BREEDING FOR RESISTANCE TO FUSARIUM RACE-4 Mike Olvey Jim Olvey O&A Enterprises Inc. Maricopa, AZ

Abstract

FOV Race-4 (FOV-4) was first identified in India and has now spread to the United States. Jim Olvey first identified FOV-4 in California (1997) then, we identified and confirmed FOV-4 in Texas (2016). FOV-4 is a very invasive disease that has the potential, and we believe is likely, to spread throughout the rest of the U.S. O&A Enterprises Inc. and Phytogen have commercially sold G. Barbadense (Pima) varieties that have a high tolerance/resistance to FOV-4. We have proved in pima cotton that finding host plant resistance has been and is the best answer to solving FOV-4 problem. Host plant resistance must be found and bred into G. Hirsutum (Upland) cotton, if the U.S. is to sustain the current cotton acreage. Not having upland cottons resistance to FOV-4 in the very near future will have dire consequences to the U.S. cotton industry.

Introduction

Fusarium oxysporum f. sp. vasinfectum (FOV) is a fungus that resides in soil. FOV-4 injures or terminates susceptible cotton plants early in the cotton growing season which usually starts off in a circular pattern in the field. This pathogen can spread a number of different ways both by man and nature. People can spread the disease through equipment and planting infected seed. The spores can travel in the wind and water. FOV-4 can survive in all different soil types. Most other crops are a host to the disease yet doesn't damage these other crops. Unlike most Fusarium Wilts, the presence of nematodes are <u>not</u> required to injure susceptible plants. No fumigant, soil or seed treatments have shown any positive results in controlling FOV-4. Crop rotations have little or no effect of trying to bring spore counts down to a manageable level. There are also a number of other factors can increase the disease severity including but not limited to weather, cultivation practices, plant characteristics, water movement, transgenes, and the presence of other diseases.

The Spread

FOV Race-4 (FOV-4) was first identified in 1960 by the Armstrongs. Since originally being discovered in India, this disease has spread to the United States. In 1997, Jim Olvey personally observed FOV-4 in the San Joaquin Valley. Injury could be seen in all commercial varieties at that time. In 2013, growers in west Texas first observed circular patterns of early season damage in their cotton fields. While we were describing the symptoms of FOV-4 at a grower field day in 2015, multiple growers said they were experiencing those same symptoms. We personally met with and saw most of the locations where the symptoms were occurring. In 2016, we planted a test trial of resistant and susceptible varieties to verify if these field spots were, in fact, FOV-4. All susceptible and moderately susceptible varieties experienced severe damage of almost no living plants. Resistant varieties had no visible damage. In 2017, we put out a test plot of a FOV-4 susceptible variety next to a resistant variety shown below:



Both varieties in this picture had perfect stands of over 90% emergence. Within a few days after emergence, the susceptible variety, shown on the left, was exhibiting signs of distress. We sent plant tissue and soil samples to multiple labs, some labs with the support of Cotton Incorporated. Multiple labs confirmed the presence of FOV-4. If FOV-4 can spread from India to the western U.S., we see no reason why it cannot spread to the eastern U.S.

Methods

We were trying to find host plant resistance and then breed the resistance lines into commercial cultivars. We first needed to identify a large enough area to field screen cotton lines. Second, establish a maintenance protocol to keep high inoculation levels in our FOV-4 screening sites over time. Third, we need a protocol to determine levels of susceptibility and resistance.

Identify Screening Sites

Year 1 – Identify and map significantly infected field planted in a FOV-4 susceptible variety. Year 2 – Plant a moderately susceptible variety in the infected area to map visually. We also take numerous soil and tissue samples to determine the variability of spores within the given affected area. Year 3 – FOV-4 screening site.

Field Maintenance Protocol

It is essential to secure FOV-4 testing sites for long durations to ensure accuracy across time. FOV-4 spore counts are must easier to control when in the same location as opposed to constantly moving testing sites. Planting moderately susceptible varieties the year before lines are being screened is a must. Constantly testing soil and plant tissue for spore count levels required to know the intensity of the pathogen. If the susceptible checks look good in your testing site, the test is worthless.

Determine Levels of Susceptibility and Resistance (SSMS Protocol)

We look at three major factors when evaluating performance under severe FOV-4.

- 1. Survivability
- 2. Vascular Root Stain
- 3. Yield/Performance

Originally determined through mostly trial and error through a massive first screening effort. 6,000 accessions of Pima and Breeding Lines were first screened. It is essential to screen a large amount of diverse lines to have the greatest chance of successfully finding resistance to any disease. From the 6,000 accessions, 20 families were found to have resistance. We confirmed these families had resistance through three years of screening. This screening and these families are the based for all of FOV-4 resistance Pima varieties from O&A Enterprises Inc.

Results and Summary

We hoped to have shown the severity of FOV-4 and the potential impact it could have on U.S. cotton production. While also showing a path to finding a viable long term solution. Host plant resistance MUST be found in Upland cotton as it has been found in Pima cotton. To accomplish this task, as an industry (State, USDA, and Private Seed Companies), we need to screen Upland germplasm to find resistance. This needs to be accomplished ASAP because no commercially sold upland on the market today has FOV-4 resistance. It will take time once finding resistance, to then incorporate the appropriate transgenes to make a commercially viable variety. For the last decade, O&A Enterprises has been releasing commercial Pima varieties with FOV-4 resistance. This all started and is possible from the screening efforts we undertook almost 20 years ago. The result of how much this disease will affect U.S. cotton is still to be determined.