Diseases of Pomegranate in Florida

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Diseases caused by many fungal pathogens have become one of the limiting factors for pomegranate fruit production in Florida. Losses to fruit rot, stem blight and die back, leaf and fruit spots are typically observed throughout the season. Our research efforts have focused on surveying the primary diseases occurring on pomegranate in Florida and the causal pathogens involved to further research on disease management. We relied on symptomatic tissues collected during surveys of pomegranate groves and from samples received from pomegranate growers. Causal organisms were cultured from diseased tissues and identified based on culture morphology and DNA sequencing of conserved genes.

Several pathogens were identified, including two fungal pathogens belonging to the Botryosphaeriaceae family (*Neofusicoccum parvum* and *Lasiodiplodia* sp.) that were isolated from fruits and stems; two *Colletotrichum* species that were isolated from leaves and fruits; and a fruit rot causing pathogen *Pilidiella granati* was also isolated from fruits. Another fungus belonging to the order Diaporthales was also frequently isolated from leaves, stems and fruits. Additional laboratory and greenhouse tests confirmed that these six pathogens are very aggressive on pomegranate fruits and leaves causing foliar spotting and blighting and fruit rot.

Additional research is underway to develop an integrated disease management program. Research includes studies to monitor the presence of each pathogen in groves throughout the pomegranate growing season, and studies to identify cultural and effective fungicidal compounds for disease management. Effective management requires an understanding of pathogen biology. The diseases caused by most of these pathogens are known to be polycyclic, i.e., the pathogens are capable of several infection cycles per growing season.

Most of these pathogens are known to survive on infected plant materials (stems, leaves, and fruits) and remain dormant until condition are favorable to reinitiate disease. Based on field observations and controlled tests, most of the pomegranate cultivars evaluated to date are susceptible to these pathogens.

The climate in Florida (temperature 80-90^{o} F and humidity 70-90%) and frequent precipitation are optimum for the pathogen(s) during the pomegranate cropping season, providing favorable conditions for rapid disease development. The frequent precipitation events help to splash disperse the spores of these pathogens to neighboring branches and trees resulting in an exponential increase in disease incidence.

We have discovered that these pathogens are present in apparently healthy buds at the beginning of the season (Fig. 1). During the 2015 growing season, flower buds were collected from late January through March from three different locations in Florida, two in Georgia and one in South Carolina. The buds were divided into six stages from early stage bud to fruit initials, surface sterilized, and incubated in plastic

chambers. In addition, some of the flower buds were plated onto artificial media to force germination of overwintering spores. All six pathogens were recovered from every flowering stage, indicating that these pathogens are already present at the early stages of fruit development.

Similarly, three pomegranate orchards in central Florida were monitored for disease symptoms every other week from late January through late August 2015. Initial disease symptoms appeared as spotting of the calyx of fruits in early May caused by *Colletotrichum* sp (Figure 2A). These symptoms spread to leaves, stems, and other parts of fruits causing spots, blight like symptoms, and defoliation (Fig. 2B -2E). Other symptoms as fruit spots, leaf spots, leaf blight, shoot blight, and fruit mummification became more prevalent towards the mid to late pomegranate season and were caused by combination of several pathogens (Fig. 2F).

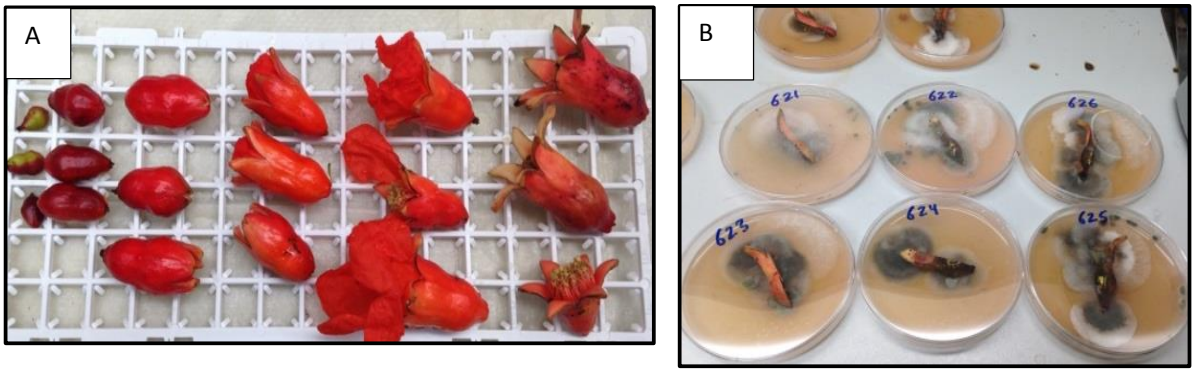

Figure 1: Evidence of latent infections: A) Six different stages of healthy looking pomegranate flower buds; B) pathogen recovery on artificial media C) on plastic chambers

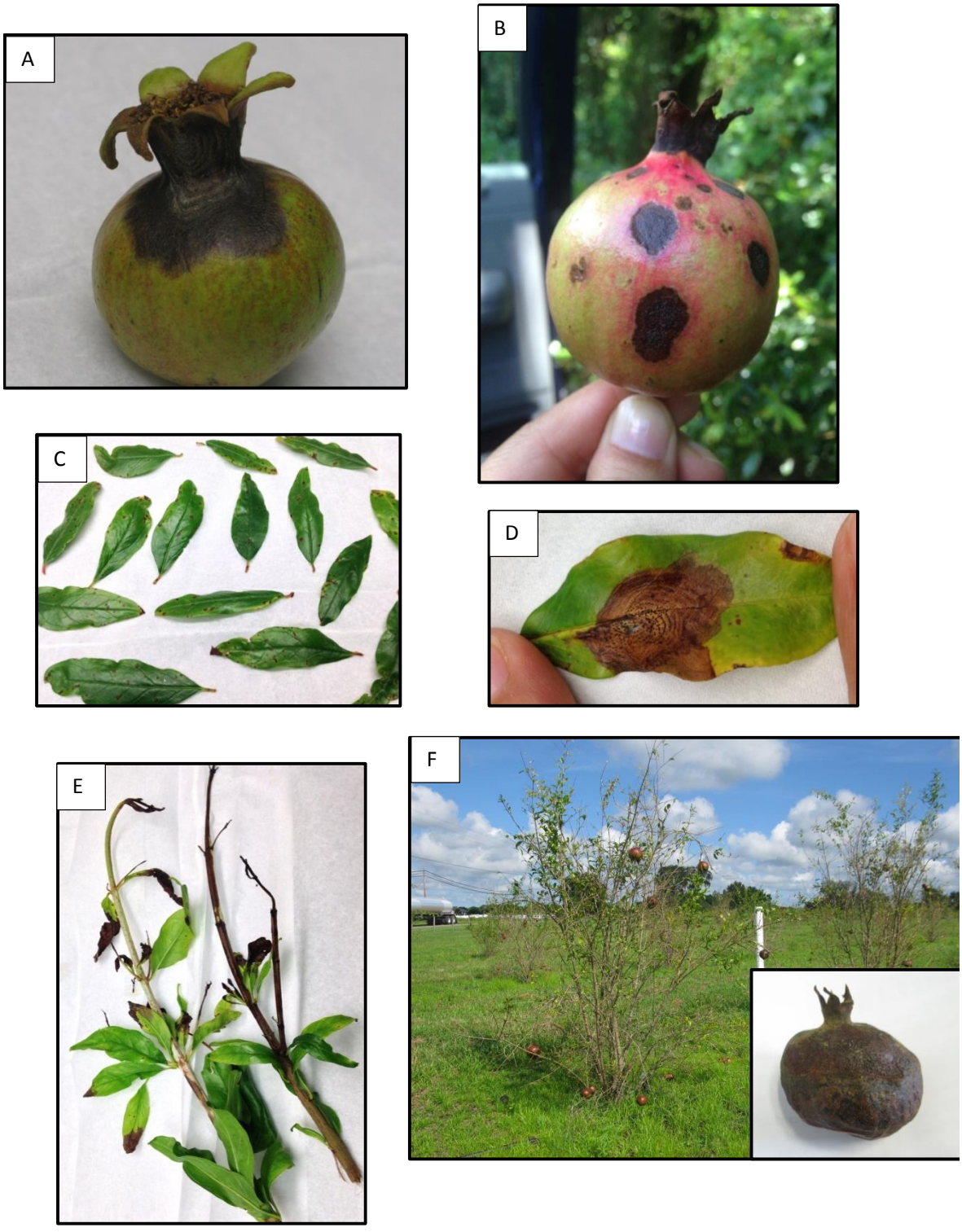

Figure 2: Symptoms of pomegranate diseases: A) Anthracnose, caused by *Colletotrichum* sp., on the calyx of a developing fruit; B) Anthracnose and fruit spots caused by *Colletotrichum* and *Cercospora* like pathogen; C) Leaf spots caused by *Cercospora* like pathogen and D) *Pilidiella granati*; E) Stem die back caused by Diaporthales and *Colletotrichum* sp.; F) Fruit mummification typical of *Pilidiella granati* at the end of growing season

Pathogens were also tested for their sensitivity to several fungicides in laboratory assays. The fungicides Cuprofix, Endura, Folicur, Topsin, Cabrio, Penncozeb, and Scala were evaluated for their ability to reduce the growth of *Neofusicoccum parvum*, *Lasiodiplodia* sp., and *Colletotrichum* sp. in culture. All pathogens were highly sensitive to Cabrio, Folicur, and Topsin, but only moderately sensitive to Penncozeb. Whereas, the fungicides Cuprofix, Scala, and Endura failed to restrict the growth of the tested fungi.

Five fungicides Cabrio, Penncozeb, Scala, Switch, and Luna Experience were also tested for their effectiveness under field conditions at several grower sites. Three fungicides, Cabrio, Luna Experience, and Penncozeb were effective against foliar and fruit diseases under field conditions when applied every 2 to 3 weeks. Although promising, additional research is necessary to further the timing and frequency of fungicide applications, as well as identifying favorable fungicide rotations. None of the tested fungicides are currently registered for use on pomegranate. However, testing to establish residue tolerances for several fungicides are planned for 2016.

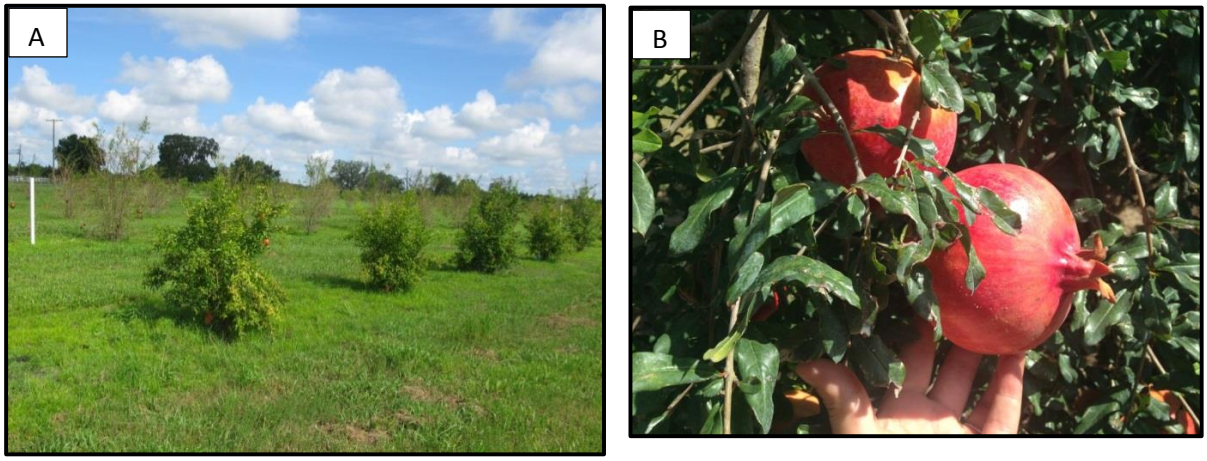

Figure 3: Fungicide field trial: A) the treated trees in front row vs untreated trees in back rows B) fungicide treated fruits at the end of growing season

The use of resistant varieties is by far the most economical and sustainable means for managing any disease. Currently there are more than 100 pomegranate cultivars that are being tested for various traits in Florida, including resistance to the *Colletotrichum* sp. and the two pathogens of the Botryosphaeriaceae. More than 2000 breeding lines have been developed that will be screened for disease resistance and other traits of economic importance.

Pomegranate is a potential alternative crop for growers in Florida and nearby states. **Disease appears to be the greatest impediment to commercial production.** The adoption of disease management practices will be critical. **Field sanitation** will likely be an integral part of any disease management strategy because many of the identified pathogens are known to survive in plant residues in other cropping systems. Sanitation efforts will help reduce local levels of the pathogen within the pomegranate orchard, which can help delay disease development. Even as research progresses, eventually leading to pomegranate varieties with improved levels of resistance and fungicide recommendations, lowering pathogen levels

through field sanitation will help enhance fungicide performance and may even help lower the risk of developing fungicide resistance in pathogen populations.

Although our knowledge about some of these pathogens is limited, it is clear from other crops that growers will benefit from implementing **sanitation practices** to minimize the presence of the pathogen in the field for the upcoming season. This can be best achieved by **clearing leaf litter, fruit, and diseased stems from orchards**. Especially during the late fall when many trees go dormant and lose their leaves, it is important to clear leaf debris from around trees that may be harboring the pathogen from the previous season. This is also an ideal time to inspect trees for diseased branches. We recovered *Neofusicoccum parvum* and *Lasiodiplodia* sp. from most of the pedicels (part of branch attached to fruit) sampled during our surveys. So, **pruning diseased branches** and pedicels should help minimize carryover of the pathogen.

All the infected leaves, stems, and fruits should be removed from the orchard to a safe distance and burnt or disposed of as permitted by local ordinances. Similarly, equipment that comes into contact with diseased tissues should be cleaned or debris. Hand tools used for pruning can be sanitized using 75% alcohol, 10% sodium hypochlorite solution (Regular Clorox® bleach), quaternary ammonium, or other approved disinfectant. Growers are encouraged to refer to the article "Disinfection of Horticultural Tools" that is available on EDIS (http://edis.ifas.ufl.edu/ep380) for additional information.