

Managing Race 4 FOV

(*Fusarium oxysporum* f. sp. vas infectum)

in California Cotton



Cotton field infected with Race 4 Fusarium

BIOLOGY OF RACE 4 FOV

Life Cycle

Fusarium oxysporum f. sp. *vasinfectum* (FOV) is a soil-inhabiting fungus. FOV spores germinate when in the proximity of host plant roots. The fungus spreads from roots to stems through xylem (water-conducting vascular tissue), produces spores (with spore quantity depending in part on plant susceptibility), and can partially plug up xylem so that plants cannot transpire water.

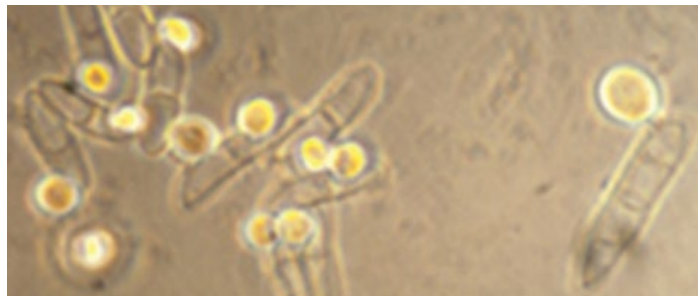
When infected, plants die of the disease or infected live plants are shredded and turned under at season end. FOV colonizes dead tissue and survives on plant debris and in the soil. In addition to susceptible cotton varieties, FOV can survive on root surfaces and tissue of many weeds and other plant species. Spores can survive for years in the soil. FOV becomes a permanent soil resident once introduced and, essentially, cannot economically be eradicated through known chemical or biological treatments or crop rotations.

Plant “hosts”

FOV can sustain itself on roots of many crops and weeds, but FOV races specific to cotton (such as Race 4 FOV) will not cause disease in other plant species.

Survival structures

FOV makes both short-lived conidia as well as long-lived, thick-walled spores (called chlamydo spores) that can survive tough environmental conditions, including high heat and dehydration. Populations can be reduced gradually



Fusarium oxysporum chlamydo spores (New York Botanical Garden)

with desiccation and long-term sun/UV exposure occurring with tillage or weed-free fallow situations.

Races of FOV

Several FOV races have been identified in California cotton, but Race 4 is currently the most problematic. Race 1 has been known in California for decades, and while it can be found in some situations where no significant nematode populations exist, in California it has only been found to cause economic levels of injury in the presence of root knot nematodes. Race 4 FOV does not require nematodes to cause plant injury and can be present in any soil type.

Seed Transmission

Although infection rates are very low, some FOV races are capable of infecting seed, including Race 4 FOV in California. Because FOV can reside within or under the seed coat, acid-delinting and surface-applied chemical seed treatments should not be expected to completely eliminate the fungus within the seed.



Cotton seedlings in FOV-infected seedbed

SCOUTING FIELDS FOR DISEASE

The best time to scout for FOV Race 4 is in the spring when cotton plants have 2-7 nodes. Definitely scout before 1st bloom.



Yellowing plants indicate early stage, moderate presence of FOV

Field Signs

“Blank” areas that are either devoid of plants or contain dying plants will be evident. The size of affected areas will depend on how long the inoculum has been accumulating and the susceptibility of the current variety and previously-planted varieties. First-year infestations typically result in a few affected plants in a few feet of row. Second and third year infestations will leave expanded blank areas in adjacent rows and down the field as inoculum spreads.

Plant Symptoms

Surviving plants and plants around periphery of “blank” areas will have wilted leaves, splotchy foliar chlorosis and/or necrosis, and nearly continuous, dark brown vascular staining in the tap roots.



Cutaway of cotton root shows vascular staining

Vascular staining is most evident in tap roots. When evaluating vascular systems for staining, do not cut stems. Instead, uproot plants with a 5- to 8-inch section of taproot intact, then slice the roots lengthwise. Look for dark brown vascular staining in roots.

FOV vs. *Verticillium* wilt

Verticillium symptoms appear later in season, usually mid-to peak-bloom and later. Compared to FOV, *Verticillium* vascular staining is generally lighter in color, more discontinuous and usually evident in lower stems (2- to 6-inches above cotyledon node), as well as in tap root tissue.

Identifying Race 4 FOV

Symptoms of all races of FOV look similar, so confirmation of Race 4 can only be made using a properly-informed plant pathology laboratory that evaluates plant tissue from suspect plants. While techniques exist for evaluation of Race 4 FOV in soil, those tests are expensive, labor intensive, and are not currently a suitable method for evaluation of sites.

Once Race 4 FOV is confirmed

To the degree possible, destroy remaining infected plants in affected areas as well as immediate adjacent rows. That practice will help prevent inoculum build-up, and is particularly important if growing a susceptible cotton cultivar. Do not bury infected plants. Instead, pull up those plants and burn or compost them at high temperatures.



Wilted, yellowing leaves of an FOV-infected plant

MANAGEMENT OF FOV RACE 4

Carefully note locations of any confirmed or likely infested areas. A hand-held GPS unit can provide GPS coordinates of infected areas. Monitor fields seasonally for changes in size of affected areas.

Plant resistant/tolerant varieties

Growing susceptible varieties increases inoculum levels in the soil. Unfortunately, many commercial cotton varieties (Pima and Uplands/Acalas) are moderately- to highly-susceptible to Race 4 FOV. Do not grow varieties known as highly susceptible in confirmed Race 4 FOV fields or even near an infested site.

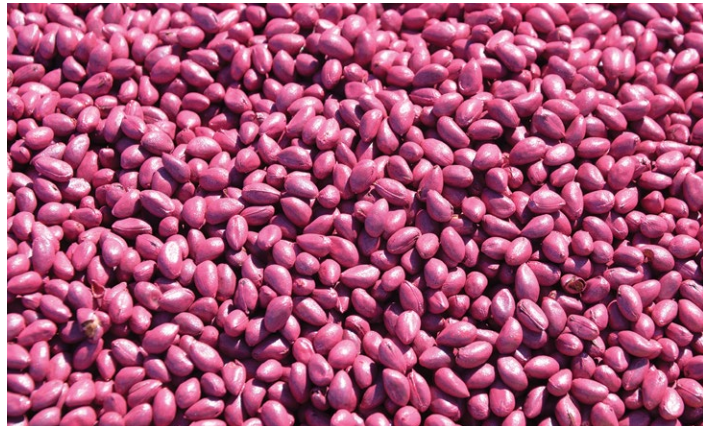
In fields identified with Race 4 FOV, plant only varieties with the highest levels of tolerance. Variety tolerance levels are identified in UC/USDA screening trials. Those trial results are posted on the University of California cotton website (<http://cottoninfo.ucdavis.edu>).

In fields considered to be absent of Race 4 FOV, continue to plant varieties with the desired quality and yield characteristics, but continue to scout for FOV disease symptoms.



Crop rotation

Based on experience with other FOV races, rotating to non-host crops or summer fallow will likely reduce inoculum survival (particularly multi-year rotations), but will not eradicate FOV. Upon replanting of susceptible cotton varieties, the disease will quickly return to damaging levels.



Containment options to limit spread

If affected area is large, plant resistant varieties or alternative crops.

If affected area is small, consider:

- 1) Soil solarization. Can be alone or in combination with fumigant chemicals, especially with double film layer for 1-2+ months duration
- 2) Long-term fallow (which must include hot summer period and be kept weed-free).
- 3) Summer flooding. A flood duration of several months or more is likely required.
- 4) Soil fumigants. Use chemicals with some fungicide activity and fumigant properties for spot treatments. Check with UC/USDA-ARS for suggestions.

CONTAINMENT PRACTICES

FOV can spread through movement of infested soil, infested plant debris and infected seed. Researchers believe that much of the field-to-field, localized introduction of FOV-4 inoculum has occurred with practices that move soil.

Limit Movement of Soil

- Pressure-wash implements, sprinkler pipe, machinery (e.g. harvesters) coming from farms or fields where FOV infection is unknown.
- In FOV-infested fields, avoid landplaning or other leveling activities that move soil. For weed control, consider practices that reduce soil movement, such as reduced-till or rolling cultivators instead of knives, etc.
- Restrict irrigation tail water movement off of infested fields. If tailwater is filled with suspended soil particles, those particles could contain spores of the pathogen.
- Limit equipment and personnel traffic on tires, equipment and boots through FOV-infested areas of fields, particularly when soil is wet and easily picked up and moved on tires and implements.

Infested plant material

Avoid any land applications of:

- 1) Gin trash from known infested fields, particularly if not well-composted
- 2) Manure from cattle corrals using gin trash for bedding
- 3) Manure from cattle fed with cottonseed from known FOV-infested fields, particularly if not well-composted

Infected seed

Seed producers should scout seed production fields for FOV Race 4. This scouting of seed fields is best done when plants are young (2- to 7-leaf stage). To prevent the possibility of infected seed entering the production system, do not allow any seed production within, or next to, known infested fields.



FOV can spread via tailwater, harvesting equipment, leveling equipment and on soil that is moved out of infested fields.



FOR MORE INFORMATION

UC Extension: <http://cottoninfo.ucdavis.edu>
CA Cotton Growers Association: www.ccgga.org
Bob Hutmacher, University of California Cotton Specialist, 559/260-8957

California Cotton Growers and Ginners Association (Roger Isom, Jodi Raley, Earl Williams) acknowledge the following contributors of information used to develop this brochure: Bob Hutmacher, Mike Davis, Steve Wright, Dan Munk, Brian Marsh (Various affiliations: University of CA, Davis Plant Science and Plant Pathology Departments, University of CA Cooperative Extension). Further contributions by Mauricio Ulloa, USDA-ARS (Lubbock, TX). Basic supporting information was originally developed for brochure available from the California Cotton Growers and Ginners Association. Mention of trade names and contributed information does not imply endorsement by the University of CA and USDA-ARS. Support for research that developed information and recommendations has been provided by: Grower cooperators, University of CA, USDA-ARS, various seed company representatives, Cotton Incorporated, Cotton Foundation, National Cotton Council, CDFA Exotic Pests and Diseases, California Cotton Alliance, CA Cotton Growers Association Research & Education Fund.

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