March 2004 UNIVERSITY OF CA COOPERATIVE EXTENSION

Cotton Management Guidelines

FUSARIUM UPDATE — March, 2004

Disease Cycle and Transmission, Containment Recommendations

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Old & New Situations with FOV

Fusarium oxysporum f. sp. *vasinfectum* (or "FOV") is a soil-inhabiting fungus that causes a vascular wilt disease in susceptible cotton varieties. It has been widely recognized in the San Joaquin Valley since the 1950's. Historically, Fusarium wilt in cotton produced visible symptoms and caused economic damage only in susceptible varieties in combination with significant populations of the root knot nematode (*Meloidogyne incognita).* Fusarium wilts usually seen in these prior recognized cases were caused by race 1 or race 2 of FOV. In recent years, however, several localized occurrences of FOV infections with moderate to severe plant damage have been confirmed in the absence of nematode populations. In these cases, the disease was caused by race 4 FOV. Evaluations in 2003 indicated that all widely-grown commercial Pima varieties tested were more seriously damaged than tested Acala or non-Acala Upland varieties. Field trials also indicated good levels of resistance to race 4 FOV in some experimental Pima varieties. It is significant, however, that many Upland/Acala varieties field-tested under high race 4 inoculum loads in 2003 were also infected, albeit with fewer symptoms and less damage than in most Pima varieties.

What to Look For? Symptoms

In addition to causing a general wilt, symptoms of Fusarium wilt include patchy leaf yellowing and necrosis that typically begin on the leaf margins of lower leaves. As the disease progresses, the vascular system (water and nutrient, food-conducting tissue) of the upper tap root and lower stem appears "stained" dark brown when cut at a diagonal or in cross-section. Vascular staining caused by FOV generally looks different than vascular staining seen with *Verticillium,* with staining associated with FOV more of a continuous, dark-brown color when compared with the irregular, flecking stain of the vascular system typical with *Verticillium.*

The amount and severity of leaf damage in fields infested with

FOV depends on a number of factors, including: a) distribution of fungal inoculum in the field; b) the degree of vascular tissue damage or "plugging" as the fungus grows in the plant; c) the duration of the fungal "attack" and ability of plants to re-grow or retain leaves; and d) to some extent, weather conditions that influence water use and water stress. The damage often occurs early in plant development, with leaf wilt and necrosis occurring in plants with as few as 1 to 2 true leaves (see photo above).

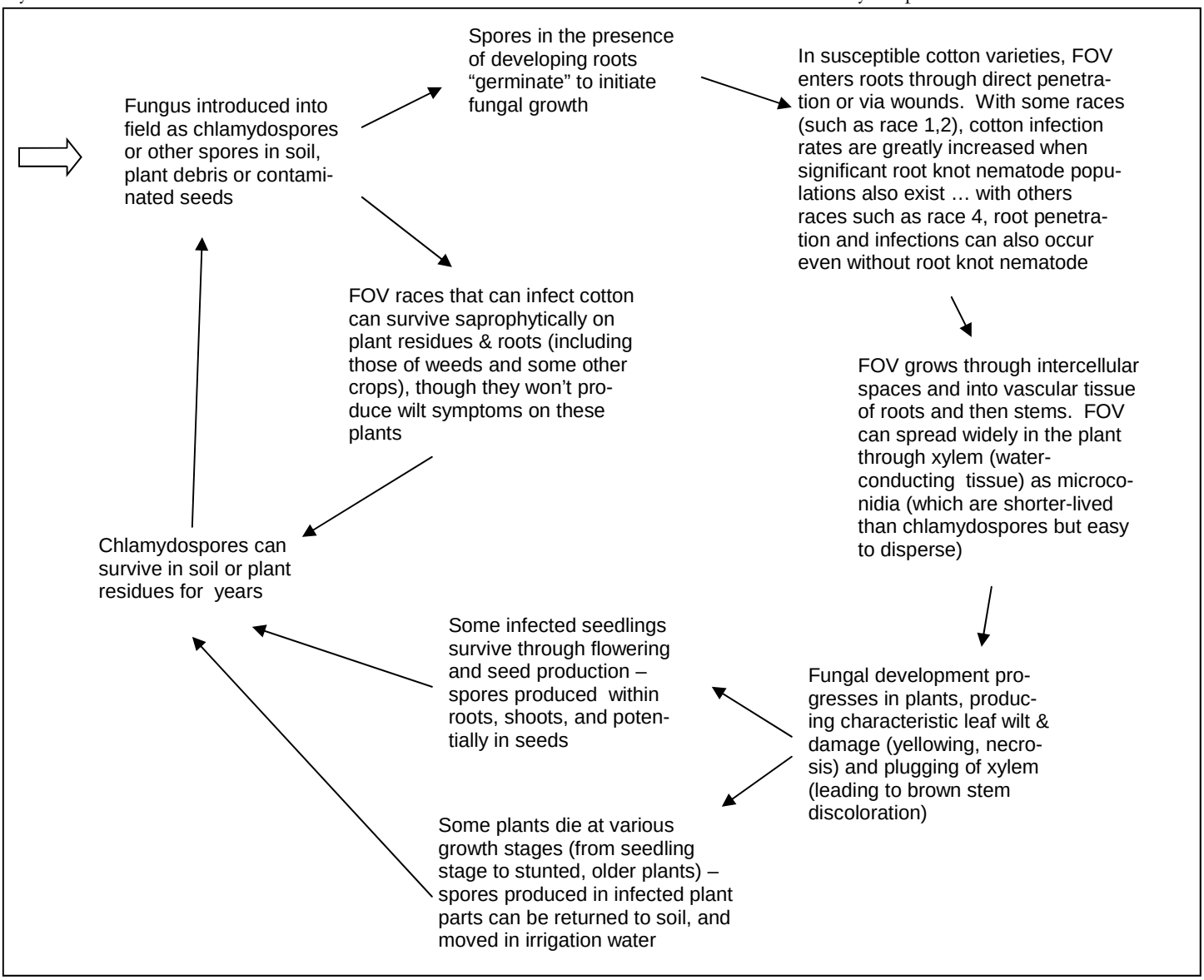
In seedlings and young plants, cotyledons and leaves wilt and drop, resulting in bare stems. In mildly-affected or older plants, the lower leaves will show symptoms but the plant will survive, albeit with reduced vigor. In the most severely affected plants, leaves wilt and drop and the plant may die. Often, all of these stages of plant damage are apparent within a small affected area. It is also possible that clearly visible disease symptoms will be limited to early growth stages, with fewer symptoms readily observable as the season progresses.

Foliar and vascular staining symptoms in cotton plants infected with different races of FOV look similar, so it is not currently possible to determine Fusarium race based on plant symptoms alone.

Disease Cycle and Transmission of *Fusarium oxysporum* f. sp. *vasinfectum* (also called "FOV")

DISEASE CYCLE ("Fusarium oxysporum f. sp. vasinfectum", or "FOV")

FOV is present in soils as specific strains of the fungus Fusarium which can cause a vascular wilt disease in susceptible cotton varieties. Multiple FOV strains have been identified in isolated areas of California, but they all share the basic life cycle and modes of disease transmission shown below. FOV does not cause disease in any crop other than cotton.



For more photos and descriptions of plant symptoms, please go to the following website

http://cottoninfo.ucdavis..edu

and review photos in the July, 2003 issue of "Cotton Management Guidelines" - located within the "GUIDELINES" section of the web site

Scouting & Testing for Fusarium

Scouting fields for FOV problems/Timing

The best TIMING for field scouting and sampling for FOV may be earlier than scouting you do looking for weed problems or Verticillium wilt. Fusarium affects plants as early as the 1-2 leaf stage or more typically around 5 to 12 nodes growth stages. After some initial die-back of plants or partial defoliation during these growth stages, it is typical to see some additional plants in affected areas develop additional damage and die, and other plants to experience some partial leaf loss followed by recovery (survivor plants). Don't plan on waiting to scout fields at peak bloom or later in boll development, as the size of unaffected plants and partial recovery of some of the surviving plants can make it much more difficult to find patchy areas where plants were damaged at early growth stages.

For pictures of plant symptoms, see the July, 2003 Fusarium update on the University of California cotton web site: http://cottoninfo.ucdavis.edu

Who Can Run a Plant Tissue Test to Evaluate Samples for FOV? How to Collect Tissue Samples?

Laboratory analysis is generally needed to determine if cotton plants are in fact infected with FOV. If it is determined that plants are indeed infected with FOV, more complicated additional tests are required to ascertain which race of FOV (race 1,2, 4, other?) is present. As of the date of preparation of this report, these services would not be expected to be routinely available at commercial Plant Pathology laboratories.

University of California Cooperative Extension has the necessary equipment and information to properly characterize both the presence of FOV and the race involved. To the degree our resources allow, we will follow up on FOV evaluations in field sites brought to our attention. If you ask for assistance in analyzing and testing for FOV, we request you contact us first to allow us either to collect the samples ourselves or to meet with you regarding proper collection and sample handling procedures.

Can all Fusarium cause Wilt Diseases in Cotton?

Various forms (both pathogenic and non-pathogenic) of the soil-inhabiting organism Fusarium are present in most agricultural soils. Some types of *Fusarium oxysporum* f. sp. ("Forma specialis") *vasinfectum* are able to infect susceptible varieties of cotton and cause a vascular wilt disease. Since there are different types of cotton (Upland "Gossypium hirsutum", Pima "Gossypium barbadense", and others) and some diversity in genetic background even across varieties, the degree of resistance to infection by Fusarium varies with cotton type and variety. Available genetic differences in resistance/tolerance to FOV can be exploited as a primary approach to dealing with FOV by incorporating resistance into agronomically desirable cotton lines. Different types of Fusarium can infect crop species such as lettuce and tomatoes, but to the best of our current knowledge, types of Fusarium which infect and damage these crops do not impact cotton, and vice versa.

Are Soil Tests Available to Detect Presence of FOV?

Soil evaluations exist which can test for and broadly enumerate all types of Fusarium, but quick tests to detect FOV in the soil are not yet available. Currently, there are no affordable, reliable quick tests available that are able to differentiate between types of FOV (such as race 1 or race 2 versus race 4 in cotton).

Identification of the Race of Fusarium in Cotton

Most cotton crop loss in the San Joaquin Valley caused by Fusarium wilt is probably associated with FOV races that only cause economic damage when the plants are also infected with root knot nematode (RKN). This RKN:FOV association has been thoroughly researched in CA, and is typical of several races of FOV impacting cotton, including races 1 and 2. This type of combined damage with these infestations is particularly likely if you are producing cotton in sandy, sandy loam and silt loam soils where there has been a history of nematode and/or Fusarium in past decades. Root knot nematode populations are typically low or negligible in finer-textured soils in California cotton areas.

In recent years, race 4 FOV has been observed in several San Joaquin Valley fields, even when root knot nematodes were absent or present only in low numbers. Incidence of race 4 FOV may therefore be recognizable first in areas with finer-textured soils which typically do not harbor large root knot nematode populations. It is important to remember, however, that race 4 FOV could also occur in coarser-textured soils, whether or not race 1 or 2 FOV was previously identified. It is not known at this time if the impacts of race 4 FOV on cotton would be worse in sites also infested with root knot nematodes.

What to Do if Your Field Tests Positive for FOV

Fusarium is a soil-inhabiting fungus. Certain forms of this organism can survive for long periods in soil, even if the host plant (in this case, cotton) is not present. Although FOV only causes disease in cotton, it can survive on the roots of many other plants, including other crops and weeds. This fungus is nearly impossible to eradicate from soil once inoculum is widely distributed, and any currently-available chemical control measures are very expensive and still not close to 100% effective in eliminating soil-borne inoculum. This means that primary efforts in fields where the problem is identified should be directed toward containment and avoidance of practices that can cause further spread of the organism.

If FOV is confirmed in cotton plant tissue from your field, practices to consider include:

- **Plant removal.** Pull out or destroy affected plants and plants in immediate adjacent rows if possible
  - If the affected area is large, consider leaving plants in place and killing them with a herbicide
  - If the affected area is relatively small, pull out or hoe out affected plants and destroy/burn them in place within the affected area
  - Make a note of the size and location of the affected area (flag it or take note of location with GPS equipment) so you can check the area again later and do additional clean-up as required
  - If problem spreads significantly beyond original area, destroy the affected plants if in a small enough area
- **Control weeds** during crop season and between crops, as FOV can survive as a saprophyte on roots and plant debris of some weed species
- **For control of within-season weeds,** use hooded sprayer with herbicides where possible instead of mechanical cultivation which could transfer infested soil
- **Control traffic of equipment and clean soil and plant debris** from tractors, planters, transplanters, sprayers, fertilizer or gypsum applicators, sprinkler pipe and harvesters that could move soil and plant debris out of infested areas. Develop practices and train personnel to do in-field clean-up procedures prior to moving equipment off of infested fields.

Personnel and equipment traffic considerations, changes in irrigation practices in FOV-infested fields:

- Limit personnel and implement traffic in affected areas to the greatest degree possible, particularly during times when soil is moist and more likely to stick to tractor and pickup tires, boots, sprinkler pipe, or implements.
- The minimum effort should be to knock off most excess soil & physically remove any plant parts stuck in or clinging to equipment before moving around or between fields
- Wash off soil stuck to equipment, sprinkler pipe or boots, either with pressure washer or with detergent-based cleaner able to penetrate soil particles. Since spores survive for long periods in soil and in plant debris, these efforts will reduce amounts of inoculum spread
- Irrigation water can move both soil and infested plant debris, potentially spreading inoculum within and between fields. To the degree possible, isolate affected areas and keep irrigation water flow, equipment and foot traffic from passing through affected areas into unaffected parts of the field. If tailwater recovery systems are in use, restrict movement of tailwater off infested fields.

Production of planting seed

Do not produce planting seed in fields confirmed as affected by FOV, or in fields immediately adjacent to affected fields. Although the incidence of seed infection with FOV has generally been described as low and has been difficult to detect in studies done in Australia as well as older studies in California and other states, the likelihood is that this race of FOV still can be seed-borne, so seed production in or adjacent to infested fields is an unacceptable risk.

When FOV is in association with root knot nematodes.

In addition to the above, if the soil type and FOV strain is one that involves both FOV and root knot nematode (such as race 1 or 2), practices that also help to limit or control nematode populations will also help with FOV containment. Use of nematicides will only kill nematodes, but will likely reduce damage levels and FOV infestations. Summer flooding and solarization of fields has been useful in reducing (but not eliminating) FOV and nematode populations.

With this information and these cautions in mind, growers and consultants should keep an eye out for symptoms of Fusarium, particularly in areas with prior low incidence of these disease symptoms. Contact your Farm Advisor or Specialists with questions or requests for field visits *(phone numbers shown below).*

UNIVERSITY OF CA COOPERATIVE EXTENSION

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