Extension
ALABAMA A&M & AUBURN UNIVERSITIES

ANR-2635

# Hemp

## Insect, Weed, and Disease Control Recommendations for 2023

IPM

Hemp is a new crop for Alabama and for the United States. With the 2014 Farm Bill's Pilot Program, many states began producing hemp for fiber, grain, or flower. The 2018 Farm Bill listed hemp as an agricultural commodity, leading to even more states signing on to grow hemp in 2019, including Alabama. Little research on hemp has been done in the last several decades, so our research-based information is limited. We are constantly learning about the insects, weeds, and diseases that infest hemp and how to control them.

This guide is the most up-to-date information we have, but it is changing as we learn more. Please contact the Alabama Cooperative Extension System if you have questions concerning pest identification or management.

### Applying Pesticides

Many of the pesticides available for hemp will require frequent applications. Rates and application frequencies may be adjusted as a function of the pest density, plant growth stage, plant density, etc. Environmental factors such as heat, humidity, and rain can affect pesticide applications in different ways. Making an application under non-recommended conditions may reduce control or even harm the plant. Refer to the label for specific information and plan accordingly.

### Important Note Regarding Pesticide Use

These products have been reviewed by the Alabama Department of Agriculture and Industries (ADAI) and Alabama Extension and appear to meet all the criteria for legal use in Alabama.

ADAI and Alabama Extension make no recommendations for the use of pesticides on hemp. This list is not an endorsement of any kind for any of the products listed nor does it ensure the safety or efficacy of these products when applied to hemp in Alabama.

It is the sole responsibility of the grower to verify processor requirements for chemical application on hemp. The grower is responsible for following all label directions as they pertain to personal protective equipment (PPE) and Worker Protection Standards (WPS).

## INSECT MANAGEMENT

Many insects and insect relatives make hemp their home. These arthropods include various species of insects, spiders, and mites. Not all arthropods found in hemp are pests. Only some of the insects found on hemp will cause damage that results in yield or quality loss. Many are actually beneficial and can provide free biological control. Beneficial arthropods include spiders, lady beetles, and lacewings. There are also insects that are incidental; they cause no harm or benefit but we find them occasionally on hemp plants.

Because of the variety of insects you will encounter, proper identification is key. It is important that you know what is on your plant before taking pest control measures. Alabama has a large diversity of insects on hemp, and these may vary from other states also growing hemp. Contact Alabama Extension for assistance with insect identification. Once pest identify is confirmed, information on that pest's biology and habits can help in creating a management plan.

Pest management in hemp should be in the form of a multifaceted, integrative approach. Do not rely on one single method to control pests in your crop. Cultural and biological control strategies should be used before chemical control. Cultural control methods such as proper fertility, irrigation, and sanitation should all be part of an integrated pest management program. Mechanical control such as tillage or hand removal of insects is also effective. The use of natural enemies is an effective biological control strategy, especially in indoor grow environments. Proactive scouting of your crop is essential to combat pest outbreaks. For both indoor and outdoor grown hemp, plants should be scouted at least weekly.

The insecticides listed in this guide have not been tested in Alabama for management of insect pests of hemp in the state. Trials will be conducted in the coming years on many of these products.

### Types of Insect and Mite Pests

There is a large diversity in the types of damage caused by insect and mite pests. These will vary depending on the insect's mouthparts, their seasonal activity and abundance, and feeding preference. In many cases, you may not see the pest on the plant but you will see signs and/or symptoms of feeding damage. These are just as important to recognize as the insects themselves. Understanding what pests cause what type of damage on hemp will aid in the proper identification and control measures.

### Piercing-Sucking Pests

These pests, which include true bugs and mites, have straw-like mouthparts capable of sucking plant sap from the plant. This can occur on the leaves, flowers, or stems. In these instances, you won't see large amounts of plant matter missing like you would for chewing pests. Damage from piercing-sucking mouthparts usually results in discoloration, wilting, stunting, and even death. In other crops, piercing-sucking pests may inject a toxin into the plant or transmit a virus while they are feeding. As far as we know, there are no insects that

transmit viruses to hemp in Alabama. However, hemp is susceptible to many diseases. See the Disease Management section.

Piercing-sucking pests can easily go unnoticed for long periods of time. This may be due to their small size, location on the plant (examples: under the leaves, on the bottom of the plant), or a lack of understanding of what the damage looks like. Some pests, such as mites and aphids, have an extraordinary reproductive capacity. Scouting the entire hemp plant is important because of the ability of these "cryptic" pests to continue feeding without being noticed.

Piercing-sucking pests in hemp include mites (two-spotted spider mites and hemp russet mites), aphids (cannabis aphid and root aphid), stink bugs (brown marmorated stink bugs) and tarnished plant bugs.

**Chewing Pests**

Insects with chewing mouthparts can damage plants by feeding on foliage or flowers. Defoliation by chewing insects is probably the easiest insect damage to recognize while scouting plants. In some cases, an entire part of the plant may be gone. Other times, you will notice that plant parts have chewed edges or middles. Some chewing insects will often "skeletonize" a leaf, feeding on the softer tissue and leaving the veins intact.

There are also chewing pests that will bore through plant stems or leaves. This damage, often called boring or mining, occurs on the inside of the plant structures. As a result, it may be difficult to notice the pest until feeding damage is visible. In many cases, the damaging life stage is the larval (immature) form of the pest. Boring larvae spend most of their time protected inside the leaf stem, feeding and causing damage, only to emerge to pupate and turn into an adult. These boring larvae are protected inside the stem and cannot be managed by insecticides.

Chewing pests in hemp include caterpillars (corn earworm, cutworm, and armyworms), beetles (banded cucumber beetle, flea beetle), termites, and fire ants.

**Beneficials**

All of the arthropods found on hemp are not pests. In fact, many are beneficial and provide free biological control for your crop. Some are predators that feed on pests, and others are parasitoids that use pest insects as hosts, which results in pest death. It is important to recognize these natural enemies so you won't mistake them for pests and remove them from the plant. It is also important to scout for beneficials when you are scouting for pests. They are a significant part of an integrated pest management plan and should not be discounted. Some insecticides are broad spectrum and will kill beneficials along with pests. Many times this results in a pest outbreak as there is no natural enemy to keep the population in check anymore.

**Organic Insecticides**

Organic farming is not without pesticide use. The Organic Material Review Institute (OMRI) lists products that can be applied in organic systems. Organic hemp producers have several products available for use in Alabama. Many, but not all, of the insecticides on the following list are OMRI listed. Azadirachtin, *Bacillus thuringiensis*, *Beauvaria bassiana*, neem oil, and pyrethrum can all be used in organic cropping systems. Please note that not all formulations are OMRI listed. For example, products with natural pyrethrins can be OMRI listed. But there are other insecticides that combine pyrethrins with piperonyl butoxide and are not organic. Refer to the label to make sure the product meets the need of your operation.

Insect management section prepared by **Katelyn Kesheimer**, *Extension Specialist*, Assistant Professor, Entomology and Plant Pathology, Auburn University.

**Table 1. Hemp Insect Control**

| Insecticide and Formulation | Rate | Comments |
|---|---|---|
| azadirachtin | | |
| AZAGUARD | Field: 8-21 fl oz/A<br>Greenhouse: 2-4 fl oz/10,000 sq ft<br>Drench: 0.15-0.3% v/v | 2-3 applications made at 7-10 day intervals is recommended. |
| AZATIN O | Spray: 4-16 fl oz/100 gal<br>Drench: 8-16 fl oz/100 gal | Spray: Repeat applications every 7 days or as needed.<br>Drench: Repeat at 14 day intervals. |
| GENERAL HYDROPONICS AZAMAX | Foliar: 0.25-1.70% v/v<br>Drench: 0.4-0.8% v/v | Spray at a 7-10 day interval as needed. |
| NEEMAZAL | Field: 1-2 pints/A<br>Greenhouse: 18-21 fl oz/100 gal<br>Drench: 1 pint/gal soil in pot | |
| NEEMIX 4.5 | 4-16 fl oz/A | Application interval 4-21 days. |
| *Bacillus thuringiensis* ssp. aizawai | | |
| AGREE WG | 0.5-2.0 lbs/A | Repeat applications may be necessary at 3-7 day intervals. |
| XENTARI BIOLOGICAL INSECTICIDE DRY FLOWABLE | 0.5-2.0 lbs/A<br>1-4 tsp/gal | Repeat applications at 3-14 days. |

**Table 1. Hemp Insect Control (con't.)**

| Insecticide and Formulation | Rate | Comments |
|---|---|---|
| *Bacillus thuringiensis* ssp. galleriae | | |
| BEETLEJUS! FOR ORNAMENTAL AND VEGETABLE PESTS | 12-36 T/gal | |
| *Bacillus thuringiensis* ssp. israelensis | | |
| GNATROL WDG BIOLOGICAL LARVICIDE | Drench: 3.2-6.4 oz/100 gal | When all life forms of fungus gnats (eggs, larvae, pupae, and adults) are present, make 3 weekly applications for heavy infestations. |
| MOSQUITO BITS QUICK KILL | Mosquito control: 1 tsp/ 25 sq ft<br>Fungus gnat control: Sprinkle granules over surface until covered" | For mosquito use around a structure, sprinkle over the surface of the containerized standing water. Apply uniformly. For fungus gnat control, sprinkle over surface of soil until covered. Water will release the Bt into the soil. |
| SUMMIT B.T.I. GRANULES | Mosquito control: 2.5-10 lbs/A<br>Fungus gnat control: 3 lbs/100 sq ft" | Apply at 7-14 day intervals. |
| *Bacillus thuringiensis* ssp. kurstaki | | |
| BT BACILLUS THURINGIENSIS READY-TO-USE | Cover surfaces thoroughly, top and bottom, for complete control. | Apply at 5-7 day intervals. |
| CRYMAX BIOINSECTICIDE | 0.5-2.0 lbs/A | |
| DELIVER BIOLOGICAL INSECTICIDE | 0.25-1.5 lbs/100 gal | |
| DIPEL DF BIOLOGICAL INSECTICIDE | 0.5-2.0 lbs/A | Apply at 3-14 day intervals. |
| JAVELIN WG BIOLOGICAL INSECTICIDE | 0.25 - 1.5 lbs/100 gal | Apply at a spray interval of 10 days or less. |
| LEPROTEC | 0.5-3.5 pints/A | Application interval is 2-10 days. |
| MONTEREY B.T. | Thoroughly cover top and bottom surfaces. | Apply at 5-7 day intervals. |
| MONTEREY B.T. RTU READY-TO-USE | Thoroughly cover top and bottom surfaces. | Apply at 5-7 day intervals. |
| SAFER BRAND CATERPILLAR KILLER FOR TREES SHRUBS AND VEGETABLES CONCENTRATE II | Thoroughly cover top and bottom surfaces. | Repeat applications at 3-14 day intervals. |
| SUMMIT BIOLOGICAL CATERPILLAR & WEBWORM CONTROL | 1.5-2 fl oz/3 gal | Apply at 5-7 day intervals. |
| THURICIDE BT CATERPILLAR CONTROL | 1.5-2 fl oz/3 gal | Apply at 5-7 day intervals. |
| THURICIDE N/G | 0.5-1.0 lbs/A | Reapply at 3-5 day intervals to sustain larval suppression. |
| BT NOW | 0.5-2.5 pints/A | Apply at 5-7 day intervals. |
| *Beauveria bassiana* strain ANT-03 | | |
| BIOCERES | 1-2 lbs/A | Do not apply fungicides within 4 days of application. Repeat at 5-7 day intervals as needed. |
| *Beauveria bassiana* strain GHA | | |
| BOTANIGARD 22WP | Spray: 0.5-2 lbs/100 gal<br>Cutting or root dip: 0.25-0.50 oz/gal<br>Drench: 1-4 oz/1,000 sq ft | Typically takes 7-10 days after first spray to see control. Apply at 5-10 day intervals. |
| MYCOTROL ESO | Field: 0.25-1 quart/A<br>Greenhouse: 0.5-3 quarts/100 gal<br>Cutting or root dip: 0.5-1 fl oz/gal | Spray until wet, but avoid runoff. Typically takes 7-10 days after first spray to see control. |

**Table 1. Hemp Insect Control (con't.)**

| Insecticide and Formulation | Rate | Comments |
|---|---|---|
| *Beauveria bassiana* strain PPRI 5339 | | |
| VELIFER | 3-13 fl oz/ 100 gal | For enclosed commercial greenhouse use only. Make applications on 3-14 day intervals. |
| *Burkholderia* sp strain A396 | | |
| VENERATE | 1-8 qt/A | Apply at 3-10 day intervals. |
| *Chromobacterium subtsugae* strain PRAA4-1 and spent fermentation media | | |
| GRANDEVEO | 1-3 lbs/A | Apply only to non-blooming plants. |
| *Chrysodeixis includens* nucleopolyhedrovirus isolate #460 | | |
| CHRYSOGEN | 1.2-2.4 fl oz/A | Use of the lower application rate at regular intervals is an effective strategy in other crops. |
| clarified hydrophobic extract of neem oil | | |
| TRILOGY | 0.5-2% v/v | Apply at 7-14 day intervals. |
| cold pressed neem oil | | |
| ECOWORKS EC | Spray: 1-4 pt/A<br>Drench: 0.5-0.2% v/v | |
| RANGO | Foliar: 0.625-1.8% v/v<br>Drench: 1.25-2.4% v/v" | Do not apply sulfur or sulfur containing products within 14 days of application. Repeat applications at 7-10 day intervals. |
| DE | | |
| CELITE 610 | Dust: 70 lbs/A<br>Slurry: 44 gal/A | Apply no more than once per week. |
| DEADZONE | Slurry: 1 lb/gal<br>Crop application: 3-70lbs/A | |
| d-limonene | | |
| ORANGE GUARD | Saturate until visibly wet. | Cover any areas of trails or nests. |
| gs-omega/kappa - hxtx-hv1a (spider venom peptides) | | |
| SPEAR-LEP, VST-006340 LC | Field: 1-3 gal/A<br>Greenhouse: 2-3 gal/100 gal<br>Cuttings dip: 1 ga/3 gal | For sprays, use fine or very fine nozzle tips to create a fine spray mist. Following dipping, allow plants to dry before watering. |
| *Helicoverpa zea* nucleopolyhedrovirus strain ABA-NPV-U | | |
| HELIGEN | 1.2-2.4 fl oz/A | Use of the lower application rate at regular intervals is an effective strategy in other crops. |
| *Isaria fumosorosea apopka* strain 97 | | |
| PFR-97 20%WDG | Field: 1-2 lbs/A<br>Greenhouse: 14-28 fl oz/100 gal | Spray until wet, but avoid runoff. Do not mix with other fungicides, or apply within 5 days of fungicide applications other than copper. Repeat applications at 3-10 day intervals. |
| mineral oil | | |
| FERTI-LOME HORTICULTURAL OIL SPRAY | 2.5-5.0 T/gal | Do not apply to wilted or otherwise stressed plants, or to newly transplanted material prior to root establishment. |
| FERTI-LOME HORTICULTURAL OIL SPRAY READY TO SPRAY | 2.5-5.0 T/gal | Do not apply to wilted or otherwise stressed plants, or to newly transplanted material prior to root establishment. |
| potassium salts of fatty acids | | |
| DES-X INSECTICIDAL SOAP CONCENTRATE | 75-200 gal/A | |
| GENERAL HYDROPONICS EXILE, M-BOLD, BANE, GH MPMT | 1-2% v/v | Do not make repeat applications at less than 7 day intervals. Do not make more than 3 sequential applications at 7-14 day intervals without first ensuring the use pattern does not injure the plant in local conditions. |
| M-PEDE | 1.25-2.5 fl oz/gal | Apply at 7-10 day intervals. |

**Table 1. Hemp Insect Control (con't.)**

| Insecticide and Formulation | Rate | Comments |
|---|---|---|
| potassium salts of fatty acids sulfer | | |
| SAFER BRAND 3-IN-1 RTU II | Thoroughly cover top and bottom surfaces. | Apply at 5-7 day intervals. |
| potassium silicate | | |
| SIL-MATRIX LC | 0.25% - 1.0% v/v | Repeat applications as necessary to maintain control, but no sooner than every 7 days. |
| pyrethrins | | |
| BUG BUSTER-O | 1-1.4 fl oz/gal | For outdoor use ONLY |
| LYNX EC 1.4 | 16-64 fl oz/A | Do not repeat applications within 24 hours. |
| LYNX EC 5.0 | 4.5-17 fl oz/A | Do not reapply within 3 days except under extreme pressure. In case of extreme pressure, do not reapply within 24 hours. |
| PYGANIC SPECIALITY | 4.5-17 fl oz/A | Do not apply more than 10 times per season. Do not reapply within 3 days except under extreme pressure. In case of extreme pressure, do not reapply within 24 hours. |
| pyrethrins, clarified hydrophobic extract of neem oil | | |
| FERTILOME TRIPLE ACTION | Thoroughly spray all plant leaf surfaces including underside of leaves until foliage is uniformly wet, but not dripping | |
| FRUIT TREE SPRAY PLUS | 1 fl oz/gal | Spray until wet, but avoid runoff. Apply at 7-14 day intervals. |
| ORTHO TREE AND SHRUB FRUIT TREE SPRAY CONCENTRATE | 1 fl oz/gal | Apply at 7-14 day intervals. |
| SHIELD-ALL PLUS | 1 fl oz/gal | Apply at 7-14 day intervals. |
| pyrethrins, piperonyl butoxide | | |
| PYRETHRUM TR TOTAL RELEASE INSECTICIDE | 2 oz/3,000 sq ft | Greenhouse use only. Initially make 2 applications 7 days apart. Additional applications may be made at 14 day intervals. |
| PYRONYL CROP SPRAY | 0.004 lbs/A | Do not apply more than 10 times per season. Do not reapply within 3 days except under extreme pressure. In case of extreme pressure, do not reapply within 24 hours. |
| STRYKER | Field: 2-16 fl oz/A<br>Greenhouse: 1-2 tps/gal | Do not wet plants to the point of runoff. |
| pyrethrins, piperonyl butoxide, clarified hydrophobic extract of neem oil | | |
| FERTILOME TRIPLE ACTION PLUS | Thoroughly spray all plant leaf surfaces including underside of leaves until foliage is uniformly wet, but not dripping | |
| pyrethrins, *Beauveria bassiana* strain GHA | | |
| BOTANIGARD MAXX | 1-2 fl oz/gal | Do not wet plants until runoff or drip. Apply at 5-10 day intervals. |
| rosemary oil, geranol, peppermint oil | | |
| BRANDT ECOTEC PLUS | 2-5 fl. oz./10 gal. | 5 day minimal interval for application. |
| HEDGE PLANT PROTECTANT | See label for application instructions | See label for application instructions. |
| silicon dioxide | | |
| BONIDE DIATOMACEOUS EARTH | Dust: 5 lbs/3,111 sq ft<br>Slurry: up to 20% solution | Product is less effective at relative humidity above 65%. Apply no more than once a week. |

**Table 1. Hemp Insect Control (con't.)**

| Insecticide and Formulation | Rate | Comments |
|---|---|---|
| s-methoprene | | |
| EXTINGUISH PRO FIRE ANT BAIT | Mound: 3-5 T/mound<br>Broadcast: 1-1.5 lbs/A | Expect control in 1-4 months. |
| soybean oil, garlic oil, capsicum oleoresin extract | | |
| GENERAL HYDROPONICS PREVASYN INSECT REPELLANT | Field: 5 pints/A<br>Greenhouse: 5 pints/ 100 gal | Spray every 4-7 days. |
| *Spodoptera frugiperda* nucleopolyhedrovirus strain 3 AP2 | | |
| FAWLIGEN | 1.2-2.4 fl oz/A | Use of the lower application rate at regular intervals is an effective strategy in hemp. |

# WEED MANAGEMENT

Weeds are a major pest of hemp in Alabama. Weed pest management begins even before the field is selected. If growing outdoors, it is important to understand the field history at your site. Herbicides used the previous season can affect hemp the next season. There are plant rotation restrictions for many commonly used herbicides. Refer to the label to ensure that you are compliant.

Sanitation is crucial for weed control. Always use weed-free topsoil, mulch, and seed and plant material. Use clean equipment and plant into a clean field. Mowing, tillage, and weed eaters are all effective means of mechanical control. Inventory your potential cultivation tools before planting to generate an integrated pest management plan. Row or plant spacing can be adjusted to fit available equipment used for weed control. Hand weeding is effective in smaller production systems.

All herbicides labeled for use in Alabama are nonselective herbicides. Nonselective herbicides generally kill all plant species. Selective herbicides kill some plant species but not others. There are no selective herbicides that are labeled for use on hemp. Be careful when applying nonselective herbicides so you won't damage or kill the hemp. Consider using a shield sprayer. Target weeds when they are small for the best chance of control.

There are many problem weeds in Alabama that can affect hemp. Grasses include large crabgrass, goosegrass, and crowfootgrass. Broadleaf weeds include horseweed, morningglory, and yellow nutsedge.

Weed management section prepared by **Katelyn Kesheimer**, *Extension Specialist*, Assistant Professor, Entomology and Plant Pathology, Auburn University.

**Table 2. Hemp Weed Control**

| Herbicide and Formulation | Rate | Comments |
|---|---|---|
| acetic acid | | |
| WEED WORKS | Thoroughly wet undesirable weed foliage. | For liverworks dilute Weed Works to 1 gal for every 2 gal water. For all other weeds use full strength. |
| VINAGREEN | Spray on unwanted weeds to the point of wetness. | For liverworks dilute Weed Works to 1 gal for every 2 gal water. For all other weeds use full strength. |
| ammonium nonanoate | | |
| FIREWORXX HERBICIDE | 3-9% v/v | |
| AXXE HERBICIDE | 6-15% v/v | |
| caprylic acid, capric acid | | |
| HOMEPLATE | 3-9% v/v | |

# DISEASE MANAGEMENT

Diseases of hemp can be divided into root and crown rots, foliar diseases, stem dieback disorders, and flower blights. Hemp is also susceptible to plant-parasitic nematodes such as root-knot, bacterial diseases, and plant viruses. We are still trying to determine the extent and effect of these pathogens on hemp production in Alabama.

Root and stem rots of hemp include Pythium and Fusarium damping-off, Fusarium stem canker, Fusarium foot and root rot, and Southern blight. Foliar diseases that cause leaf spots and premature defoliation of plants include hemp leaf spot, Cercospora leaf spot, Septoria leaf spot, target spot, hemp rust, and powdery mildew. The pathogen Botryosphaeria can infect and kill terminal and lateral portions of plant stems resulting in stem dieback. Botrytis blight, brown blight and Fusarium bud rot are fungal diseases that attack the flower buds.

The fungicides listed in this guide have not been tested in Alabama for management of diseases of hemp in the state. Trials will be conducted in the coming years on many of these products. However, research with these materials on other crops has shown that their effectiveness is limited.

Cultural controls to limit damage from plant diseases include using disease-free transplants/cuttings (also called clones). The disease management options for hemp produced in greenhouses are the same as for hemp fields. Transplant producers must rely on greenhouse sanitation, organization, and environment control to minimize disease. Hemp producers should work with their transplant sources to ensure that the plants they receive are as healthy as possible. In both settings, questionable plants should be discarded or segregated to avoid potential disease spread.

**Disease Management in Hemp Greenhouses**

Sanitation is a critical tool for control of plant diseases in greenhouses. Growers should remove weeds and volunteer hemp plants from within the greenhouse as well as from around the outside of the greenhouse especially air intakes. All surfaces of the operation should be cleaned and sanitized with a commercial disinfectant before starting a new crop. Remove excess soil and plant debris from floors and benches before planting begins. Footwear should be disinfected before entering the greenhouse, and greenhouse entries and walkways should be covered with gravel, concrete, or landscape cloth. Avoid using EPS (Styrofoam) trays, but if they must be used, steam-sterilize trays before use, maintaining steam at 160 to 175 degrees F for at least 30 minutes. All plastic pots, trays and tools must be disinfected using a commercial disinfectant. Never reuse soil or potting media or bring field soil into a greenhouse to avoid introducing plant pathogens. To avoid contamination in the house never use surface water from ponds or streams to water plants. Prune infected plant parts and dispose of infected plant material. Dip pruning tools in a commercial disinfectant before and between each use to avoid spreading fungi, bacteria, or plant viruses. Empty the greenhouse between crops and resanitize all surfaces.

Crop management to prevent disease starts with promoting rapid seed germination and root production by cuttings. Seed can carry pathogens without visible damage to the seed, which can lead to poor germination, damping-off, and diseased plants. Seed can be heat treated (50 degrees C for 30 minutes; soak in cold water afterward). Thermal damage may delay seed germination or stunt seedlings.

Optimize moisture in growth media around lower stems and roots. Detect and correct drainage problems in and around the greenhouse because when combined with cool, wet conditions, they can predispose plants to root/crown rot and damping off diseases. Use drip/trickle irrigation to minimize overhead watering and the splashing of media from one tray or container to another in the greenhouse. Minimize the presence of moisture on leaves and plant parts to avoid condensation by maintaining humidity at 60 percent to 80 percent and ensuring good airflow through the greenhouse. Maintain an optimum fertilization schedule, avoiding too little or excess nitrogen.

**Disease Management in Hemp Production Fields**

Select fields with well-drained soil and no history of diseases common to hemp such as Fusarium, southern blight, Phytophthora, or Pythium. Avoid sites with poor air movement and set up rows to encourage good airflow and optimum soil drainage. Try to use raised beds for transplanting for CBD hemp. Discard heavily infected plants and those with untreatable diseases such as root rots and vascular wilts. Maximize weed control to reduce disease spread from alternate hosts, and to improve airflow to keep leaves and flower parts as dry as possible. There are no products that can save plants in the field from Fusarium or southern blight. Fungicides for hemp are used as protectants and do not have curative activity. Follow all label directions when using any pesticide. The fungicides listed in this guide will perform better if used according to label directions.

Disease management section prepared by **Ed Sikora**, *Extension Specialist*, Professor, Entomology and Plant Pathology; **Kassie Conner**, *Extension Specialist*, Auburn University Plant Diagnostic Laboratory, Joe Kemble, *Extension Specialist*, Professor, Horticulture; and **Katelyn Kesheimer**, *Extension Specialist*, Assistant Professor, Entomology and Plant Pathology, all with Auburn University.

**Table 3. Hemp Disease Control**

| Fungicide and Formulation | Rate | Comments |
|---|---|---|
| *Bacillus amyloliquefaciens* strain D747 | | |
| DOUBLE NICKEL 55 BIOFUNGICIDE | 0.25-3 lbs/A | A broad-spectrum preventative biofungicide for control or suppression of fungal and bacterial plant diseases. See label for application instructions. |
| DOUBLE NICKEL LC | 0.5-6 quarts/A | A broad-spectrum preventative biofungicide for control or suppression of fungal and bacterial plant diseases. See label for application instructions. |
| GARDEN SENTINEL BIOFUNGICIDE | 1 Tsp./1 gal. | Provides protection against fungal and bacterial diseases; See label for application instructions. |
| GENERAL HYDROPONICS DEFGUARD | 0.5-6 quarts/A | Broad-spectrum preventative biofungicide and bactericide for control of fungal and bacterial plant diseases; See label for application instructions. |
| TRIATHLON BA | 0.5-6 quarts/A | For control of foliage and flowers as well as soil borne diseases; See label for application instructions. |
| *Bacillus amyloliquefaciens* strain F727 | | |
| MBI-110 EP | 1-4 quarts/A | See label for application instructions. |
| STARGUS | Plant dip : 1-4 qts/100 gallon<br>soil drench 2-4 qts/A<br>In-furrow/banded: 2-4 qts/A | Broad spectrum biofungicide for control of fungal and bacterial diseases |
| *Bacillus mycoides* isolate J | | |
| LIFEGUARD WG | 4.5 oz./100 gallons | A broad spectrum preventative biofungicide for control of fungal and bacterial pathogens. Apply at first appearance of disease or just after transplanting and repeat at 3-14-day intervals as needed. Tank mix with or rotate with other registered fungicides for improve disease management. |
| *Bacillus pumilus* MBI 600 | | |
| PRO-MIX WITH BIOFUNGICIDE | See label for application instructions | Is for use in protected growing environments only (e.g. glasshouse or greenhouse). See label for application instructions. |
| *Bacillus pumilus* strain GHA 180 | | |
| PRO-MIX BIOFUNGICIDE + MYCORRHIZAE | See label for application instructions | For use in protected growing environments only (e.g. greenhouses). See label for application instructions. |
| *Bacillus pumilus* strain GHA 181 | | |
| PRO-MIX BRK BIOFUNGICIDE + MYCORRHIZAE | See label for application instructions | For use in protected growing environments only (e.g. greenhouses). See label for application instructions. |
| *Bacillus pumilus* strain GHA 182 | | |
| PRO-MIX BRK20 BIOFUNGICIDE + MYCORRHIZAE | See label for application instructions | For use in protected growing environments only (e.g. greenhouses). See label for application instructions. |
| *Bacillus pumilus* strain GHA 183 | | |
| PRO-MIX HPCC BIOFUNGICIDE + MYCORRHIZAE | See label for application instructions | For use in protected growing environments only (e.g. greenhouses). See label for application instructions. |
| *Bacillus pumilus* strain GHA 184 | | |
| PRO-MIX MP BIOFUNGICIDE + MYCORRHIZAE | See label for application instructions | Greenhouse use only. See label for application instructions. |
| *Bacillus subtilis* MBI 600 | | |
| SERIFEL NG BIOLOGICAL FUNGICIDE | Field Application: 1.0-2.7 lbs/A<br>Greenhouse Application: 0.4-1.2 fl oz/1000 sq ft | Serifel is an agricultural biofungicide/bactericide product for suppression of plant diseases. See label for application instructions. |
| *Bacillus subtilis* MBI 601 | | |
| SUBTILEX NG BIOLOGICAL FUNGICIDE | 0.4-1.2 fl oz/1000 sq ft | Subtilex NG is for use in soil or growing media, and for foliar applications to greenhouse-grown crops. Thoroughly soak soil or growing media through root zone. See label for application instructions. |

**Table 3. Hemp Disease Control (con't.)**

| Fungicide and Formulation | Rate | Comments |
|---|---|---|
| *Bacillus subtilus* QST713 Strain | | |
| BAYER ADVANCED NATRIA DISEASE CONTROL READY TO SPRAY | Spray plant to run-off, thoroughly covering both top and bottom surface of foliage to ensure thorough coverage | See label for application instructions. |
| BAYER ADVANCED NATRIA DISEASE CONTROL READY TO USE | Spray leaves, stems, and new shoots until run-off, providing complete coverage of plants. | See label for application instructions. |
| CEASE | 3-6 qt./100 gal. | Cease is a broad spectrum biofungicide for the prevention, suppression and control of soil borne diseases. See label for application instructions. |
| PLANT GUARDIAN BIOFUNGICIDE LIQUID CONCENTRATE | 1/4 cup/gal. | See label for application instructions. |
| PLANT GUARDIAN BIOFUNGICIDE WETTABLE POWDER | 2-8 TBSP/gal | See label for application instructions. |
| SERENADE ASO | 2-6 qt/A | See label for application instructions. |
| SERENADE GARDEN DISEASE CONTROL CONCENTRATE | 2-4 fl. oz./gal. | See label for application instructions. |
| SERENADE GARDEN DISEASE CONTROL READY TO SPRAY | Spray plants to run-off, thoroughly covering both top and bottom surface of foliage to ensure thorough coverage, sweeping the spray in an overlapping motion to cover the area to be treated | This product is a broad spectrum, preventative biofungicide for the control or suppression of many important plant diseases. See label for application instructions. |
| SERENADE GARDEN DISEASE CONTROL READY TO USE | Spray leaves, stems, and new shoots until run-off, providing complete coverage of the entire plants. | This product is a broad spectrum, preventative biofungicide recommended for the control or suppression of many important plant diseases. See label for application instructions. |
| SERENADE MAX | 1-3 lbs/A | Serenade Max is a broad spectrum, preventative product for the control or suppression of many important plant diseases. See label for application instructions. |
| SERENADE OPTI | 14-20 oz/A | Serenade Opti is a broad spectrum, preventative product for the control or suppression of many important plant diseases. See label for application instructions. |
| SERENADE OPTIMUM | 14-20 oz/A | Serenade Optimum is a broad spectrum, preventative product for the control or suppression of many important plant diseases. See label for application instructions. |
| clarified hydrophobic extract of neem oil | | |
| TRILOGY | Disease: 32 fl oz/ 25 gal<br>Mites and insects: 32-64 fl oz/25 gal | For foliar control of fungal disease and insect pests; See label for application instructions. |
| cold pressed neem oil | | |
| ECOWORKS EC | 1-4 pt/A | Can be used for root-knot nematode control; See label for application instructions. |
| extract of *Reynoutria sachalinensis* | | |
| REGALIA BIOPROTECTANT CONCENTRATE | 0.5-4 qt./A | For control of anthracnose, Botrytis bud blight, downy mildew, Fusium spp., Gary mold, powdery mildew and white mold. |
| extract of *Swingleta glutinosa* | | |
| ECOSWING | 0.25-0.32 oz/1 gal | See label for application instructions. |
| *Gliocladium catenulatum* strain J1445 | | |
| PVENT | 0.33 oz./1000 sq. ft. | See label for application instructions. |

**Table 3. Hemp Disease Control (con't.)**

| Fungicide and Formulation | Rate | Comments |
|---|---|---|
| *Gliocladium catenulatum* Strain J1446 | | |
| LALSTOP G46 WG | See label for application instructions. | LALSTOP® G46 WG controls seed-borne and soil-borne plant diseases such as damping-off, root and stem rot, charcoal rot and wilt caused by a variety of fungal pathogens. Apply by spraying or drenching the growth substrate, by incorporation into the growth substrate, as a foliar spray, by fogging, or by hydroponic or chemigation application in the field as an aqueous suspension. |
| hydrogen dioxide, peroxyacetic acid | | |
| TERRACLEAN 5.0 | Soil treatment prior to seeding or transplanting: 128 fl oz/100 gal<br>Soil treatment with established plants: 25 fl oz/200 gal | Soil treatment for the control of soil-borne plant pathogens; See label for application instructions. |
| OXIDATE 2.0 | Preventative: 1:200 - 1:400 dilution<br>Curative: 1:100 dilution | For the prevention and management of plant diseases caused by bacterial and fungal pathogens; See label for application instructions. |
| OXIDATE 5.0 | Preventative: 1:800 - 1:500 dilution<br>Curative: 1:256 dilution | For the prevention and management of plant diseases caused by bacterial and fungal pathogens; See label for application instructions. |
| ZEROTOL | Preventative: 1:200 - 1:400 dilution<br>Curative: 1:100 dilution | A bactericide/fungicide used to treat plant pathogens on greenhouse-grown crops; it can also be used on greenhouse structures, benches, pots, watering systems, evaporative coolers, storage rooms, ventilation equipment, floors and other equipment. |
| mono- and di-potassium salts of phosphorous acid | | |
| RELIANT | Foliar Spray: 4-6 pts/ 30-100 gal<br>Recirculating hydroponic systems: 1-2 qt in 5,300 gal of nutrient solution" | See label for application instructions. |
| neem oil | | |
| TNO70 BROAD SPECTRUM | Fungicide foliar applications: 1.25-1.8% v/v | See label for application instructions. |
| potassium bicarbonate | | |
| BI-CARB OLD FASHIONED FUNGICIDE | 4 tsp./2 gal. | For the control of powdery mildew; See label for application instructions. |
| CARB-O-NATOR | Field Application: 2.5-5 lbs/100 gal<br>Greenhouse Application: 2.5-5 lbs/100 gal | See label for application instructions. |
| MILSTOP BROAD SPECTRUM FUNGICIDE | 2.0-5.0 lbs./A | For control of multiple fungal diseases; See label for application instructions. |
| potassium silicate | | |
| SIL-MATRIX LC | See label for application instructions | Sil-Matrix LC is a broad spectrum, preventative fungicide. See label for application instructions. |
| reynoutria sachalinesis | | |
| MBI-102 12 BIOFUNGICIDE | 1-4 quarts/A | Use as a preventative treatment; See label for application instructions. |
| rosemary oil<br>HEDGE PLANT PROTECTANT | See label for application instructions | See label for application instructions. |
| Streptomyces sp. Strain K61 | | |
| LALSTOP K61 WP | See label for application instructions. | LALSTOP K61 WP controls seed rots, root and stem rots, and wilt diseases. See label for application instructions. |

| Table 3. Hemp Disease Control (con't.) | | |
|---|---|---|
| **Fungicide and Formulation** | **Rate** | **Comments** |
| Thyme oil<br>GUARDA | 1 gallon per 29-159 gallons of water (See label) | A botanical based product to protect against certain fungal and bacterial diseases. Apply at a spray volume sufficient to ensure thorough coverage to the point of runoff – generally 15-50 gallons per acre. Apply this product preventively or when the first disease symptoms are visible and reapply every 7-14 days. |
| *Ulocladium oidemansii* (U3 Strain)<br>BOTRYSTOP | 2-4 lbs/A | BotryStop is a biofungicide for *Botrytis cinerea, Sclerotinia sclerotiorum* and other organisms. See label for application instructions. |

**FOR MORE INFORMATION** on pesticides, pesticide safety, or submitting samples for analysis, see the following publications in the IPM series:
IPM 1293, "Safety." Safety contact information; worker protection standards; the safe use, handling, and storage of pesticides
IPM 1294, "Submitting Samples." Procedures for submitting samples for diagnosis, analysis, and identification
IPM 1295, "General Pesticide Information." Federal and state restricted use pesticide lists; pesticides and water quality
IPM 1317, "Appendix." Pesticide guidelines for agronomic crops, including preharvest intervals; rain-free requirements; grazing restrictions; crop rotation guidelines; and the names, classifications, and toxicities of pesticides.

**2023 ANR-2635**


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