# A Comprehensive Analysis of Pests Affecting Cannabis sativa Cultivation

**1. Introduction: The Significance of Cannabis Pest Research**

The global cultivation of *Cannabis sativa* has witnessed a significant surge in recent years, driven by its expanding applications across medicinal, recreational, and industrial sectors. This increased cultivation has brought to the forefront the substantial challenges posed by various pests and diseases that can inflict considerable economic and yield losses. A thorough understanding of these detrimental organisms is paramount for the development of effective management strategies and the promotion of sustainable cultivation practices. This research plan aims to provide a comprehensive and systematically organized overview of all known pests affecting Cannabis plants. By categorizing these pests and detailing their identification, biology, lifecycle, environmental influences, damage mechanisms, and current control measures, this report seeks to consolidate existing knowledge and pinpoint critical gaps that necessitate further scientific investigation.

**2. Insect Pests of Cannabis**

* 2.1. Aphids (Order Hemiptera, Family Aphididae)  
  Aphids represent a significant challenge in cannabis cultivation, with several species specifically adapted to infest this crop.1 These insects are characterized as small, soft-bodied organisms that utilize their piercing-sucking mouthparts to extract sap from the plant.1 Among the prominent aphid species affecting Cannabis are the Cotton aphid (Aphis gossypii), the Potato aphid (Macrosiphum euphorbiae), the Green peach aphid (Myzus persicae), the Cannabis aphid (Phorodon cannabis), and the Rice root aphid (Rhopalosiphum rufiabdominale).1 The coloration of aphids can vary considerably depending on the species and their life stage, encompassing hues of green, black, red, yellow, brown, and white.3 Furthermore, aphids exhibit both winged and wingless forms, a characteristic that influences their dispersal and colonization patterns.9  
  The Cotton aphid demonstrates a cosmopolitan distribution, with a preference for warmer climates.13 It has been observed in both European and North American cannabis cultivation.5 The Potato aphid, while originating in North America, has now established itself globally 14, with notable prevalence in the western regions of the United States.18 The Green peach aphid, with its origins in Asia, has achieved a worldwide distribution 19 and is commonly found throughout North America.20 The Cannabis aphid is a more recent arrival to North America, first documented in Colorado in 2016. It has since become widespread in that state and Oregon, with its range extending to other US states and Canada.12 Its origin is traced back to India.12 The Rice root aphid exhibits a broad distribution across North America 26 and is capable of surviving outdoors throughout the year.29 There has been an increasing number of reports of this species infesting indoor-grown cannabis in both the US and Canada.26  
  A defining characteristic of aphids is their rapid reproductive capacity, which can lead to swift population explosions on cannabis plants.1 Their reproductive strategies can involve both sexual reproduction, where eggs overwinter to initiate new generations, and asexual reproduction through live birth, depending on the specific species and prevailing environmental conditions.9 Many aphid species exhibit multiple overlapping generations within a single year.9 The nymphal stages of aphids can mature quite rapidly, as seen in the Cotton aphid, which can reach maturity in approximately 5 days.16 Notably, the Rice root aphid follows an anholocyclic lifecycle, characterized by the presence of only asexual females.44  
  Several environmental factors significantly influence the occurrence and severity of aphid outbreaks on cannabis plants. Warm temperatures generally promote rapid reproduction and development in aphids.9 High humidity levels can also be conducive to the proliferation of certain aphid species.8 An agricultural practice that can inadvertently favor aphid infestations is over-fertilization, particularly with nitrogen, which can make cannabis plants more attractive to these pests.2 In contrast, stagnant air conditions, while potentially favoring thrips, might also indirectly relate to aphid presence by creating an environment less conducive to natural aphid predators.8 Indoor cultivation environments often provide stable and favorable conditions that allow for year-round aphid reproduction and development.29  
  Aphid infestations can manifest in various ways on cannabis plants, leading to a range of detrimental effects. Stunted growth and an overall reduction in plant vigor are common consequences of aphid feeding.1 Aphid feeding can also cause leaves to become distorted or curled 1, and may lead to the yellowing of leaves, a condition known as chlorosis.4 Wilting of the plant can also occur as a result of extensive sap removal by aphids.6 A characteristic sign of aphid infestation is the excretion of a sticky substance called "honeydew," which can subsequently promote the growth of unsightly sooty mold on the plant surfaces.3 Furthermore, aphids are known vectors of various viral diseases in Cannabis, including cucumber mosaic virus, alfalfa mosaic virus, and hemp streak virus.1 Other symptoms can include leaf speckling 49, and in the case of the Rice root aphid, direct damage to the root system.3 The presence of shed aphid skins, known as exuviae, on the leaves can also indicate an infestation.9  
  Current management strategies for aphid infestations in Cannabis encompass a range of approaches. Chemical control methods include the application of insecticidal soaps, neem oil, spinosad, pyrethrins, and horticultural oils.3 In some cases, more potent chemical miticides may be employed. It is important to rotate the use of different chemical classes to mitigate the development of insecticide resistance in aphid populations.2 Biological control involves the introduction of natural predators such as ladybugs, lacewings, parasitic wasps (including species of *Aphidius*), predatory mites (*Neoseiulus californicus*, *Phytoseiulus persimilis*, *Amblyseius swirskii*), predatory midges (*Aphidoletes aphidimyza*), minute pirate bugs (*Orius spp.*), and assassin bugs.3 Entomopathogenic fungi like *Beauveria bassiana* and *Isaria fumosorosea*, as well as entomopathogenic nematodes such as *Steinernema feltiae*, are also utilized for biological aphid control.1 Cultural control practices include maintaining healthy plants, ensuring proper watering regimes (particularly avoiding overwatering to manage fungus gnats, which can sometimes be associated with aphids), promoting good air circulation, physically removing infested leaves, and using yellow sticky traps for both monitoring and direct control.3 Avoiding excessive nitrogen fertilization, employing row covers and reflective mulches, and diligently removing weeds and crop debris are also important cultural strategies for aphid management.2 Quarantining any new plants introduced into a cultivation area is a crucial preventative measure.8  
  Despite the array of existing control methods, several gaps remain in our knowledge regarding aphid management in Cannabis. Further research is needed to evaluate the long-term effectiveness and ecological impact of various biological control agents in the diverse environments where Cannabis is cultivated. The development of Cannabis varieties exhibiting resistance to specific aphid species would represent a significant advancement. Optimizing cultural practices for aphid management in the context of large-scale commercial operations also warrants further investigation. A more detailed understanding of the specific mechanisms involved in virus transmission by different aphid species affecting Cannabis is crucial. The influence of environmental factors such as temperature, humidity, and light on the lifecycle and population dynamics of these aphid species on Cannabis requires more thorough study. Given the regulatory restrictions on chemical pesticides in many regions, there is a pressing need to assess the efficacy of new and emerging organic and biopesticide options for aphid control in Cannabis. Finally, establishing economic thresholds for aphid infestations in Cannabis at different growth stages and for various end-uses (flower, seed, fiber) is essential for guiding timely and appropriate management interventions.
* 2.2. Leaf Miners (Order Diptera, Family Agromyzidae)  
  Leaf miners pose a challenge to cannabis crops as larvae of small flies that create tunnels within the leaf tissue.1 Several species are known to affect Cannabis, including the Tomato leaf miner (Liriomyza bryoniae), the Pea leaf miner (Liriomyza huidobrensis), and the American serpentine leaf miner (Liriomyza trifolii).1 The larvae of these insects are typically small worms, often white or pale green in color 73, while the adults are small flies with yellow and black markings.48  
  The Tomato leaf miner is a Palaearctic species that likely originated in Southern Europe and has now spread to many parts of Central and Northern Europe (primarily in greenhouses), as well as North Africa and Asia.75 The Pea leaf miner has its origins in South and Middle America but has since become widespread across the globe.83 The American serpentine leaf miner is native to North America and has also established itself in Europe since around 1976, with a current distribution that spans the world.96  
  Leaf miners undergo a complete metamorphosis, progressing through the egg, larval (with three instars), pupal, and adult stages.48 The adult females lay their eggs within the leaf tissue.1 Upon hatching, the larvae begin to tunnel and feed on the mesophyll tissue of the leaves.1 Pupation typically occurs either in the soil or on the surface of the leaves.48 The duration of the leaf miner lifecycle is influenced by temperature; for example, the Tomato leaf miner's cycle can range from 17 to 41 days at temperatures between 25°C and 15°C.48 Female leaf miners are capable of laying hundreds of eggs, contributing to their potential for rapid population growth.48  
  Several environmental factors can contribute to outbreaks of leaf miners on cannabis. High light intensities and the presence of vigorous host plants are thought to favor their development 48, as are high humidity levels (80-90%).48 Indoor and greenhouse cultivation environments often provide the stable conditions necessary for leaf miners to thrive.75 Additionally, an excess of nitrogen in the growing medium may attract leaf miners to cannabis plants.73  
  The damage caused by leaf miners to cannabis is characterized by distinctive winding mines or trails that appear on the leaves.1 This larval feeding activity reduces the plant's ability to photosynthesize and produce energy 1, potentially leading to stunted growth and overall weakened plants.1 In severe infestations, premature leaf drop may occur 72, and the cosmetic damage to the foliage can affect the marketability of the crop.72 The feeding sites and exit holes created by leaf miners can also serve as entry points for disease-causing fungal or bacterial pathogens.48  
  Current management and control strategies for leaf miners in cannabis include chemical applications of spinosad, neem oil, insecticidal soaps, pyrethrum, abamectin, and cyromazine.4 Systemic insecticides such as imidacloprid may also be used.103 Biological control options include the introduction of parasitic wasps like *Diglyphus isaea* 4, as well as predatory mites and entomopathogenic nematodes.1 Cultural control methods involve removing and destroying infested leaves, crushing larvae within the mines, maintaining environmental control in indoor and greenhouse settings, practicing proper sanitation, and utilizing yellow sticky traps to capture adult flies.1  
  Several gaps in our understanding of leaf miners affecting cannabis require further research. The specific susceptibility of different Cannabis varieties to various leaf miner species remains to be fully elucidated. Detailed studies on the lifecycle and behavior of *Liriomyza cannabis* specifically on Cannabis are needed. Optimizing biological control strategies for leaf miners in Cannabis, considering the unique cultivation practices of this crop, is an important area for future investigation. The impact of leaf miner damage on the cannabinoid and terpene profiles of Cannabis also warrants study. Developing early detection methods for leaf miner infestations in Cannabis would be beneficial for timely intervention. The efficacy of novel organic and biorational insecticides against leaf miners in Cannabis, with a focus on minimizing harm to beneficial organisms, should be explored. Finally, understanding the interaction between leaf miner infestations and the incidence of secondary infections in Cannabis is crucial for developing comprehensive management plans.
* 2.3. Caterpillars (Order Lepidoptera)  
  Caterpillars, the larval stage of moths and butterflies, pose significant challenges to cannabis cultivation due to their voracious appetites and chewing mouthparts.1 Various species are known to infest Cannabis, including the Hemp moth (Grapholita delineana), the Beet armyworm (Spodoptera exigua), the Corn earworm (Helicoverpa zea), the European corn borer (Ostrinia nubilalis), the Tobacco budworm (Heliothis virescens), the Cabbage looper (Trichoplusia ni), and the Zebra caterpillar.1 The coloration of caterpillars varies widely depending on the species, ranging from green and pink to brown, black, and striped patterns.1  
  The Hemp moth is widespread in eastern Colorado 112 and is native to East Asia, having spread to Europe and North America.120 The Beet armyworm, originally from Asia, has been introduced worldwide 128 and is common in the US, particularly in warmer regions.132 The Corn earworm is found across North America 150 and is a major agricultural pest in California.155 The European corn borer is native to Europe and was introduced to North America 166, also being widespread in eastern Colorado.112 The Tobacco budworm is distributed throughout the eastern and southwestern US.187 The Cabbage looper is native to America and found throughout North America 197, being present nearly the entire growing season.203  
  Caterpillars undergo complete metamorphosis, with a lifecycle consisting of egg, larva (with multiple instars), pupa, and adult (moth or butterfly) stages.113 Eggs are typically laid on leaves, stems, or buds of the cannabis plant.1 The larval stage involves feeding on various parts of the plant, including leaves, buds, stems, and seeds.1 Pupation can occur in the soil, leaf litter, or directly on the plant.1 Many caterpillar species exhibit multiple generations per year.112  
  Environmental factors such as warm weather generally favor the development and activity of caterpillars.45 In some species, late planting can increase the risk of infestation.217 Adequate air circulation may help prevent infestations of certain caterpillar types.6  
  Caterpillar damage to cannabis is manifested through chewed leaves with holes or ragged edges 1, as well as damage to buds and the potential for bud rot.1 Some species bore into stems and stalks 1, and some can cause significant defoliation.1 Some species also damage seeds.1 The presence of frass (excrement) is a common sign of caterpillar activity.1 Other damage symptoms include wilting and dieback, stem swelling, excessive branching, hollowed buds, leaf skeletonization, webbing, premature topping, the production of "oakum" (twisted fibers), and in some cases, cannibalism. Color changes in leaves, a "windowpane" effect on leaves, stalk cankers, dropped ears, a "shot hole" appearance on leaves, damage to tassels and petioles, "hits" (skeletonized foliage), leaf rolling, abnormal seed production, and even leaf mining in early instars are also associated with various caterpillar species.  
  Current management strategies for caterpillars on cannabis involve chemical controls such as BT spray (*Bacillus thuringiensis*), spinosad, pyrethrins, and neem oil.3 Biological control methods include the introduction of natural predators like parasitic wasps (*Trichogramma spp.*, *Macrocentrus delicatus*, *Campoletis sonorensis*, *Cardiochiles nigriceps*), green lacewings, ladybugs, assassin bugs, predatory mites, and entomopathogenic nematodes.3 Cultural control practices involve handpicking caterpillars, removing infested plant parts, crop rotation, removing crop debris to reduce overwintering, keeping fields weed-free, ensuring adequate air circulation, and using netting.3  
  Several areas related to caterpillar pests of cannabis require further research. The host specificity and preference of different caterpillar species on various Cannabis cultivars need more detailed investigation. Understanding the phenology and population dynamics of key caterpillar pests in different geographical regions is crucial for effective management. The development of effective pheromone traps and monitoring programs tailored for specific caterpillar species in Cannabis would be beneficial. The impact of cannabinoid and terpene profiles on caterpillar feeding behavior and development is an interesting area that warrants further study. Optimizing biological control strategies, including the selection of the most effective natural enemies and their application methods, is essential for sustainable pest management. The efficacy of new organic and biorational insecticides for caterpillar control in Cannabis, with a focus on minimizing harm to beneficial insects, should be explored. Establishing economic thresholds for caterpillar infestations in Cannabis at different growth stages and for different end-uses is necessary for informed decision-making regarding interventions. Finally, the role of environmental factors such as temperature and humidity in caterpillar outbreaks on Cannabis needs further investigation.
* 2.4. Thrips (Order Thysanoptera)  
  Thrips are tiny, slender insects characterized by their fringed wings and a typical length of 1-2 mm.1 Common species that affect Cannabis include the Western flower thrips (Frankliniella occidentalis), Onion thrips (Thrips tabaci), and Impatiens thrips (Echinothrips americanus).1 Their color can vary, including yellow, brown, black, golden, and translucent hues.6 Thrips exhibit both winged adult and wingless nymph forms.4  
  The Western flower thrips has a worldwide distribution and originated in California 220, being considered the most damaging thrips species in many greenhouse crops.222 The Onion thrips is also found globally 234 and is a common pest on both outdoor and indoor cannabis.69 The Impatiens thrips is native to eastern North America and is increasingly problematic in greenhouses, having spread through the trade of foliage plants.241  
  Thrips undergo a lifecycle with six stages: egg, two larval instars, prepupa, pupa, and adult.52 Eggs are laid in leaves, flower petals, and soft parts of stalks.52 The larvae feed on plant tissues.4 Pupation usually occurs in the ground, though sometimes on leaves or in flowers.52 The entire lifecycle can be completed in about two weeks under favorable conditions.52 Female thrips can lay hundreds of eggs 52, and parthenogenesis is common in some species.52  
  Warm temperatures favor the rapid development of thrips 52, while dry conditions can also be conducive for certain species.3 Stagnant air conditions are known to favor thrips 8, and the presence of pollen can increase their activity and reproduction.223 High nitrogen fertilization may also attract thrips to cannabis plants.225 Indoor and greenhouse environments often provide the stable conditions necessary for thrips to thrive.1  
  Thrips feeding on cannabis plants causes silver or bronze spots and streaks on the leaves, a symptom known as stippling.1 They also leave behind small black fecal droppings.1 Infestations can lead to stunted growth 1 and cause leaves and flowers to become deformed.1 Leaves may also become brittle 6, and flowers can wilt.224 Premature leaf drop may occur in some cases.52 Thrips are also known to transmit plant viruses, such as Tomato spotted wilt virus and Impatiens necrotic spot virus.1 Necrotic patches and silvering of leaves are also characteristic of thrips damage.1  
  Management of thrips on cannabis involves chemical controls such as insecticidal soaps, neem oil, spinosad, pyrethrins, horticultural oils, abamectin, and cyromazine.1 Biological control includes predatory mites (*Amblyseius swirskii*, *Neoseiulus cucumeris*, *Amblyseius andersoni*, *Amblydromalus limonicus*, *Neoseiulus californicus*), predatory bugs (*Orius insidiosus*, *Orius laevigatus*), green lacewings, ladybugs, predatory nematodes, and entomopathogenic fungi.1 Cultural controls include sanitation, quarantining new plants, ensuring proper ventilation, and using sticky traps (blue or yellow) for monitoring and control.1  
  Further research is needed to identify specific thrips species affecting Cannabis in different regions and their potential for virus transmission. The impact of environmental factors on thrips populations and virus transmission in Cannabis cultivation requires further investigation. Optimization of biological control strategies, including the use of banker plants, is essential. The efficacy of new organic and biorational insecticides against thrips on Cannabis needs to be explored, with a focus on minimizing harm to beneficial insects. Developing Cannabis varieties with resistance to thrips would be a significant advancement. Establishing economic thresholds for thrips infestations at different growth stages is necessary. Finally, understanding the role of Cannabis secondary metabolites in thrips deterrence or susceptibility warrants further study.
* 2.5. Whitefly (Order Hemiptera, Family Aleyrodidae)  
  Whiteflies are small, winged insects that pose a significant threat to cannabis plants by feeding on their sap.1 Two species are of particular concern: the Tobacco whitefly (Bemisia tabaci) and the Greenhouse whitefly (Trialeurodes vaporariorum).1 These insects are small, white, and often described as moth-like in appearance.6 They typically lay their eggs on the undersides of leaves.6  
  The Tobacco whitefly has a global distribution and is especially prevalent in warmer regions.1 The Greenhouse whitefly is also widespread and commonly found in greenhouse environments.1  
  Whiteflies undergo complete metamorphosis, with a lifecycle that includes the egg stage, several larval instars (crawler and sessile stages), a pupal stage (red-eyed nymph), and the adult stage.1 Eggs are laid on the undersides of leaves and are often sticky.6 The larvae, initially mobile crawlers, soon become sessile and resemble scales.8 The pupae, also known as red-eyed nymphs, are also immobile.8 Adults emerge and are capable of flight.6 Whiteflies are known for their rapid reproduction rates, which can quickly lead to large infestations on cannabis plants.3  
  Warm and moist weather conditions tend to favor whitefly outbreaks.271 These pests often show a preference for weaker plants.6 Indoor and greenhouse environments provide the stable and often warm conditions that allow whiteflies to thrive.1  
  Whitefly infestations can cause leaves to yellow and wilt.1 The feeding activity of these insects reduces plant vigor and hinders overall growth 1, ultimately impacting the yield of the cannabis crop.1 A significant issue associated with whiteflies is their secretion of honeydew, a sugary substance that promotes the growth of sooty mold on the plant surfaces.1  
  Current management and control strategies for whiteflies on cannabis include chemical applications of insecticidal soaps, neem oil, spinosad, and Essentria IC3.1 Biological control methods involve the introduction of parasitic wasps such as *Encarsia formosa* and *Eretmocerus eremicus*, as well as predatory mites like *Amblyseius swirskii*.1 Cultural control practices include removing infested leaves, ensuring good air circulation, using yellow sticky traps to monitor and capture adults, and quarantining any new plants before introducing them to the existing crop.7  
  Further research is needed to understand the specific impact of different whitefly species on various Cannabis cultivars. Detailed studies on the lifecycle and behavior of whiteflies on Cannabis are also necessary. Optimizing biological control strategies for whiteflies in Cannabis cultivation is an important area for future investigation. The efficacy of new organic and biorational insecticides against whiteflies on Cannabis should be explored. Finally, understanding the role of environmental factors in whitefly outbreaks on Cannabis warrants further study.
* **2.6. Other Notable Insect Pests:**
  + Barnacles / Scale Insects are stationary pests that attach themselves to the stems, branches, and leaves of cannabis plants, resembling seaside barnacles.3 They can be white or red and are also known as wax scales.3 Like aphids, they produce a sticky honeydew substance, which can lead to sooty mold.3 Control methods include using soap sprays, a powerful water spray, neem oil, or introducing predator insects such as lacewings and ladybirds.3
  + Leafhoppers come in a wide variety of colors and are characterized by their ability to suck sap from plants, leaving behind spots that may be white, brown, or yellow.3 These insects have wings, six legs, and can jump. They tend to be more problematic in hot, dry weather.3 Control strategies include specialist insecticidal sprays, neem oil, and beneficial predators such as ladybirds, lacewings, and parasitic wasps.3
  + Mealybugs are small, white insects with a cotton-like, waxy appearance, often found around the joints between branches.4 They suck sap from the plants and secrete honeydew, which can attract ants and promote the growth of sooty mold, leading to leaf yellowing and stunted growth, and affecting overall yield.4 They are more commonly found on outdoor crops.271 Control options include insecticidal soaps, limonene products, and neem oil.4
  + Crickets will often feed on cannabis leaves and are generally easy to remove manually.3 While typically not major pests, mole crickets can burrow into the cannabis root system and cause a nuisance, although they are encountered infrequently.3 Plant netting can be useful to keep these insects away from plants.3
  + Grasshoppers enjoy eating the foliage on cannabis plants and are also easy to remove manually.3 A layer of netting around the plants can prevent grasshoppers from landing on them.3
  + Fungus Gnats are small, dark flies that often emerge from the soil after hatching from their eggs. Soils containing compost made from wood chips can be particularly prone to fungus gnats.3 Their larvae can cause significant damage to root systems, leading to stunted growth.3 Control methods include allowing the topsoil to dry out between waterings, using yellow sticky traps, diatomaceous earth, neem oil, beneficial nematodes, predatory mites, predatory beetles, and UVB supplemental lights.1
  + Beetles and Grubs are listed as a category of pests affecting Cannabis, with beneficial nematodes mentioned as a control measure.30
  + Plant Bugs, such as Lygus spp., can pierce through plant tissues and feed on the sap, causing distorted growth and blemished leaves in cannabis crops. Their feeding can also lead to necrotic spots and reduced flower quality.5
  + Borers, which are the larval stage of small moths, tunnel into stems and buds, becoming evident when the latter wilt and die. They can cause stunting and stem and stalk distortion, which affect yield.6 Notorious species include the Eurasian Hemp Borer and the European Corn Borer.8
  + Stink Bugs are conspicuous pests that, while also feeding on young leaves and flowers, primarily damage developing seeds.6 Examples include the Conchuela and Say's Stink Bug, and the Red-shouldered Stink Bug.117
  + Leafhoppers, including the Curly top Beet Leafhopper and Potato Leafhopper, are also known to affect cannabis plants.117

**3. Mite Pests of Cannabis**

* 3.1. Spider Mites (Order Trombidiformes, Family Tetranychidae)  
  Spider mites, particularly the Two-spotted spider mite (Tetranychus urticae), are a major concern for cannabis growers, especially in indoor cultivation environments.1 These tiny arachnids inflict considerable harm by piercing plant cells and extracting essential fluids, leading to the appearance of stippled leaves.1 A telltale sign of their presence is the fine webbing they produce on the leaves and buds.1 Adult spider mites are minute, typically straw or green colored with two distinctive dark spots on their sides.6 They lay their eggs on the underside of leaves, and these mites are notorious for their rapid reproductive rates, enabling them to quickly multiply and overwhelm cannabis crops.1 The lifecycle includes egg, larval, and nymph stages before reaching adulthood.273 Temperatures below 15°C have been shown to significantly reduce their rate of reproduction.273  
  Outbreaks of spider mites are often favored by hot, dry, and dusty conditions 6, which are common in indoor growing settings.1 Besides the characteristic stippling and webbing, spider mite infestations can cause yellowing or bronzing of the leaves 31, and a general decline in the overall health of the plant.1 In severe cases, the leaves may become brittle and turn dark before eventually crumbling.6  
  Current management strategies for spider mites include chemical controls such as neem oil, sesame oil, cinnamon-clove tea, and sulfur.3 Insecticidal soaps, horticultural oils, and more potent miticides like 'Forbid', 'Avid', and 'IC3' are also used.1 Biological control agents such as predatory mites like *Phytoseiulus persimilis* and *Neoseiulus californicus* are effective in controlling spider mite populations.1 Cultural control methods involve removing infested leaves, vacuuming areas with high webbing, and managing the environment by controlling heat, as colder temperatures make it difficult for them to reproduce.4  
  Further research is needed to develop Cannabis varieties that exhibit resistance to spider mites. The long-term effectiveness of different predatory mite species in Cannabis cultivation requires more evaluation. The impact of environmental factors on the spider mite lifecycle and control in indoor Cannabis grows should be further investigated. The efficacy of novel organic and biorational miticides for Cannabis needs to be explored. Finally, understanding the resistance mechanisms that spider mites develop against common control agents in Cannabis is crucial for developing sustainable management strategies.
* 3.2. Other Pest Mites (Order Trombidiformes)  
  Beyond spider mites, cannabis plants are also susceptible to other types of pest mites, including russet mites and broad mites. Russet mites, particularly the Hemp russet mite (Aculops cannabicola) from the Eriophyidae family, are known to significantly impact cannabis plants.1 These mites are extremely tiny and can only be seen with magnification.3 Infestations lead to distorted growth, necrosis, and a reduction in yields.1 Growers may observe new growth that appears twisted, blistered, and wet or plasticky. During the flowering stage, buds may turn brown and die.6 Control measures include specialist chemical sprays (miticides like 'Forbid', 'Avid', 'IC3'), neem oil, soapy sprays, and predatory mites such as Amblyseius swirskii and Neoseiulus californicus. Diatomaceous earth can also be helpful.1  
  Broad mites (*Polyphagotarsonemus latus*) from the Tarsonemidae family can also be a severe problem in cannabis crops.1 These mites are so small that they may not be noticeable even with a magnifying glass.3 Their presence can be identified by the tortured appearance of the leaves, which look twisted, droopy, glossy, blistered, and unhealthy.3 Growers often misdiagnose broad mite infestations as pH, heat stress, or nutrient problems.3 Control strategies mirror those for russet mites, including specialist chemical sprays, neem oil, soapy sprays, and predatory mites like *Neoseiulus*.3 Cyclamen mites are also listed as a potential pest of cannabis.30

**4. Fungal Diseases of Cannabis**

Fungal pathogens thrive in moist environments and can spread rapidly among cannabis plants, causing various diseases such as damping off in seedlings, powdery mildew, and root or crown rot.6

Powdery Mildew, often caused by *Golovinomyces spp.*, manifests as white spots and/or a thin white dusty covering on the leaves and other parts of the plant.6 This fungal disease competes with the plant for nutrients, leading to stunted growth and a decrease in the quality of the final product.49 It is favored by moist conditions.6 Control measures include selecting cannabis varieties that are less susceptible to powdery mildew, ensuring adequate spacing and pruning to promote air circulation and light penetration, avoiding over-fertilization, removing any infected plant parts, sterilizing tools, and avoiding high humidity levels, potentially through the use of a dehumidifier.49 Neem oil can also be used as a preventative measure against powdery mildew.66

Botrytis, also known as gray mold or bud rot and caused by *Botrytis cinerea*, affects the buds, flowers, and seeds of cannabis plants.1 The infection often starts within the bud and can be difficult to detect in its early stages, eventually causing the tissue to turn brown or grey.275 This mold can remain hidden or dormant for extended periods.275 Like powdery mildew, Botrytis is favored by moist environments.6 Management strategies include removing any injured or dying parts of the plant, sterilizing tools, avoiding high humidity through the use of dehumidifiers, and pruning out the impacted sections of the plant.49 It is also advisable to avoid strains with large, dense flowers that tend to retain moisture and to maintain dry grow rooms with optimal humidity and temperature.70

Fusarium, encompassing various species such as *Fusarium oxysporum*, *F. proliferatum*, and *F. solani*, can cause root and crown rot, stem canker/rot, bud rot, and symptoms like wilting and leaf spots.6 Infected plants may exhibit brown and necrotic areas on the roots, discolored lesions near the soil line, and leaves that turn yellow and wilt.275 The fungus can remain dormant in the soil for years before becoming active.275 Currently, there is no effective treatment for Fusarium infections.275 Preventative measures include avoiding strains with large, dense flowers and pruning out any diseased buds.70

Pythium, including species like *Pythium myriotylum*, *P. dissotocum*, and *P. aphanidermatum*, is another fungal pathogen that causes root and crown rot, primarily affecting the roots of cannabis plants.6 Symptoms include root browning, and the plant may appear stunted, wilted, and have yellow leaves.275 Pythium thrives in moist conditions.6

Other fungal diseases that can affect cannabis include damping off, which impacts seedlings 6; various forms of root rot and infection 274; stem canker and rot 274; stem rot, often caused by *Fusarium* and *Pythium* 6; post-harvest mold, such as that caused by *Penicillium species* 6, which can be managed by avoiding damage to buds during harvesting and trimming, and by irradiating dried buds 70; and leaf spot and blight, caused by fungi like *Alternaria alternata*, *Cercospora spp.*, and *Septoria spp.* 6, which can be mitigated by reducing ambient humidity and moisture.70 Sooty mold, while not a direct pathogen, is a black fungus that grows on the honeydew excreted by sap-sucking insects like aphids and whiteflies.6

**5. Bacterial Diseases of Cannabis**

Plant pathogenic bacteria are primarily microscopic, single-celled organisms, with most being rod-shaped (bacilliform).274 This category also includes fastidious prokaryotes such as phytoplasmas and spiroplasmas.274 Bacterial diseases in cannabis can manifest as soft rot, fire blight, leaf spot or speck, wilt, and stem and root rot.274 Evidence of bacterial infection can include slimy growth on hemp tissue and bacterial streaming from the hemp stem.274 Stem rot can be caused by a combination of *Fusarium* and *Pythium*.6 Symptoms like wilting and leaf spots can be attributed to *Xanthomonas* bacteria 6, and management involves using resistant cultivars and pathogen-free mother plants.70 Various bacteria can also cause root rot in cannabis.274

**6. Viral Diseases of Cannabis**

Viruses are infectious agents that function as intracellular pathogens, existing as submicroscopic particles.271 They require living organisms, known as vectors, for transmission, which can include insect pests or even the grower themselves.271 Viral diseases can affect various parts of the cannabis plant, leading to systemic issues and impacting buds, flowers, seeds, foliage, stems, and roots.274

Tobacco mosaic virus (TMV) is one such viral disease, characterized by the development of alternating yellow and green spots on the leaves, creating a mosaic pattern.271 Notably, TMV was the first virus ever discovered.275 Hop latent viroid (HLVd) is another concern, causing a condition known as Dudding, where buds are small and loose with a reduced number of trichomes. It can also lead to plant stunting during the vegetative growth phase, resulting in small, narrow, and discolored leaves.6 HLVd is believed to be transmitted through clones 275, and currently, there is no cure. Prevention relies on testing stock plants to ensure they are free from the viroid.70 Beet Curly Top Virus (BCTV) results in distorted cannabis plants with leaves exhibiting curling or twisting. Infected plants may also show shortened internodes, overall stunting, bright yellow leaves, upward leaf curling, and new growth that appears "twisted".275 Lettuce Chlorosis Virus can cause stunted growth if infection occurs early, although visual signs may not appear until a few weeks into flowering. Leaves of infected plants turn yellow, roll upwards, and become brittle during the flowering stage.275 Several viruses are known to be transmitted by the Cannabis aphid, including hemp streak virus, hemp mosaic virus, hemp leaf chlorosis virus, cucumber mosaic virus, hemp mottle virus, and alfalfa mosaic virus.24

**7. Other Pests**

* **7.1. Nematodes (Phylum Nematoda)** Nematodes are non-segmented roundworms that are among the most abundant multicellular animals on Earth, with most species being free-living.31 However, some are parasitic and possess specialized feeding structures.274 Plant-parasitic nematodes are typically soil-borne pathogens that attack the roots of cannabis plants, although a few species can affect stems and leaves.31 Root-knot disease is caused by certain types of nematodes, and cyst nematodes can be observed feeding on plant roots.274 Harmful nematode infestations can lead to stunted growth and wilting of the plants, despite adequate watering.31 Control strategies for nematodes in cannabis cultivation include the use of some beneficial nematode species.30

**8. Conclusion and Future Research Needs**

The cultivation of *Cannabis sativa* is impacted by a diverse array of pests, spanning insects, mites, fungi, bacteria, viruses, and nematodes. These pests can cause significant damage, leading to substantial economic and yield losses. Effective management necessitates a comprehensive understanding of each pest's biology, lifecycle, and interaction with the environment. Integrated pest management (IPM) strategies, combining cultural, biological, and chemical control methods, are crucial for sustainable cannabis production.

This analysis has highlighted several key gaps in our current knowledge of Cannabis pests. Future research should prioritize the development of pest-resistant Cannabis varieties to reduce reliance on pest control interventions. Improving early detection and monitoring methods, such as advanced sensing technologies and diagnostic tools, will enable timely responses to infestations. Optimizing biological control strategies for various pests and across different cultivation environments, including indoor, outdoor, and greenhouse settings, is essential for environmentally friendly pest management. Further investigation into the role of Cannabis secondary metabolites, such as cannabinoids and terpenes, in plant defense mechanisms against pests could lead to novel control approaches. The efficacy of new organic and biorational pesticides and miticides for Cannabis, with a focus on their selectivity and minimal impact on beneficial organisms, warrants thorough evaluation. Establishing economic thresholds for key pests at different growth stages of Cannabis and for various end-uses will provide growers with data-driven decision-making tools. Finally, a deeper understanding of the complex interactions between environmental factors and pest outbreaks on Cannabis is crucial for developing predictive models and proactive management strategies. Collaborative research efforts involving academic institutions, industry stakeholders, and regulatory agencies are vital to address these knowledge gaps and advance sustainable pest management practices in the rapidly evolving Cannabis industry.

| **Pest Category** | **Example Pests** | **Primary Damage Symptoms** | **Key Control Strategies** | **Gaps in Knowledge** |
| --- | --- | --- | --- | --- |
| Aphids | Cotton aphid, Cannabis aphid, Root aphid | Stunted growth, leaf curl, yellowing, honeydew, root damage | Insecticidal soaps, neem oil, predatory insects, cultural practices | Long-term efficacy of biocontrol, resistance development, virus transmission mechanisms |
| Leaf Miners | Tomato leaf miner, Pea leaf miner | Winding trails in leaves, reduced photosynthesis | Spinosad, neem oil, parasitic wasps, removing infested leaves | Host specificity, *L. cannabis* lifecycle, impact on plant chemistry |
| Caterpillars | Hemp moth, Corn earworm, Cabbage looper | Chewed leaves/buds, stem boring, defoliation | BT spray, spinosad, handpicking, beneficial insects | Host preference, phenology, pheromone traps, impact of cannabinoids |
| Thrips | Western flower thrips, Onion thrips | Silver streaks on leaves, deformed growth, black fecal spots | Insecticidal soaps, neem oil, predatory mites, blue sticky traps | Species-specific impacts, virus transmission, biocontrol optimization |
| Whitefly | Tobacco whitefly, Greenhouse whitefly | Yellowing leaves, reduced vigor, sooty mold | Insecticidal soaps, neem oil, parasitic wasps | Species-specific impacts, lifecycle details on Cannabis, biocontrol |
| Spider Mites | Two-spotted spider mite | Stippled leaves, webbing, yellowing | Neem oil, predatory mites, sulfur | Resistance mechanisms, long-term biocontrol efficacy |
| Russet & Broad Mites | Hemp russet mite, Broad mite | Distorted growth, necrosis, twisted leaves | Miticides, neem oil, predatory mites | Specific control methods for Cannabis |
| Fungi | Powdery mildew, Botrytis, Fusarium | White powdery growth, bud rot, wilting | Cultural practices, fungicides (limited options) | Efficacy of specific fungicides on Cannabis |
| Bacteria | *Xanthomonas*, various root rot bacteria | Wilting, leaf spots, stem/root rot | Sanitation, resistant cultivars (limited options) | Specific bacterial pathogens and their management |
| Viruses | TMV, HLVd, BCTV | Mosaic patterns, stunted growth, deformed buds | Prevention (clean clones), no direct cures | Transmission vectors and mechanisms in Cannabis |
| Nematodes | Root-knot nematodes | Root galls, wilting, stunted growth | Beneficial nematodes | Species affecting Cannabis and effective control |

#### Works cited

1. Cannabis - Pests, Diseases and Biological Control - Koppert US, accessed May 5, 2025, <https://www.koppertus.com/crops/ornamentals/cannabis/>
2. Cannabis Aphids - USU Extension, accessed May 5, 2025, <https://extension.usu.edu/planthealth/ipm/notes_ag/veg-cannabis-aphid>
3. A Visual Guide to Cannabis Pests and Diseases | Dutch Passion, accessed May 5, 2025, <https://dutch-passion.com/en/blog/a-visual-guide-to-cannabis-pests-and-diseases-n1073>
4. Common Cannabis Pests and Diseases - DripWorks.com, accessed May 5, 2025, <https://www.dripworks.com/blog/common-cannabis-pests-and-diseases>
5. Cannabis - Pests, Diseases and Biological Control - Koppert UK, accessed May 5, 2025, <https://www.koppert.co.uk/crops/ornamentals/cannabis/>
6. Cannabis Pests and Pathogens - Emerald Harvest, accessed May 5, 2025, <https://emeraldharvest.co/cannabis-pests-and-pathogens/>
7. Cannabis Pests, Bugs & Viruses: Picture Guide - Grow Weed Easy, accessed May 5, 2025, <https://www.growweedeasy.com/bugs-pests-symptoms-marijuana-grow>
8. How to identify and treat common cannabis pests and diseases - Weedmaps, accessed May 5, 2025, <https://weedmaps.com/learn/the-plant/cannabis-pest-disease-identification>
9. Cannabis aphid - Agricultural Biology, accessed May 5, 2025, <https://agsci.colostate.edu/agbio/ipm-pests/cannabis-aphid/>
10. Cannabis Aphid | USU, accessed May 5, 2025, <https://extension.usu.edu/pests/ipm/notes_ag/hemp-cannabis-aphid>
11. Cannabis Aphid, accessed May 5, 2025, <https://webdoc.agsci.colostate.edu/hempinsects/PDFs/Cannabis%20aphid%20October%202018%20revision%20(1).pdf>
12. Phorodon cannabis, the Cannabis (Bhang) Aphids: (Hemiptera: Aphididae) - LSU AgCenter, accessed May 5, 2025, <https://www.lsuagcenter.com/articles/page1619552130426>
13. Cotton aphid - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/aphids/cotton-aphid/>
14. Potato aphid - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/aphids/potato-aphid/>
15. Hemp-Aphids - Pacific Northwest Pest Management Handbooks |, accessed May 5, 2025, <https://pnwhandbooks.org/insect/agronomic/hemp/hemp-aphids>
16. Cotton aphid (Aphis gossypii) and how to control them - Royal Brinkman, accessed May 5, 2025, <https://royalbrinkman.com/knowledge-center/crop-protection-disinfection/control-cotton-aphids>
17. Cotton Aphid - Pests - Bayer CropScience, accessed May 5, 2025, <https://www.cropscience.bayer.eg/en-eg/pests/pests/cotton-aphid.html>
18. POTATO APHID Homoptera: Aphididae Macrosiphum euphorbiae DESCRIPTION ECONOMIC IMPORTANCE DISTRUBTION AND LIFE HISTORY MANAGEMEN - USPest.org, accessed May 5, 2025, <https://uspest.org/potato/potatoaphid.pdf>
19. Green peach aphid - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/aphids/green-peach-aphid/>
20. Green Peach Aphid, Myzus persicae (Sulzer) (Insecta: Hemiptera: Aphididae) | EDIS, accessed May 5, 2025, <https://journals.flvc.org/edis/article/view/111002?articlesBySameAuthorPage=4>
21. EENY222/IN379: Green Peach Aphid, Myzus persicae (Sulzer) (Insecta: Hemiptera: Aphididae) - UF/IFAS EDIS, accessed May 5, 2025, <https://edis.ifas.ufl.edu/publication/IN379>
22. Green peach aphid - Biocontrol, Damage and Life Cycle - Koppert US, accessed May 5, 2025, <https://www.koppertus.com/plant-pests/aphids/green-peach-aphid/>
23. Myzus persicae (green peach aphid) | CABI Compendium, accessed May 5, 2025, <https://www.cabidigitallibrary.org/doi/full/10.1079/cabicompendium.35642>
24. Cannabis aphid - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/aphids/cannabis-aphid/>
25. We're seeing a lot of phorodon cannabis ( aphid ) lately: here's what I think is going on. : r/macrogrowery - Reddit, accessed May 5, 2025, <https://www.reddit.com/r/macrogrowery/comments/j4v1ha/were_seeing_a_lot_of_phorodon_cannabis_aphid/>
26. Cannabis sativa as a Host of Rice Root Aphid (Hemiptera: Aphididae) in North America, accessed May 5, 2025, <https://www.researchgate.net/publication/345330373_Cannabis_sativa_as_a_Host_of_Rice_Root_Aphid_Hemiptera_Aphididae_in_North_America>
27. Rhopalosiphum rufiabdominale - Wikipedia, accessed May 5, 2025, <https://en.wikipedia.org/wiki/Rhopalosiphum_rufiabdominale>
28. Rice root aphids living on the roots of aeroponically grown Cannabis sativa. - ResearchGate, accessed May 5, 2025, <https://www.researchgate.net/figure/Rice-root-aphids-living-on-the-roots-of-aeroponically-grown-Cannabis-sativa_fig3_345330373>
29. Rice root aphid - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/aphids/rice-root-aphid/>
30. Pest Control | Hemp & Cannabis Cultivation - Arbico Organics, accessed May 5, 2025, <https://www.arbico-organics.com/category/pest-control-hemp-cannabis-crops>
31. Cannabis Pests: Symptoms, Prevention, and Treatment - ILGM, accessed May 5, 2025, <https://ilgm.com/resources/guides/cannabis-pests-symptoms-prevention-and-treatment>
32. Cotton Aphids - Texas A&M AgriLife Research & Extension Center at Lubbock, accessed May 5, 2025, <https://lubbock.tamu.edu/files/2017/07/Cotton-aphid_ENTO074.pdf>
33. EENY-173/IN330: Melon Aphid or Cotton Aphid, Aphis gossypii Glover (Insecta: Hemiptera: Aphididae) - UF/IFAS EDIS, accessed May 5, 2025, <https://edis.ifas.ufl.edu/publication/IN330>
34. Potato Aphid - Oklahoma State University Extension, accessed May 5, 2025, <https://extension.okstate.edu/programs/digital-diagnostics/insects-and-arthropods/potato-aphid-macrosiphum-euphorbiae/>
35. Green Peach Aphid | NC State Extension Publications, accessed May 5, 2025, <https://content.ces.ncsu.edu/green-peach-aphid>
36. Cannabis Aphid in Industrial Hemp | NC State Extension Publications, accessed May 5, 2025, <https://content.ces.ncsu.edu/cannabis-aphid-in-industrial-hemp>
37. Rice Root Aphid – Management and Life Cycle | - mlachapell.com, accessed May 5, 2025, <https://mlachapell.com/rice-root-aphid-management-and-life-cycle/>
38. Rice root aphids: a nuisance for any cannabis grower - MMJDaily, accessed May 5, 2025, <https://www.mmjdaily.com/article/9525714/rice-root-aphids-a-nuisance-for-any-cannabis-grower/>
39. Rice Root Aphid - Utah State University Extension, accessed May 5, 2025, <https://extension.usu.edu/pests/ipm/notes_ag/hemp-rice-root-aphid>
40. Root Aphids | Natural Enemies Organic Chemical-Free Pest Control, accessed May 5, 2025, <https://naturalenemies.com/by-pest/root-aphids/>
41. Melon or Cotton Aphid - Oklahoma State University Extension, accessed May 5, 2025, <https://extension.okstate.edu/programs/digital-diagnostics/insects-and-arthropods/melon-or-cotton-aphid-aphis-gossypii/>
42. Potato Aphid on Ornamental Plants | NC State Extension Publications, accessed May 5, 2025, <https://content.ces.ncsu.edu/potato-aphid-on-ornamental-plants>
43. Cotton Aphid (Aphis gossypii) - Insecticide Resistance Action Committee, accessed May 5, 2025, <https://irac-online.org/documents/aphis-gossypii-irm-poster/>
44. Rice Root Aphids: What growers should know about treating the pervasive pest - Fluence, accessed May 5, 2025, <https://fluence-led.com/science-articles/root-aphids/>
45. New genetic resources for aphid resistance were identified from a newly developed wheat mutant library - PubMed Central, accessed May 5, 2025, <https://pmc.ncbi.nlm.nih.gov/articles/PMC10912258/>
46. Aphids Management Guidelines - UC IPM, accessed May 5, 2025, <https://ipm.ucanr.edu/PMG/PESTNOTES/pn7404.html>
47. Cannabis Aphid, accessed May 5, 2025, <https://webdoc.agsci.colostate.edu/hempinsects/PDFs/Cannabis%20Aphid%20Management%20Indoors%20May%2015%202018.pdf>
48. Leaf miners - Melon - Ephytia, accessed May 5, 2025, <http://ephytia.inra.fr/en/C/7930/Melon-Leaf-miners>
49. Common pests on homegrown cannabis - Gov.bc.ca, accessed May 5, 2025, <https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/public-safety/cannabis/common-pests-homegrown.pdf>
50. Cannabis Aphid - Utah State University Extension, accessed May 5, 2025, <https://extension.usu.edu/pests/ipm/notes_ag/hemp-cannabis-aphid.php>
51. Integrated Pest Management (I.P.M.) for Aphids - HGIC, Clemson, accessed May 5, 2025, <https://hgic.clemson.edu/factsheet/integrated-pest-management-i-p-m-for-aphids/>
52. Dealing with Thrips on Cannabis: Effective Strategies for Pest Management - FloraFlex, accessed May 5, 2025, <https://floraflex.com/default/blog/post/dealing-with-thrips-on-cannabis-effective-strategies-for-pest-management>
53. Glasshouse potato aphid - Biocontrol, Damage and Life Cycle - Koppert US, accessed May 5, 2025, <https://www.koppertus.com/plant-pests/aphids/glasshouse-potato-aphid/>
54. Green Peach Aphid on Peppers - Penn State Extension, accessed May 5, 2025, <https://extension.psu.edu/green-peach-aphid-on-peppers>
55. Rice Root Aphid, accessed May 5, 2025, <https://webdoc.agsci.colostate.edu/hempinsects/PDFs/Rice%20Root%20Aphid%20extra%20info.pdf>
56. Cannabis Pest Control: Prevention and Management Strategies, accessed May 5, 2025, <https://cleanleaf.com/cannabis-pest-and-prevention.php>
57. HPIPM:Potato Aphid - Bugwoodwiki, accessed May 5, 2025, <https://wiki.bugwood.org/HPIPM:Potato_Aphid>
58. Green Peach Aphid - Integrated Pest Management, accessed May 5, 2025, <https://ipm.uga.edu/files/2020/02/GreenPeachAphid.pdf>
59. What to Do about Common Cannabis Pests & Bugs? - Hey abby, accessed May 5, 2025, <https://heyabby.com/blogs/articles/pests-bugs-on-weed-plants>
60. How To Spot, Treat, And Prevent Aphids On Cannabis Plants - Royal Queen Seeds, accessed May 5, 2025, <https://www.royalqueenseeds.com/us/blog-how-to-spot-treat-and-prevent-aphids-on-cannabis-plants-n499>
61. How To Control Aphids | Organic Pest Control - Arbico Organics, accessed May 5, 2025, <https://www.arbico-organics.com/category/pest-solver-guide-aphids>
62. How to get rid of aphids once and for all? : r/HotPeppers - Reddit, accessed May 5, 2025, <https://www.reddit.com/r/HotPeppers/comments/rkpjl0/how_to_get_rid_of_aphids_once_and_for_all/>
63. I need help getting aphids of my marijuana plants. : r/gardening - Reddit, accessed May 5, 2025, <https://www.reddit.com/r/gardening/comments/17e0zc9/i_need_help_getting_aphids_of_my_marijuana_plants/>
64. Pesticides Allowed for Managing Insects and Mites on Cannabis in Colorado, accessed May 5, 2025, <https://webdoc.agsci.colostate.edu/hempinsects/PDFs/Allowable%20Insecticides%20for%20Cannabis%20in%20Colorado.pdf>
65. Insecticides to Control Hemp Pests & Bolster Yield | Extension | West Virginia University, accessed May 5, 2025, <https://extension.wvu.edu/agriculture/agribusiness-farm-management/pesticide-education/insecticides-for-hemp-pests>
66. 5 Organic Pesticides for Commercial Cannabis Growers - Riococo MMJ, accessed May 5, 2025, <https://www.riococo-mmj.com/5-organic-pesticides-for-professional-cannabis-growers/>
67. The Power of Beneficial Insects in Cannabis Cultivation: Protecting Your Plants from Pests, accessed May 5, 2025, <https://cannabisworkforce.org/blog/the-power-of-beneficial-insects-in-cannabis-cultivation-protecting-your-plants-from-pests/>
68. Nematodes against cannabis pests - e-nema GmbH, accessed May 5, 2025, <https://www.e-nema.de/en/nematodes/professionals/application-areas/cannabis>
69. Thrips, accessed May 5, 2025, <https://webdoc.agsci.colostate.edu/hempinsects/PDFs/Thrips%20extra%20info.pdf>
70. Managing Cannabis Pests and Pathogens - Emerald Harvest, accessed May 5, 2025, <https://emeraldharvest.co/managing-cannabis-pests-and-pathogens/>
71. Guidance on Integrated Pest Management - Cannabis Control Commission, accessed May 5, 2025, <https://masscannabiscontrol.com/wp-content/uploads/2019/04/202108_Guidance_Integrated_Pest_Management.pdf>
72. Leaf miners - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/leaf-miners/>
73. How to protect and defend your cannabis plants from leaf miners - Kannabia Seeds, accessed May 5, 2025, <https://www.kannabia.com/en/blog/how-to-protect-and-defend-your-cannabis-plants-from-leaf-miners?qt-noestamossolos=0>
74. How to control and get rid of leaf miner invasions - Humboldt Seed Organization, accessed May 5, 2025, <https://www.humboldtseeds.net/en/blog/control-leaf-miner-invasions/>
75. Pest categorisation of Liriomyza bryoniae - PMC - PubMed Central, accessed May 5, 2025, <https://pmc.ncbi.nlm.nih.gov/articles/PMC7447992/>
76. Liriomyza cannabis - Agromyzidae, accessed May 5, 2025, <https://agromyzidae.co.uk/species/agromyzidae/phytomyzinae/liriomyza/liriomyza-cannabis/>
77. Tomato Leaf Miner | Liriomyza bryoniae (Kaltenbach) - CA.gov, accessed May 5, 2025, <https://blogs.cdfa.ca.gov/Section3162/?p=5606>
78. Liriomyza cannabis | Overview | Finnish Biodiversity Info Facility, accessed May 5, 2025, <https://laji.fi/en/taxon/MX.279101>
79. Tomato leaf miner - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/leaf-miners/tomato-leaf-miner/>
80. Tomato Leaf Miner Guide - GrowVeg.com, accessed May 5, 2025, <https://www.growveg.co.uk/pests/uk-and-europe/tomato-leaf-miner/>
81. Leafminers - Tomato - UC IPM, accessed May 5, 2025, <https://ipm.ucanr.edu/agriculture/tomato/leafminers/>
82. Leaf miners - Tomato - Ephytia - INRAE, accessed May 5, 2025, <http://ephytia.inra.fr/en/C/5138/Tomato-Leaf-miners>
83. Pea leaf miner - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/leaf-miners/pea-leaf-miner/>
84. Liriomyza huidobrensis Pest Information - Defra Plant Health Portal, accessed May 5, 2025, <https://planthealthportal.defra.gov.uk/data/pests/20889/data>
85. Liriomyza huidobrensis (serpentine leafminer) | CABI Compendium, accessed May 5, 2025, <https://www.cabidigitallibrary.org/doi/full/10.1079/cabicompendium.30956>
86. The Invasive Liriomyza huidobrensis (Diptera: Agromyzidae): Understanding Its Pest Status and Management Globally - PubMed Central, accessed May 5, 2025, <https://pmc.ncbi.nlm.nih.gov/articles/PMC5388319/>
87. Molecular Survey for the Invasive Leafminer Pest Liriomyza huidobrensis (Diptera: Agromyzidae) in California Uncovers Only the Native Pest Liriomyza langei | Journal of Economic Entomology | Oxford Academic, accessed May 5, 2025, <https://academic.oup.com/jee/article/107/5/1959/810742>
88. Liriomyza [Serpentine Leafminer] on Cannabis - YouTube, accessed May 5, 2025, <https://www.youtube.com/watch?v=nVADd4d-w6Q>
89. Leafminers on Vegetables | University of Maryland Extension, accessed May 5, 2025, <https://extension.umd.edu/resource/leafminers-vegetables>
90. Leafminers - Celery - UC IPM, accessed May 5, 2025, <https://ipm.ucanr.edu/agriculture/celery/leafminers/>
91. Pea Leafminer | Center for Invasive Species Research - University of California, Riverside, accessed May 5, 2025, <https://cisr.ucr.edu/invasive-species/pea-leafminer>
92. Serpentine leafminer | Business Queensland, accessed May 5, 2025, <https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/biosecurity/plants/priority-pest-disease/serpentine-leafminer>
93. Leafminers | USU, accessed May 5, 2025, <https://extension.usu.edu/vegetableguide/leafy-greens/leafminers>
94. EENY255/IN507: Vegetable Leafminer, Liriomyza sativae Blanchard (Insecta: Diptera: Agromyzidae) - UF/IFAS EDIS, accessed May 5, 2025, <https://edis.ifas.ufl.edu/publication/IN507>
95. Leafminers / Floriculture and Ornamental Nurseries / Agriculture - UC IPM, accessed May 5, 2025, <https://ipm.ucanr.edu/agriculture/floriculture-and-ornamental-nurseries/leafminers/>
96. American serpentine leaf miner - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/leaf-miners/american-serpentine-leaf-miner/>
97. Diglyphus isaea | Beneficial Insects for Cannabis - Plantsman, accessed May 5, 2025, <https://www.plantsmangroup.com/product/diglyphus-isaea/>
98. EENY254/IN506: American Serpentine Leafminer, Liriomyza trifolii (Burgess) (Insecta: Diptera: Agromyzidae) - UF/IFAS EDIS, accessed May 5, 2025, <https://edis.ifas.ufl.edu/publication/IN506>
99. Liriomyza trifolii (American serpentine leafminer) | CABI Compendium, accessed May 5, 2025, <https://www.cabidigitallibrary.org/doi/full/10.1079/cabicompendium.30965>
100. Liriomyza trifolii (American serpentine leafminer) - | Plantwise Knowledge Bank, accessed May 5, 2025, <https://plantwiseplusknowledgebank.org/doi/full/10.1079/pwkb.species.30965>
101. Responses of Liriomyza trifolii (Diptera: Agromyzidae) to Chemical and Biorational Insecticides - BioOne Complete, accessed May 5, 2025, <https://bioone.org/journals/florida-entomologist/volume-99/issue-4/024.099.0405/Responses-of-Liriomyza-trifolii-Diptera--Agromyzidae-to-Chemical-and/10.1653/024.099.0405.full>
102. American serpentine leafminer | Business Queensland, accessed May 5, 2025, <https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/biosecurity/plants/priority-pest-disease/american-leafminer>
103. American Serpentine Leafminer | NC State Extension Publications, accessed May 5, 2025, <https://content.ces.ncsu.edu/american-serpentine-leafminer>
104. Leafmining Insects - 5.548 - CSU Extension - Colorado State University, accessed May 5, 2025, <https://extension.colostate.edu/topic-areas/insects/leafmining-insects-5-548/>
105. Tomato leaf miner - Biocontrol, Damage and Life Cycle - Koppert US, accessed May 5, 2025, <https://www.koppertus.com/plant-pests/leaf-miners/tomato-leaf-miner/>
106. Leaf Miner - Aggie Horticulture, accessed May 5, 2025, <https://aggie-horticulture.tamu.edu/vegetable/problem-solvers/tomato-problem-solver/insect-pests/leaf-miner/>
107. Control of leaf miners on pot and bedding plants - NET, accessed May 5, 2025, <https://projectblue.blob.core.windows.net/media/Default/Horticulture/Publications/Control%20of%20leaf%20miners%20on%20pot%20and%20bedding%20plants.pdf>
108. Leafminers / Lettuce / Agriculture - UC IPM, accessed May 5, 2025, <https://ipm.ucanr.edu/agriculture/lettuce/leafminers/>
109. Leafminers in home gardens | UMN Extension, accessed May 5, 2025, <https://extension.umn.edu/yard-and-garden-insects/leafminers>
110. Cannabis Pests - Identification Guide - Happy Harvest, accessed May 5, 2025, <https://happyharvest.co.za/cannabis-pests-identification-guide/>
111. Eurasian Hemp Borer - Utah State University Extension, accessed May 5, 2025, <https://extension.usu.edu/pests/ipm/notes_ag/hemp-eurasian-hemp-borer>
112. Eurasian hemp borer, Grapholita delineana - College of Agricultural Sciences, accessed May 5, 2025, <https://agsci.colostate.edu/agbio/ipm-pests/eurasian-hemp-borer/>
113. Hemp-Caterpillars | Pacific Northwest Pest Management Handbooks, accessed May 5, 2025, <https://pnwhandbooks.org/insect/agronomic/hemp/hemp-caterpillars>
114. Caterpillars - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/caterpillars/>
115. Dealing with Caterpillars and Worms in Cannabis Gardens - FloraFlex Media, accessed May 5, 2025, <https://floraflex.com/default/blog/post/dealing-with-caterpillars-and-worms-in-cannabis-gardens>
116. How to Keep Caterpillars Off Your Cannabis Plants - RQS Blog - Royal Queen Seeds, accessed May 5, 2025, <https://www.royalqueenseeds.com/us/blog-how-to-keep-caterpillars-off-your-cannabis-plants-n203>
117. Hemp Insect Fact Sheets - College of Agricultural Sciences, accessed May 5, 2025, <https://agsci.colostate.edu/hempinsects/hemp-insects-text/>
118. Grapholita delineana (hemp borer) | CABI Compendium, accessed May 5, 2025, <https://www.cabidigitallibrary.org/doi/full/10.1079/cabicompendium.25948>
119. Grapholita delineana (hemp borer) - | Plantwise Knowledge Bank, accessed May 5, 2025, <https://plantwiseplusknowledgebank.org/doi/full/10.1079/pwkb.species.25948>
120. Factsheet - Grapholita delineana, accessed May 5, 2025, <https://idtools.org/id/leps/tortai/Grapholita_delineana.htm>
121. Eurasian hemp borer (Grapholita delineana (Walker)) - Invasive.Org, accessed May 5, 2025, <https://www.invasive.org/browse/detail.cfm?imgnum=5596853>
122. Eurasian Hemp Borer Active in Kentucky Hemp Transplants & Mother Plants, accessed May 5, 2025, <https://kentuckypestnews.wordpress.com/2024/07/23/eurasian-hemp-borer-active-in-kentucky-hemp-transplants-mother-plants/>
123. Epidemiology of the Hemp Borer, Grapholita delineana Walker (Lepidoptera: Oleuthreutidae), a Pest of Cannabis sativa L. - ResearchGate, accessed May 5, 2025, <https://www.researchgate.net/profile/John-Mcpartland/publication/233434720_Epidemiology_of_the_Hemp_Borer_Grapholita_delineanaWalker_Lepidoptera_Oleuthreutidae_a_Pest_of_Cannabis_sativa_L/links/5d77c0dda6fdcc9961bf4fe4/Epidemiology-of-the-Hemp-Borer-Grapholita-delineanaWalker-Lepidoptera-Oleuthreutidae-a-Pest-of-Cannabis-sativa-L.pdf>
124. “New” Pest Of Hemp May Have Been Here For Years - Extension Entomology, accessed May 5, 2025, <https://extension.entm.purdue.edu/newsletters/pestandcrop/article/new-pest-of-hemp-may-have-been-here-for-years/>
125. The European Corn Borer in Hops and Hemp - University of Vermont, accessed May 5, 2025, <https://www.uvm.edu/sites/default/files/Northwest-Crops-and-Soils-Program/Articles_and_Factsheets/European_Corn_Borer_Hemp_Hops_factsheet_FINAL.pdf>
126. Corn earworm management in hemp | OSU Extension Service - Oregon State University, accessed May 5, 2025, <https://extension.oregonstate.edu/crop-production/hemp/corn-earworm-management-hemp>
127. Beet Armyworm, accessed May 5, 2025, <https://webdoc.agsci.colostate.edu/hempinsects/PDFs/Beet%20armyworm%20with%20photos.pdf>
128. Beet armyworm - Wikipedia, accessed May 5, 2025, <https://en.wikipedia.org/wiki/Beet_armyworm>
129. Beet armyworm - Biocontrol, Damage and Life Cycle - Koppert Canada, accessed May 5, 2025, <https://www.koppert.ca/plant-pests/caterpillars/beet-armyworm/>
130. How to detect and fight caterpillars, one of the worst plagues attacking cannabis plants, accessed May 5, 2025, <https://www.humboldtseeds.net/en/blog/how-to-detect-and-fight-caterpillars-one-of-the-worst-plagues-attacking-cannabis-plants/>
131. Learn to avoid and eliminate caterpillars and other creepy crawlies that can threaten your cannabis grow - Kannabia, accessed May 5, 2025, <https://www.kannabia.com/en/blog/learn-to-avoid-and-eliminate-caterpillars-and-other-creepy-crawlies-that-can-threaten-your-cannabis-grow>
132. Beet Armyworm Spodoptera exigua - Arbico Organics, accessed May 5, 2025, <https://www.arbico-organics.com/category/Beet-Armyworm-Spodoptera-exigua>
133. Beet armyworm - Spodoptera exigua Hbn. - CSALOMON PHEROMONE TRAPS, accessed May 5, 2025, <http://www.csalomontraps.com/4listbylatinname/pdffajonkentik/spodopteraexigua.pdf>
134. Off-season survival and life history of beet armyworm, Spodoptera exigua (Hubner) on various host plants - PubMed Central, accessed May 5, 2025, <https://pmc.ncbi.nlm.nih.gov/articles/PMC11178929/>
135. Evaluation of Hemp (Cannabis sativa) (Rosales: Cannabaceae) as an Alternative Host Plant for Polyphagous Noctuid Pests - PubMed, accessed May 5, 2025, <https://pubmed.ncbi.nlm.nih.gov/36269156/>
136. Beet armyworm - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/caterpillars/beet-armyworm/>
137. The beet armyworm (Spodoptera exigua) - Cropaia, accessed May 5, 2025, <https://cropaia.com/blog/beet-armyworm/>
138. Beet Armyworm / Tomato / Agriculture - UC IPM, accessed May 5, 2025, <https://ipm.ucanr.edu/agriculture/tomato/beet-armyworm/>
139. Beet armyworm (Order: Lepidoptera, Family: Noctuidae Spodoptera exigua (Hubner)) - UGA Cooperative Extension, accessed May 5, 2025, <https://extension.uga.edu/content/dam/extension/programs-and-services/integrated-pest-management/documents/insect-pdfs/baw.pdf>
140. Beet Armyworm – Earthwise Agriculture, accessed May 5, 2025, <https://earthwiseagriculture.net/monographs/beet-armyworm/>
141. Armyworms - Utah State University Extension, accessed May 5, 2025, <https://extension.usu.edu/planthealth/ipm/notes_ag/hemp-armyworms>
142. Monitor Beet Armyworms in Cotton - Bayer Crop Science, accessed May 5, 2025, <https://www.cropscience.bayer.us/articles/dad/beet-armyworms-cotton>
143. Armyworm - AggieTurf, accessed May 5, 2025, <https://aggieturf.tamu.edu/turfgrass-insects/armyworm/>
144. Beet Armyworm in Kentucky - UK Entomology, accessed May 5, 2025, <https://entomology.ca.uky.edu/ef308>
145. EENY105/IN262: Beet Armyworm, Spodoptera exigua (Hübner) (Insecta: Lepidoptera: Noctuidae) - UF/IFAS EDIS, accessed May 5, 2025, <https://edis.ifas.ufl.edu/publication/IN262>
146. Corn earworm - Agricultural Biology, accessed May 5, 2025, <https://agsci.colostate.edu/agbio/ipm-pests/corn-earworm/>
147. Influence of varieties of hemp, Cannabis sativa (Rosales: Cannabaceae), and fertilization rates on damage caused by corn earworm, Helicoverpa zea (Lepidoptera: Noctuidae) - PubMed, accessed May 5, 2025, <https://pubmed.ncbi.nlm.nih.gov/37431786/>
148. Influence of varieties of hemp, Cannabis sativa (Rosales: Cannabaceae), and fertilization rates on damage caused by corn earworm, Helicoverpa zea (Lepidoptera: Noctuidae) | Environmental Entomology | Oxford Academic, accessed May 5, 2025, <https://academic.oup.com/ee/article/53/1/26/7222529>
149. Hemp Pest Spectrum and Potential Relationship between Helicoverpa zea Infestation and Hemp Production in the United States in the Face of Climate Change, accessed May 5, 2025, <https://pmc.ncbi.nlm.nih.gov/articles/PMC8541464/>
150. Corn Earworm Management in Hemp | Agronomy, accessed May 5, 2025, <https://hemp.ucdavis.edu/news/corn-earworm-management-hemp>
151. Pest Management Needs and Limitations for Corn Earworm (Lepidoptera: Noctuidae), an Emergent Key Pest of Hemp in the United States - Oxford Academic, accessed May 5, 2025, <https://academic.oup.com/jipm/article/12/1/34/6368497>
152. Corn Earworm and Tobacco Budworm in Industrial Hemp | NC State Extension Publications, accessed May 5, 2025, <https://content.ces.ncsu.edu/corn-earworm-and-tobacco-budworm-in-industrial-hemp>
153. Insects Associated with Industrial Hemp, Cannabis sp. L., in Tennessee and Development of Helicoverpa zea (Boddie) on a Hemp-Bas, accessed May 5, 2025, <https://trace.tennessee.edu/cgi/viewcontent.cgi?article=7020&context=utk_gradthes>
154. Corn Earworm Monitoring & Management in Hemp - YouTube, accessed May 5, 2025, <https://www.youtube.com/watch?v=eJZgeEjgEMo>
155. Corn Earworms - UC Vegetable Research & Information Center, accessed May 5, 2025, <https://vric.ucdavis.edu/pdf/pests_CornEarworms.pdf>
156. Corn earworm - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/caterpillars/corn-earworm/>
157. Corn Earworm in Missouri | MU Extension, accessed May 5, 2025, <https://extension.missouri.edu/publications/g7110>
158. Corn Earworm Biology and Management in Soybeans | VCE Publications | Virginia Tech, accessed May 5, 2025, <https://www.pubs.ext.vt.edu/444/444-770/444-770.html>
159. Corn earworm - Cesar Australia, accessed May 5, 2025, <https://cesaraustralia.com/pestnotes/caterpillars/corn-earworm/>
160. Corn Earworm Management - New Century FS, accessed May 5, 2025, <https://www.newcenturyfs.com/Products-Services/Resource-Center/Resource-Detail/corn-earworm-management>
161. Corn Earworm [fact sheet] - UNH Extension, accessed May 5, 2025, <https://extension.unh.edu/resource/corn-earworm-fact-sheet>
162. Corn Earworm in Corn - Bayer Crop Science, accessed May 5, 2025, <https://www.cropscience.bayer.us/articles/bayer/corn-earworm-in-corn>
163. Corn Earworm (Helicoverpa zea) - IPM, accessed May 5, 2025, <https://ipm.illinois.edu/fieldcrops/insects/corn_earworm.pdf>
164. Corn Earworm | Wisconsin Vegetable Entomology, accessed May 5, 2025, <https://vegento.russell.wisc.edu/pests/corn-earworm/>
165. Cannabis pests - International Hemp Association, accessed May 5, 2025, <http://www.internationalhempassociation.org/jiha/iha03201.html>
166. Ostrinia nubilalis (Hübner), European Corn Borer / Pyrale du maïs (Lepidoptera: Crambidae), accessed May 5, 2025, <https://www.cabidigitallibrary.org/doi/10.1079/9781800623279.0033>
167. European corn borer - BioBee, accessed May 5, 2025, <https://www.biobee.com/pests/european-corn-borer/>
168. VIR - Resistance of accessions to corn stem borer - International Hemp Association, accessed May 5, 2025, <http://www.internationalhempassociation.org/jiha/jiha5206.html>
169. (PDF) Widespread Occurrence of European Corn Borer (Ostrinia nubilalis) and Damage of Industrial Hemp (Cannabis sativa) Crop in Northern Europe - ResearchGate, accessed May 5, 2025, <https://www.researchgate.net/publication/374844293_Widespread_Occurrence_of_European_Corn_Borer_Ostrinia_nubilalis_and_Damage_of_Industrial_Hemp_Cannabis_sativa_Crop_in_Northern_Europe>
170. Apparent Increase in Biomass and Seed Productivity in Hemp (Cannabis sativa) Resulting from Branch Proliferation Caused by the European Corn Borer (Ostrinia nubilalis) - Taylor & Francis Online, accessed May 5, 2025, <https://www.tandfonline.com/doi/abs/10.1300/J237v12n01_03>
171. How To Control European Corn Borers - Arbico Organics, accessed May 5, 2025, <https://www.arbico-organics.com/category/european-corn-borer-control>
172. A typical hemp (Cannabis sativa) plant infested by European corn borer... - ResearchGate, accessed May 5, 2025, <https://www.researchgate.net/figure/Atypical-hemp-Cannabis-sativa-plant-infested-by-European-corn-borer-Ostrinia_fig2_374844293>
173. European Corn Borer [fact sheet] - UNH Extension, accessed May 5, 2025, <https://extension.unh.edu/resource/european-corn-borer-fact-sheet>
174. Life Cycle of European Corn Borer - Plant and Soil Sciences eLibrary, accessed May 5, 2025, <https://passel2.unl.edu/view/lesson/488bc25cd8ff/3>
175. European Corn Borer | Integrated Crop Management, accessed May 5, 2025, <https://crops.extension.iastate.edu/encyclopedia/european-corn-borer>
176. Life Cycle and Impact of European Corn Borer - Beck's Hybrids, accessed May 5, 2025, <https://www.beckshybrids.com/resources/agronomy-talk/agronomy-talk-european-corn-borer>
177. European Corn Borer: A Multiple-Crop Pest in Missouri - MU Extension, accessed May 5, 2025, <https://extension.missouri.edu/publications/g7113>
178. European corn borer - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/caterpillars/european-corn-borer/>
179. European corn borer - Ostrinia nubilalis (Hubner) - Entomology and Nematology Department, accessed May 5, 2025, <https://entnemdept.ufl.edu/creatures/field/e_corn_borer.htm>
180. European Corn Borer - Cornell eCommons, accessed May 5, 2025, <https://ecommons.cornell.edu/bitstream/handle/1813/42367/european-corn-borer-FS-NYSIPM.pdf?sequence=1&isAllowed=y>
181. European Corn Borer | Wisconsin Vegetable Entomology, accessed May 5, 2025, <https://vegento.russell.wisc.edu/pests/european-corn-borer/>
182. Pepper IPM: European Corn Borer | Integrated Pest Management, accessed May 5, 2025, <https://ipm.cahnr.uconn.edu/pepper-ipm-european-corn-borer/>
183. Tobacco Budworm Control - Arbico Organics, accessed May 5, 2025, <https://www.arbico-organics.com/category/Tobacco-budworm-control>
184. Budworms - The Daily Garden, accessed May 5, 2025, <https://www.thedailygarden.us/garden-word-of-the-day/budworms>
185. tobacco budworm - Heliothis virescens (Fabricius), accessed May 5, 2025, <https://entnemdept.ufl.edu/creatures//field/tobacco_budworm.htm>
186. Tobacco budworm - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/caterpillars/tobacco-budworm/>
187. Chloridea virescens - Wikipedia, accessed May 5, 2025, <https://en.wikipedia.org/wiki/Chloridea_virescens>
188. EENY-219/IN376: Tobacco Budworm, Heliothis virescens (Fabricius) (Insecta: Lepidoptera: Noctuidae) - UF/IFAS EDIS, accessed May 5, 2025, <https://edis.ifas.ufl.edu/publication/IN376>
189. Tobacco Budworm on Ornamentals | NC State Extension Publications, accessed May 5, 2025, <https://content.ces.ncsu.edu/tobacco-budworm>
190. Insects – Tobacco Budworms | NC State Extension, accessed May 5, 2025, <https://tobacco.ces.ncsu.edu/tobacco-pest-management-insects-tobacco-budworms/>
191. Tobacco budworm (Order: Lepidoptera, Family: Noctuidae, Heliothis virescens (Fabricius)) Description: Adult - UGA Cooperative Extension, accessed May 5, 2025, <https://extension.uga.edu/content/dam/extension/programs-and-services/integrated-pest-management/documents/insect-pdfs/tbw.pdf>
192. How To Prevent and Control Budworm Damage - Stutzmans Greenhouse & Garden Centers, accessed May 5, 2025, <https://stutzmans.com/budworm/>
193. Tobacco (Geranium) Budworm - 5.581 - Extension, accessed May 5, 2025, <https://extension.colostate.edu/topic-areas/insects/tobacco-geranium-budworm-5-581/>
194. Tobacco budworms - University of Minnesota Extension, accessed May 5, 2025, <https://extension.umn.edu/yard-and-garden-insects/tobacco-budworms>
195. Cannabinoids function in defense against chewing herbivores in Cannabis sativa L, accessed May 5, 2025, <https://www.researchgate.net/publication/374720267_Cannabinoids_function_in_defense_against_chewing_herbivores_in_Cannabis_sativa_L>
196. Cabbage looper - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/caterpillars/cabbage-looper/>
197. Trichoplusia ni - Knowledge Master, accessed May 5, 2025, <http://www.extento.hawaii.edu/kbase/crop/Type/trichopl.htm>
198. cabbage looper (Trichoplusia ni (Hubner)) - Weed Images, accessed May 5, 2025, <https://www.weedimages.org/browse/detail.cfm?imgnum=5596666>
199. Trichoplusia ni (cabbage looper) | CABI Compendium, accessed May 5, 2025, <https://www.cabidigitallibrary.org/doi/full/10.1079/cabicompendium.54832>
200. Cannabinoids function in defense against chewing herbivores in Cannabis sativa L. | Horticulture Research | Oxford Academic, accessed May 5, 2025, <https://academic.oup.com/hr/article/10/11/uhad207/7311041>
201. Cannabinoids function in defense against chewing herbivores in Cannabis sativa L, accessed May 5, 2025, <https://pubmed.ncbi.nlm.nih.gov/38023471/>
202. cabbage looper Trichoplusia ni (Hubner) | Filters: Host - Insect Images, accessed May 5, 2025, <https://www.insectimages.org/browse/subthumb.cfm?sub=2521&host=5259>
203. Cabbage looper - Missouri Botanical Garden, accessed May 5, 2025, <https://www.missouribotanicalgarden.org/gardens-gardening/your-garden/help-for-the-home-gardener/advice-tips-resources/pests-and-problems/insects/caterpillars/cabbage-looper>
204. Cabbage Loopers: A Fall Nuisance - Insight Pest Solutions, accessed May 5, 2025, <https://insightpestnorthwest.com/cabbage-loopers-a-fall-nuisance/>
205. Cabbage Looper & Alfalfa Looper - OSU Horticulture Department - Oregon State University, accessed May 5, 2025, <https://horticulture.oregonstate.edu/oregon-vegetables/cabbage-looper-alfalfa-looper>
206. Cabbage Looper - Oklahoma State University Extension, accessed May 5, 2025, <https://extension.okstate.edu/programs/digital-diagnostics/insects-and-arthropods/cabbage-looper-trichoplusia-ni/>
207. Cabbage Looper - UGA Cooperative Extension, accessed May 5, 2025, <https://extension.uga.edu/content/dam/extension/programs-and-services/integrated-pest-management/documents/insect-pdfs/cabbagelooper.pdf>
208. Cabbage Loopers: What Are They and How Can You Control Them? - Gardenary, accessed May 5, 2025, <https://www.gardenary.com/blog/cabbage-loopers-what-are-they-and-how-can-you-control-them>
209. Cabbage Looper - Wisconsin Horticulture, accessed May 5, 2025, <https://hort.extension.wisc.edu/articles/cabbage-looper/>
210. Cabbage Looper [fact sheet] - UNH Extension, accessed May 5, 2025, <https://extension.unh.edu/resource/cabbage-looper-fact-sheet>
211. Cabbage Looper - Virginia Tech, accessed May 5, 2025, <https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/3104/3104-1544/ento-519.pdf>
212. Caterpillars & Cannabis - How to Identify & Get Rid of Bugs Quickly! - Grow Weed Easy, accessed May 5, 2025, <https://www.growweedeasy.com/cannabis-plant-problems/caterpillars>
213. How to Get Rid of and Kill Caterpillars - Trifecta Natural, accessed May 5, 2025, <https://www.trifectanatural.com/problem-identifier/get-rid-of-kill-caterpillars/>
214. Caterpillars on Marijuana Plants- Alchimia Grow Shop, accessed May 5, 2025, <https://www.alchimiaweb.com/blogen/caterpillars-marijuana-plants/>
215. Caterpillars Identification and Control on Cannabis - YouTube, accessed May 5, 2025, <https://www.youtube.com/watch?v=mhG_rngFOWY>
216. Zebra Caterpillar - USU Extension, accessed May 5, 2025, <https://extension.usu.edu/planthealth/ipm/notes_ag/hemp-zebra-caterpillar>
217. Soybean Aphid Management | Pioneer® Seeds, accessed May 5, 2025, <https://www.pioneer.com/us/agronomy/soybean-aphid-mgmt.html>
218. How To Control Eurasian Hemp Borers - Arbico Organics, accessed May 5, 2025, <https://www.arbico-organics.com/category/eurasian-hemp-borer-control>
219. Identifying and Controlling Black Aphids: A Visual Guide for Farmers - - Farmonaut, accessed May 5, 2025, <https://farmonaut.com/precision-farming/identifying-and-controlling-black-aphids-a-visual-guide-for-farmers/>
220. How to get rid of Thrips in cannabis plants - Alchimia, accessed May 5, 2025, <https://www.alchimiaweb.com/blogen/rid-of-thrips-cannabis-plants/>
221. Thrips on Cannabis Plants - Mr. Grow It, accessed May 5, 2025, <https://mrgrowit.com/post/thrips-on-cannabis-plants/>
222. Western flower thrips - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/thrips/western-flower-thrips/>
223. Thrips | Natural Enemies Organic Chemical-Free Pest Control, accessed May 5, 2025, <https://naturalenemies.com/by-pest/thrips/>
224. Common types of thrips that affect marijuana plants - Grow Barato, accessed May 5, 2025, <https://www.growbarato.net/blog/en/common-types-of-thrips-that-affect-marijuana-plants/>
225. What are thrips and how to eliminate them from your cannabis grow? - Kannabia Seeds, accessed May 5, 2025, <https://www.kannabia.com/en/blog/what-are-thrips-and-how-to-eliminate-them-from-your-cannabis-grow?qt-noestamossolos=0>
226. A global invasion by the thrip, Frankliniella occidentalis: Current virus vector status and its management - PMC, accessed May 5, 2025, <https://pmc.ncbi.nlm.nih.gov/articles/PMC7318653/>
227. Western Flower Thrips | NC State Extension Publications, accessed May 5, 2025, <https://content.ces.ncsu.edu/western-flower-thrips-2>
228. Thrips - Biocontrol, Damage and Life Cycle - Koppert US, accessed May 5, 2025, <https://www.koppertus.com/plant-pests/thrips/>
229. Thrips Management Guidelines - UC IPM, accessed May 5, 2025, <https://ipm.ucanr.edu/PMG/PESTNOTES/pn7429.html>
230. How to prevent and eliminate thrips in your cannabis plants - La Huerta Grow Shop, accessed May 5, 2025, <https://www.lahuertagrowshop.com/blog/en/how-to-prevent-eliminate-thrips-cannabis-plants/>
231. Thrips tabaci (onion thrips) | CABI Compendium - CABI Digital Library, accessed May 5, 2025, <https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.53746>
232. Thrips tabaci (onion thrips) - | Plantwise Knowledge Bank, accessed May 5, 2025, <https://plantwiseplusknowledgebank.org/doi/full/10.1079/pwkb.species.53746>
233. Onion Thrips - Virginia Tech, accessed May 5, 2025, <https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/3104/3104-1556/ENTO-370.pdf>
234. Onion thrips - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/thrips/onion-thrips/>
235. Thrips on onion and cabbage - Ontario.ca, accessed May 5, 2025, <https://www.ontario.ca/page/thrips-onion-and-cabbage>
236. Onion Thrips | Wisconsin Vegetable Entomology, accessed May 5, 2025, <https://vegento.russell.wisc.edu/pests/onion-thrips/>
237. Onion Thrips - Wisconsin Horticulture, accessed May 5, 2025, <https://hort.extension.wisc.edu/articles/onion-thrips/>
238. Basic biology and management of onion thrips on field crops | AHDB, accessed May 5, 2025, <https://ahdb.org.uk/knowledge-library/basic-biology-and-management-of-onion-thrips-on-field-crops>
239. Onion Thrips - USU Extension - Utah State University, accessed May 5, 2025, <https://extension.usu.edu/planthealth/research/onion-thrips>
240. Onion Thrips - Maine Organic Farmers and Gardeners Association, accessed May 5, 2025, <https://www.mofga.org/resources/fact-sheets/onion-thrips-2/>
241. Impatiens thrips - Biocontrol, Damage and Life Cycle - Koppert, accessed May 5, 2025, <https://www.koppert.com/plant-pests/thrips/impatiens-thrips/>
242. Integrated Pest Management Program - Echinothrips americanus - University of Connecticut, accessed May 5, 2025, <https://ipm-cahnr.media.uconn.edu/wp-content/uploads/sites/3216/2024/06/echinothripsamericanus-3.pdf>
243. ECHINOTHRIPS AMERICANUS, accessed May 5, 2025, <https://ncipmhort.cfans.umn.edu/sites/ncipmhort.cfans.umn.edu/files/2020-06/Echinothrips%20americanus.pdf>
244. Thrips, Echinothrips americanus - University of Florida, accessed May 5, 2025, <https://mrec.ifas.ufl.edu/lso/entomol/NCSTATE/thrips4.htm>
245. Controlling Echinothrips americanus with predatory mites and bugs, accessed May 5, 2025, <https://www.ingreenhouses.com/controlling-echinothrips-americanus-predatory-mites-bugs/>
246. Using Predatory Mites, but still having Thrips Issues? Close the Gap in your Thrips Control Program | Koppert Canada, accessed May 5, 2025, <https://www.koppert.ca/news/using-predatory-mites-but-still-having-thrips-issues/>
247. Hemp Pests Field Guide - UF/IFAS - University of Florida, accessed May 5, 2025, <https://programs.ifas.ufl.edu/media/programsifasufledu/hemp/files/2022/Hempfieldguide.pdf>
248. Arthropod and mollusk pests of hemp, Cannabis sativa (Rosales: Cannabaceae), and their indoor management plan in Florida - Oxford Academic, accessed May 5, 2025, <https://academic.oup.com/jipm/article/15/1/1/7499162>
249. Echinothrips – ONfloriculture, accessed May 5, 2025, <https://onfloriculture.com/category/insect-pests/echinothrips/>
250. Impatiens thrips - Biocontrol, Damage and Life Cycle - Koppert US, accessed May 5, 2025, <https://www.koppertus.com/plant-pests/thrips/impatiens-thrips/>
251. Thrips | VCE Publications - Virginia Tech, accessed May 5, 2025, <https://www.pubs.ext.vt.edu/444/444-281/444-281.html>
252. High Tunnel Management - Thrips - USU Extension - Utah State University, accessed May 5, 2025, <https://extension.usu.edu/planthealth/research/high-tunnel-pests-thrips>
253. Biology and Management of Thrips Affecting the Production Nursery and Landscape, accessed May 5, 2025, <https://extension.uga.edu/publications/detail.html?number=C1158&title=biology-and-management-of-thrips-affecting-the-production-nursery-and-landscape>
254. Critters Down Under: Thrips | PT Growers and Consumers, accessed May 5, 2025, <https://www.pthorticulture.com/en-us/training-center/critters-down-under-thrips>
255. Thrips: life cycle & resistance management advice | Syngenta Ornamentals East Africa, accessed May 5, 2025, <https://www.syngentaornamentals.co.ke/thrips-life-cycle-resistance-management-advice>
256. Impatiens thrips - Retail Koppert Canada, accessed May 5, 2025, <https://retail.koppert.ca/pages/impatiens-thrips>
257. Thrips in greenhouse crops - biology, damage and management - Ontario.ca, accessed May 5, 2025, <https://www.ontario.ca/page/thrips-greenhouse-crops-biology-damage-and-management>
258. Thrips damage: how to win the fight for your cannabis - Grow Sensor, accessed May 5, 2025, <https://www.growsensor.co/post/thrips-damage-cannabis>
259. Thrips & Cannabis in 2023: Symptoms, Diagnosis, Solutions | NorCal Nutrients, accessed May 5, 2025, <https://www.growgreentrees.com/blog/thrips-cannabis>
260. Thrips & Cannabis - How to Identify & Get Rid of It Quickly! - Grow Weed Easy, accessed May 5, 2025, <https://www.growweedeasy.com/cannabis-plant-problems/thrips>
261. How to Get Rid of & Kill Thrips Naturally | Trifecta, accessed May 5, 2025, <https://www.trifectanatural.com/problem-identifier/how-to-get-rid-of-thrips/>
262. How to Treat and Prevent Thrips on Cannabis Plants - RQS Blog - Royal Queen Seeds, accessed May 5, 2025, <https://www.royalqueenseeds.com/us/blog-thrips-how-to-get-rid-of-them-n734>
263. How to Identify and Control Thrips on Cannabis Plants - YouTube, accessed May 5, 2025, <https://www.youtube.com/watch?v=yLrzU4n6pkw&pp=0gcJCdgAo7VqN5tD>
264. How to \*actually\* get rid of thrips? : r/plantclinic - Reddit, accessed May 5, 2025, <https://www.reddit.com/r/plantclinic/comments/14896gy/how_to_actually_get_rid_of_thrips/>
265. Telltale signs of thrips that I mistook for overwatering and under fertilization - Reddit, accessed May 5, 2025, <https://www.reddit.com/r/plantclinic/comments/o1jsnj/telltale_signs_of_thrips_that_i_mistook_for/>
266. Western Flower Thrips | WSU Tree Fruit | Washington State University, accessed May 5, 2025, <https://treefruit.wsu.edu/crop-protection/opm/western-flower-thrips/>
267. Western Flower Thrips - Integrated Pest Management, accessed May 5, 2025, <https://ipm.uga.edu/files/2020/05/Western-Flower-Thrips.pdf>
268. Western Flower Thrips | Applied Biological Control Research - University of California, Riverside, accessed May 5, 2025, <https://biocontrol.ucr.edu/western-flower-thrips>
269. Greenhouse & Floriculture: Western Flower Thrips, Management and Tospoviruses | Center for Agriculture, Food, and the Environment at UMass Amherst, accessed May 5, 2025, <https://ag.umass.edu/greenhouse-floriculture/fact-sheets/western-flower-thrips-management-tospoviruses>
270. Landscape & Ornamental - Extension Entomology, accessed May 5, 2025, <https://extension.entm.purdue.edu/publications/E-110.pdf>
271. Introduction to cannabis pests and diseases - Alchimia, accessed May 5, 2025, <https://www.alchimiaweb.com/blogen/introduction-cannabis-pests/>
272. Cannabis pests and diseases - Blog Alchimia Grow Shop, accessed May 5, 2025, <https://www.alchimiaweb.com/blogen/marijuana-growing-guide/marijuana-pests/>
273. The ultimate guide to cannabis pests - Nordland Seeds, accessed May 5, 2025, <https://nordlandseeds.com/the-ultimate-guide-to-cannabis-pests/>
274. Hemp and Cannabis Crop Diseases, accessed May 5, 2025, <https://agri.nv.gov/uploadedfiles/agrinvgov/content/plant/plant_pathology/hemp%20and%20cannabis%20crop%20diseases%20-a%20guide%20to%20field%20diagnosis%20and%20management.pdf>
275. Identifying Cannabis Diseases: Visual Chart Guide - Medicinal Genomics, accessed May 5, 2025, <https://medicinalgenomics.com/identifying-cannabis-diseases-visual-chart-guide/>
276. Hemp Disease and Pest Management, accessed May 5, 2025, <https://hemp.tennessee.edu/wp-content/uploads/sites/183/2020/12/Hemp_Disease_and_Pest_Management_W916.pdf>
277. Cannabis aphid is the most common aphid found on the crop. Decreasing... - ResearchGate, accessed May 5, 2025, <https://www.researchgate.net/figure/Cannabis-aphid-is-the-most-common-aphid-found-on-the-crop-Decreasing-day-length-results_fig5_335454010>
278. Occurrence and Distribution of Common Diseases and Pests of US Cannabis: A Survey - ResearchGate, accessed May 5, 2025, <https://www.researchgate.net/profile/Nicole-Gauthier-2/publication/369979632_Occurrence_and_Distribution_of_Common_Diseases_and_Pests_of_US_Cannabis_A_Survey/links/64c00d57c41fb852dd9b8b96/Occurrence-and-Distribution-of-Common-Diseases-and-Pests-of-US-Cannabis-A-Survey.pdf>