

MANAGEMENT OF FOV RACE 4

- **Plant resistant / tolerant varieties!**
 - Growing **susceptible varieties** will **increase inoculum levels** in the soil.
 - Unfortunately, many commercial cotton varieties (Pima and Uplands/Acalas) are moderately to highly susceptible to Race 4 FOV. **In particular, do not grow those varieties known as highly susceptible in confirmed Race 4 FOV fields or even near infested sites!**
 - **Fields identified with Race 4 FOV.** Plant only varieties with the highest levels of tolerance as identified in UC/USDA screening trials. More information from variety screenings for Race 4 FOV is available at University of CA cotton website (<http://cottoninfo.ucdavis.edu>)
 - **In fields considered to be w/o Race 4 FOV.** Continue to plant varieties with quality & yield characteristics you want, but remain on the lookout for FOV disease symptoms and follow up with sampling and analyses as needed.
- **Crop rotation**

Based on experience with other FOV races, rotation 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.
- **Practice containment strategies to limit spread among your fields.**
 - If affected area is small,** consider:
 - **Soil solarization** alone or in combination with fumigant chemicals, especially with double film layer for 1-2+ months duration
 - **Long-term Fallow** - must include hot summer period, and must be kept **weed-free**
 - **Summer Flooding** – duration of several months or more most likely required (little research on efficacy for FOV)
 - **Soil fumigants** – use chemicals with some fungicide activity and fumigant properties for spot or small area treatments (check with UC/USDA-ARS for suggestions)
 - If affected area is large,** plant **resistant varieties or alternative crops.**

IMPORTANT POINTS TO REMEMBER

- ✓ **FOV cannot be eradicated** once it is established in your fields. Take steps to prevent its introduction or to help with containment to the degree possible.
- ✓ FOV is spread through (1) **infested soil**, (2) **infested plant debris**, and (3) **infected seed**. Introduce practices to reduce or prevent **movement** of these materials within and between fields.
- ✓ **Scout fields** for FOV in the **spring**, ideally when plants have **2-7 main stem nodes** (complete scouting before first bloom so you can find & evaluate weak growth or blank areas in fields).
- ✓ If Race 4 has been confirmed, **plant resistant or known highly tolerant varieties only** and **limit soil movement between infested and non-infested areas** or among fields.

For more information, visit: <http://cottoninfo.ucdavis.edu>, www.ccgga.org, or contact Bob Hutmacher (University of CA) at (559) 260-8957

For more copies of this brochure, please contact:
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Race 4 FOV (*Fusarium oxysporum* f. sp. vas infectum) in California Cotton



A grower's guide to:

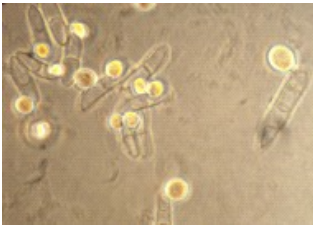
- Basic Fusarium (FOV) **biology**
- **Containment** practices to limit spread of FOV
- **Scouting** fields to **identify** potentially infected plants
- **Managing** Race 4, once presence is confirmed



BASIC FOV BIOLOGY

Fusarium oxysporum f. sp. *vas infectum* (FOV) is a soil-inhabiting fungus.

- **Life Cycle:** FOV spores germinate when in the proximity 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 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 is able to 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 be eradicated**.
 - **Other 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 shorter-lived conidia as well as long-lived, thick-walled spores (chlamydospores) that can survive tough environmental conditions (heat, dehydration).



Fusarium oxysporum
chlamydospores
(New York Botanical
Garden)

- **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 CA for decades, but causes economic injury only 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 have been found to be capable of infecting seed, including Race 4 FOV in California**. Since 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.

CONTAINMENT PRACTICES

FOV can spread through movement of (1) infested soil, (2) infested plant debris, and (3) infested seed

- **Limit Movement of Soil**
 - Pressure-wash implements, sprinkler pipe, machinery (eg. Harvesters) coming from farms or fields that you cannot vouch for as FOV-free.
 - In FOV-infested fields, avoid land planing or other leveling activities that move soil, consider practices that reduce soil movement (reduced-till, rolling cultivators instead of knives, etc.)
 - Restrict irrigation tail water movement off infested fields to the extent possible (if tailwater has a lot of suspended soil particles in it, those could contain spores of the pathogen).
 - Limit equipment traffic through FOV-infested areas of fields, particularly when soil is moist and you could pick up and move wet soil on tires and implements.
- **Infested plant material:** Avoid any land applications of gin trash from known infested fields, use of manure from cattle corrals using gin trash for bedding, or cattle fed with cottonseed from known FOV-infested fields.
- **Infested 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) in order to do the best job of scouting. Do not allow any seed production within or next to known infested fields to prevent the possibility of infected seed entering the production system.

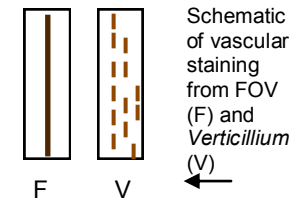
SCOUTING FIELDS FOR DISEASE

The best time to scout for FOV Race 4 is in SPRING when plants have 2-7 nodes — (certainly try to complete before 1st bloom).

Field Signs: “Blank” areas either devoid of plants or with dying plants will be evident (as shown on the brochure cover). Size of affected areas will depend on how long inoculum has been accumulating and susceptibility of varieties grown currently and previously (at the site). First year infestations are typically a few affected plants in a few feet of row, while 2nd and 3rd year blank areas will expand to 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. For more photos, visit Univ. CA cotton website.

- **Vascular staining is most evident in tap roots.** When evaluating vascular systems for staining, do not cut stems—uproot plants with an intact 5 to 8 inch section of taproot, slice those roots lengthwise, and look for dark brown vascular staining in roots (similar to that shown in picture below or on Univ. CA cotton website).
- **Differentiating symptoms of FOV from Verticillium wilt:**
 - *Verticillium* symptoms appear later in season (mid- to peak-bloom & later)
 - *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 will look similar, so **confirmation of Race 4 can only be made through a properly-informed plant pathology laboratory based on evaluations of plant tissue from suspect plants**. While techniques do exist for evaluation of Race 4 FOV in soil, the tests are expensive and labor intensive, and are not currently a suitable method for evaluation of sites for likely presence of Race 4.
 - Race 1 FOV may be a possible diagnosis if you have sandy/loam soils and root-knot nematodes (visual symptoms are similar to Race 4 FOV, so pathology evaluations are required to differentiate between FOV races).
- **If Race 4 FOV is confirmed**, to the degree possible, destroy remaining infected plants in affected areas as well as immediate adjacent rows in order to prevent inoculum build-up. **This is particularly important if you are growing a susceptible cotton cultivar.** Do not bury infected plants if possible; pull up plants and burn them or compost them at high temperatures.

MANAGEMENT OF FOV RACE 4

Carefully note locations of any confirmed or likely infested areas. Get a hand-held GPS unit to provide GPS coordinates of infected areas if possible. Monitor seasonally for changes in size of affected areas, and use Race 4 management recommendations.