e-GRO Edible Alert

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Fusarium Wilt of Hemp

Fusarium wilt (*Fusarium oxysporum*) causing crown and root rots is a common fungal pathogen of hemp (*Cannabis sativa* L.) whether it is grown outdoors, in greenhouses, or indoor production systems. Due to a scarcity of fungicide products available, sanitation protocols are essential for ensuring a successful production cycle. In this article, we will discuss symptoms of *F. oxysporum* infection and methods for prevention.

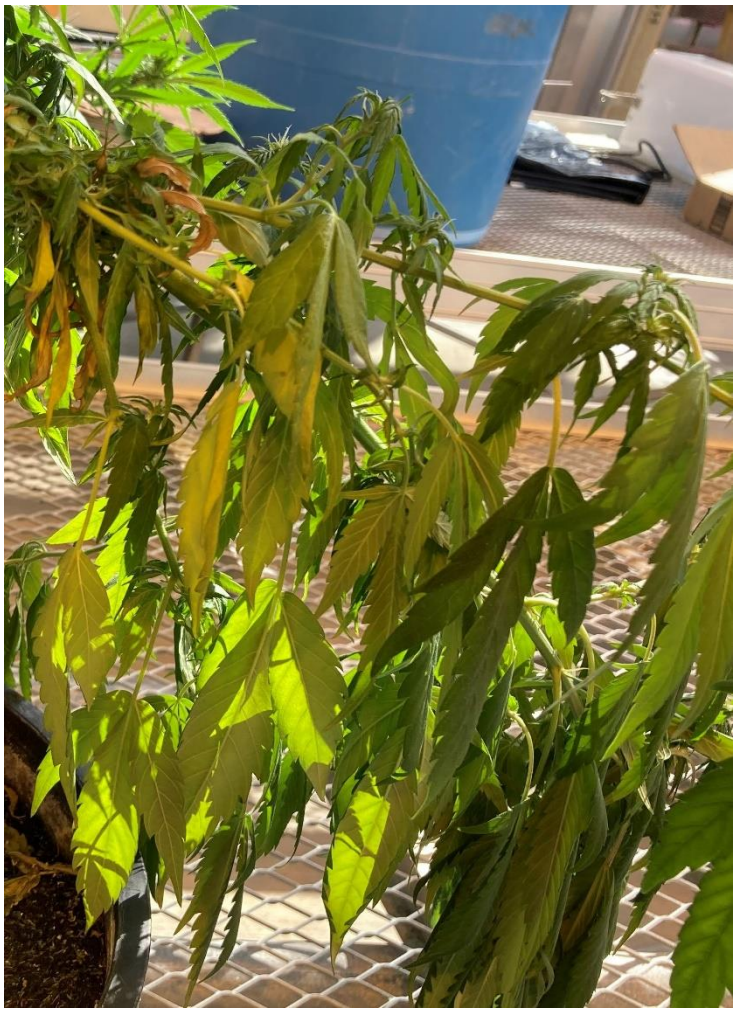

Figure 1. Wilting of leaves and branches is a symptom of hemp *Fusarium oxysporium*. Image: Bret Timmons, Cornell University

Symptoms and Signs

Fusarium oxysporum gets its common name of "wilt," because one of the most characteristic symptoms are wilted leaves and stems due to insufficient water uptake (Figures 1 and 2). This comes from the fungal organisms plugging vascular elements or causing poor rooting. Initially, the plant may wilt only during the hottest portion of the day but may recover at night. Overtime, the entire plant may turn yellow and collapse. Overall symptoms of Fusarium wilt include yellow or necrotic leaves which may curl, wilt, and eventually fall off the plant, and stunted or brown/necrotic roots. Identifying brown roots may be easier in hydroponic systems than in soil. Beyond the symptoms noted above, signs of the causal agent include dark-red to brown discoloration of veins of the lower stem. A diagnostic laboratory can confirm that the disease is Fusarium wilt.

Figure 2. A mother plant of hemp exhibiting severe wilting of leaves and branches due to infection with *Fusarium oxysporum*. Image: Bret Timmons, Cornell University

Entry Points

F. oxysporum can come from water, air, substrate or from contact with a contaminated source. Roots, stems, and flowers are susceptible. The pathogen can be found at all stages of the hemp plant growth cycle, which means it can be spread to all areas of a facility. Fusarium favors warm and humid environments, and warm soil temperatures. In the soil, Fusarium fungi is capable of remaining viable for long periods of time. Soil or media that has been saturated for prolonged periods would be considered susceptible to disease.

Figure 3. Discolored water-conducting vessels apparent when cutting through the stem near the base is a sign of *Fusarium oxysporum*. Image: Erica Hernandez, Griffin GGSPro.

Figure 4. Advanced vessel discoloration apparent on a stem section from a hemp plant infected with *Fusarium oxysporum*. Image: Erica Hernandez, Griffin GGSPro.

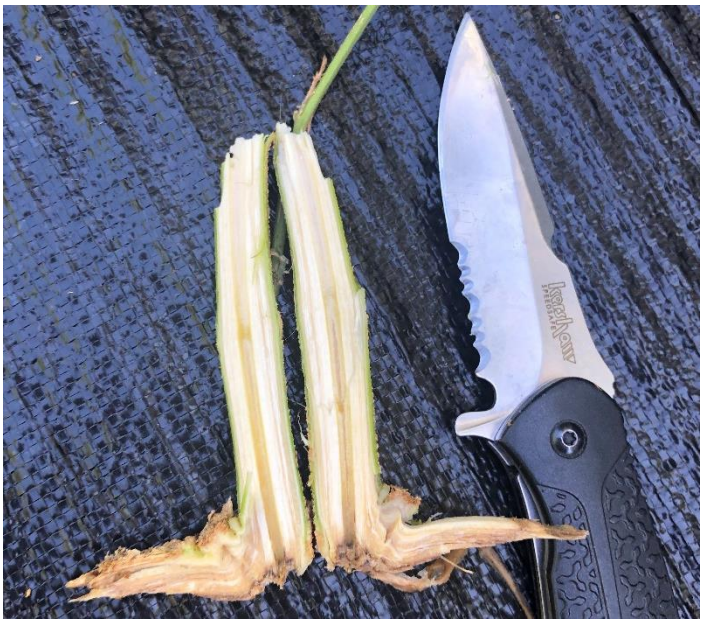

Figure 5. Reddish brown vessel discoloration visible along the length of a lower hemp stem due to Fusarium infection. Image: Erica Hernandez, Griffin GGSPro.

The distribution of *F. oxysporum* through aerially dispersed spores and through the vegetative cuttings from stock plants are critical methods of dispersion. Once sporulation occurs, infected crown tissues can even spread the disease to flowers of neighboring plants. Currently, there are no disease-free certifications being offered by plant propagators for hemp Fusarium wilt. Taking a cutting from an infected stock plant can spread the infection through the propagule. The spread of *F. oxysporum* through stock plants is suspected to occur through xylem and pith tissues.

Recirculating hydroponic systems provide another method to spread fungal pathogens from plant to plant. New plants that are fertilized with untreated nutrient solutions containing the pathogen can become infected through their roots. Using recirculating systems is a dangerous practice for hemp, as it could infect all plants in a facility that use that nutrient solution.

New plants can also be infected by workers not following best sanitary practices, such as using the same cutting tool on more than one plant without prior sanitization. Another entry point can be handling infected plants without sanitizing hands or replacing gloves before working on clean plants.

Unsanitary growing media may also infect plants if Fusarium spores are present. Some research has found that growing media that has not been properly sanitized can introduce fungal pathogens into an operation.

Cultural management and sanitation
Any good management strategy for preventing fungal pests, begins with a good hygiene plant Identify areas where fungal pathogens may be present or where the environment is conducive to its growth.

- Ensure components like substrates are disease free from the manufacturer and have been stored properly.
- Use clean stock plants for taking cuttings. Replacing stock plants might be a good strategy to ensure new material is disease free. Fusarium pathogens can reside in within plant tissues and the plant be asymptomatic, leaving visual detection in stock plants difficult to confirm until cuttings begin to show symptoms.
- Modify the growing conditions (in CEA facilities) to reduce the potential for pathogen establishment.
    - Drier environments (reduce relative humidity)
    - Reduce incidence of water on foliage
- Treat recirculating irrigation systems.
- After harvest, sanitizing the grow room with a labeled disinfectant will reduce the chance of spread.
- The propagation stage is a time when the risk can be especially high. Wounded sites provide opportunities for *F. oxysporum* to enter by air or water.

Ensure all employees have received proper training in the management of diseases of hemp throughout all growth stages.

- Use gloves or wash hands with soap and water prior to handling plant material or moving from one grow area to another.
- It is also important for employees who frequent more than one grow area to work in the cleanest space first and then move to areas where pathogens may be present. Do not reenter spaces that are known to be free of pathogens from areas that may have disease presence.
- Use clean tools, and if possible, new sanitary uniforms (lab coat, Tyvek, etc.) before entering a new grow space.
- Adding sanitary measures outside the grow space also adds a layer of security (foot baths, hand sanitizer, hose containing hydrogen peroxide to spray down carts or tools, etc).
- Avoid dipping cuttings into the container of rooting hormone. Instead, pour the liquid, gel, or powder into a separate container and change or clean it out periodically through the process.

Fungicides
All of the following products are applied as substrate/soil drenches. Fungicides have limited success controlling *Fusarium oxysporum*, but they can be used preventively to help protect healthy plants.

Please note: Not all of the products mentioned in this bulletin are registered or approved for use on hemp in all states. This bulletin is not intended to provide recommendations for specific production sites, which may be subject to state or local regulation. It is the grower's responsibility to understand federal, state, and local regulations regarding pesticide use on cannabis crops. Some pesticides are approved by some states and not by others. Additionally, some states conduct residue testing for products listed for hemp/cannabis. It is the grower's responsibility to understand the action levels for this testing and to make decisions regarding use of these products.
Active Ingredients/Products:

- *Streptomyces lydicus* (e.g. Actinovate SP)
- *Bacillus subtilis* QST 713 strain (e.g. Cease)
- *Trichoderma asperellum* and *Trichoderma gamsii* (e.g. Obtego)
- *Trichoderma harzianum* (e.g. RootShield Plus WP)

Sanitation products
For heavier cleaning treatments between crops, use a chemical cleaner to shock irrigation lines and other hard surfaces. First, use a chemical cleaner to reduce mineral deposits and biological debris. Options such as Strip-It acid cleaner or Horti-Klor, an alkaline cleaner, provide effective chemical cleaning action. Hard surfaces should then be rinsed thoroughly and treated with a Sanitizer such as ZeroTol 2.0 or SaniDate 5.0. Irrigation lines can also be continuously treated with a dilute sanitizer such as SaniDate 12.0, ZeroTol 2.0, or EcoClean, to prevent biofilm and algae build up during production.

In summary
Cultural management and sanitation are key to reducing spread of hemp Fusarium wilt. Seek to identify and dispose of infected plants as quickly as possible. Identifying plants as early as possible that are infected and disposing of them quickly is critical. In a CEA facility, this may require removing a plant carefully, bagging and disposing of it. In the field, burning or tilling it under deep. Testing stock plants may be an effective tool at catching asymptomatic plants and preventing that material from entering different parts of the facility as the plants stage of growth progresses.

Good hygiene practices are the foundation of any good disease mitigating plan. Using properly sanitized materials, growth media, and treated drainage water from recirculated systems, may help in the prevention of disease spread. Make sure workers have access to clean tools and workspaces, as well as having access to PPE (gloves, suits, footwear) that can facilitate the process of managing disease when workers need to operate in different parts of the facility. This includes having workers follow a plan that that places them in areas of low/ no diseased areas first, then transition to areas where disease may be present to minimize spread.

If possible, modify the growing environment. Examples include lowering the relative humidity, keeping leaf surfaces dry, and reducing rootzone saturation. Finally, preventive biofungicides can help to keep a healthy crop healthy. Ultimately, utilizing effective and methodical growing practices should reduce grower's encounters with Fusarium wilt when growing hemp.

Figure 6. Advanced Fusarium wilt causing necrosis and death of a hemp plant. Image: Erica Hernandez, Griffin GGSPro.

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