UPDATE ON FUSARIUM RACE 4 VARIETAL EVALUATIONS IN CALIFORNIA

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Abstract

In recent years, differences have been noted in field situations with the fungal pathogen *Fusarium oxysporum* f. sp. *vas infectum* in Acala and Pima cotton in the San Joaquin Valley of California. Typically, earlier-recognized races of this organism found in California cotton only caused significant crop foliar damage and yield impacts under conditions where it was found in combination with susceptible varieties of cotton and at least moderate populations of root knot nematode. A race 4 isolate of *Fusarium oxysporum* f. sp. *vasinfectum* (FOV) has been identified in Pima and Acala cotton fields in the San Joaquin Valley in recent years, and research to date has shown that this race can infect susceptible varieties, cause damage, and may reproduce inoculum under soil conditions that do not support significant root knot nematode populations. Research efforts to date have focused on (1) development of genetic tools to more clearly identify current Fusarium races found in California cotton samples; (2) evaluation of plant samples under field conditions to verify presence or absence of the pathogen, and (3) initiation of variety screening programs under both greenhouse conditions with inoculated soil, and in field sites where this FOV race 4 pathogen has been confirmed. Field screening trials to evaluate relative FOV resistance in commercial and experimental cotton lines have shown that susceptible Pima varieties are more severely affected in terms of foliar damage, stem vascular staining and plant stunting or mortality than tested Acala and non-Acala Upland varieties. The most tolerant (lowest seedling mortality, least stunted) varieties in field screenings have also been Pima cottons. Field and greenhouse trials have both repeatedly confirmed that tested Acala and non-Acala Upland varieties can also be infected, although generally with reduced plant mortality and stunting. Significant varietal differences in susceptibility to the race 4 FOV pathogen have been seen in both Pima and Acala cotton entries.

Current Status

Fusarium wilt of cotton is a vascular wilt disease caused by the fungus *Fusarium oxysporum* f.sp. *vasinfectum* (FOV). In the San Joaquin Valley (SJV), Fusarium wilt has not historically caused major crop losses due to what has previously been recognized as California's mildly pathogenic strains and the high percentage of FOV-tolerant Upland cotton varieties grown. An exception occurs when plants are also infected with root-knot nematodes; in that case, even mild strains of FOV can be very damaging to most cotton varieties (both Acala and Pima). Root knot nematodes are most widely found in coarser-textured soils (sands, sandy loams), or in sand streak areas. Many SJV soils more susceptible to root knot nematode infestations have, in the past decade, been planted to perennial crops instead of cotton. For these reasons, Fusarium has generally been a less-seen problem in much of the SJV cotton production area in recent years.

Between 2002 and 2007, in a limited number of locations, Fusarium wilt damage has been observed in both Pima *(Gossypium barbadense* L.*)* and Acala / Upland *(G. Hirsutum* L.*)* cotton growing in soils ranging from sandy loam to loam and clay loam soils, and the presence of the Fusarium pathogen has been confirmed to match plant symptoms. The disease in these limited locations is different in that it has developed and caused plant damage even in the absence of root-knot nematode or other kinds of significant stress. The Fusarium at these sites was found to be different than those with the nematode association, and can be separated genetically as a different race of FOV, race 4. Although the initial evaluated fields were planted to susceptible Pima cotton varieties, follow-up field evaluations have confirmed that the pathogen is able to also infect and produce wilt disease symptoms in susceptible Acala and Upland cotton varieties.

Field varietal screens were done in grower fields confirmed to be infested with FOV race 4 and only in parts of fields where a prior cotton crop showed consistent, significant plant losses due to FOV race 4 (greater than 40 percent mortality in susceptible Pima entries). In greenhouse pathogenicity tests, cotton seedlings with 1 to 3 true leaves were root dip-inoculated in a conidial suspension of 6 X 10^5 spores/ml for 3 minutes. Plants were then transplanted into heat-treated potting soil mix in 8 cm square by 20 cm deep pots and grown in a temperature-controlled greenhouse for a minimum of several weeks to allow time for disease and symptom development. After approximately 6 to 8 weeks, plants were removed from pots by pulling up on the roots and cutting the tap root at 2-3 cm below the soil line. The vasculature near the soil line and distal several centimeters of stem were examined for vascular staining (discoloration) typical of Fusarium wilt. Roots were washed and the dry weights of both the plant tops and root system were determined.

Efforts to date have focused on a mix of Acala and non-Acala Uplands and commercial Pima varieties of interest to California commercial cotton producers and seed producers, plus some experimental materials both from public and private sources. Because long-term management of Fusarium wilt relies on the development of resistant varieties, efforts focus on screens of cultivars from a wide range of cotton seed companies, in order to get a broad germplasm base. Among the public germplasm materials, resistance has been identified in certain lines, so future USDA-ARS and University efforts will also try to identify specific resistance genes to the various races of FOV. This would allow breeders to target desired traits instead of using a 'hit or miss' approach.

Early greenhouse tests of the pathogen isolated from these fields indicated that several Pima varieties tested were infected at a higher rate and damaged much more seriously than several Acala varieties evaluated in the same greenhouse tests. Subsequent field tests in 2003 through 2007 and several greenhouse variety screening studies conducted since 2004 have clearly shown that some Acala varieties can also be infected by this race of FOV, albeit with significantly less plant damage than in most Pima varieties tested to date. Germplasm highly-resistant to FOV race 4 were identified in Pima at the inoculum levels tested under greenhouse conditions and levels found in multiple infected field test sites. Further field and greenhouse evaluations of a range of Acala and Pima varieties are underway, and will help determine how broadly susceptible Acala, Pima and non-Acala Uplands may be to this pathogen.