach can be implemented, utilizing predators like spiders and dragonflies[48]. In nature, various organisms maintain a dynamic equilibrium, and the microbial world is no exception. Pathogenic microorganisms can be utilized for pest control. For example, *B. thuringiensis* demonstrates effective control against geometrid moths, slug moths, and tussock moths. The biological sterilization methods involve using attractants to lure pests into pre-set devices where they come into contact with sterilizing agents. This prevents their offspring from developing normally, thereby protecting kiwifruit plants from damage[49].

Parasitic wasps can be employed to control *E. fullo*[50]. For managing root-knot nematodes, intercropping companion plants within kiwifruit orchards can reduce nematode infestation[51]. The most crucial aspect of biological control lies in adopting environmentally friendly methods that effectively protect kiwifruit plants. This includes extracting natural insecticidal compounds from specific botanical sources[52-60] or cultivating these plants within orchards as alternatives to chemical sprays. Such approaches prevent mass pest infestations while ensuring normal plant growth, bud formation, flowering, and fruit development.

In kiwifruit cultivation, plant immunity induction serves as an important green pest control technology. By combining immune inducers with pesticides, this approach significantly enhances disease resistance and reduces pest damage in kiwifruit trees. Immune inducers should typically be applied during both the flowering and early fruit-setting stages. Examples include Bihu (0.136% gibberellin · indole-3-acetic acid · brassinolide), chitosan oligosaccharides, and Taikang (0.5% chitosan), which effectively improve plant resistance[61].

Summary and Prospects

Both domestic and international experience demonstrates that establishing standardized cultivation models for kiwifruit is an effective approach to enhance yield and product quality. However, firstly, priority should be given to selecting suitable regions rather than blindly expanding planting areas during cultivation. Instead, site-specific approaches should be adopted by rationally considering regional growing conditions, such as water-fertilizer management and appropriate cultivar selection for different planting zones. Secondly, rational construction of kiwifruit orchards should be implemented. By adopting agricultural, physical and biological control methods, the use of chemical pesticides can be reduced. Growers should be educated to raise their awareness of proper pesticide application. Targeted guidance should be provided for different growth periods, ensuring standardized pesticide application with strict control to produce green and safe fruit products.

Currently, dozens of kiwifruit pests have been identified. However, with continuous expansion of cultivation areas, new pests keep emerging. To maximize economic benefits, growers need to learn and master various pest control methods for kiwifruit plants. They should adhere to the principle of "prevention first, integrated control," strengthen pest monitoring efforts, and achieve early detection and treatment to reduce economic losses caused by pest damage.

To produce safe and green agricultural products, the most crucial measure is to reduce chemical pesticide usage. During kiwifruit cultivation, pesticides should be applied strictly according to national standards to avoid losses caused by excessive pesticide residues. The concept of "green pesticides" has been introduced, and these pesticides are harmless to human health, environmentally friendly, characterized by ultra-low dosage and high selectivity, and produced through green manufacturing processes. Such pesticides are expected to be widely adopted in future kiwifruit cultivation practices.

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