Stigma and Style Necrosis is Associated with Postbloom Fruit Drop Disease in Citrus Following Artificial Inoculation

Youjian Lin, Ed Stover, and Ron Sonoda

University of Florida Indian River REC, Fort Pierce, FL 34945

Erin Roskopf

USDA Horticultural Research Laboratory, Fort Pierce, FL 34945

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Postbloom fruit drop (PFD) of citrus is caused by *Colletotrichum acutatum* J.H. Simmonds, and is economically important in Florida, the Caribbean, and many Central and South American countries (Denham, 1988; Fagan, 1979; Sonoda and Pelosi, 1988; Timmer and Zitko, 1995). *Colletotrichum acutatum* infects petals of various citrus cultivars. Symptoms include water soaking and necrosis of petals ranging from small spots to large lesions, abscission of fruitlets, persistent floral disks and calices, and leaf distortion (Denham, 1988; Fagan 1979). It has been proposed that petal infection triggers abscission of the developing fruitlet, but in this paper, we report direct infection of the stigma and style, which may provide an alternative explanation for the fruit drop characteristic of PFD.

'Temple' orange (tangor, *Citrus reticulata* × *C. sinensis*) trees, in a randomized complete-block design with six trees per treatment, were left nontreated or were inoculated with strain RST of *C. acutatum* originally isolated from PFD petal lesions on citrus in Ft. Pierce, Fla. Trees were inoculated at 50% to 60% of full bloom on 22 Mar. 2000 with either spores at $1 \times 10^6/\text{mL}$ or mycelia at $10 \text{ g}\cdot\text{L}^{-1}$ in sterile water. Spore and mycelial inoculum preparations were applied using a commercial orchard sprayer (Mini-Blast Rear's MFG. Co., Eugene, Ore.) at 4 L/tree. Trees were initially examined for symptom development 4 d after inoculation.

Stigma and style necrosis, on 23.9% to 48.6% of flowers, and lesions on petals were observed on the flowers of trees that were inoculated with *C. acutatum* strain RST, but not on nontreated trees. The first symptoms on the stigma and style were small peach brown to dark brown necrotic spots. Necrosis was progressive, and the entire stigma and distal zone of the style eventually became dark brown and water-soaked (Fig. 1 A and B).

Two hundred flowers, displaying stigma and style necrosis, from trees inoculated with RST, and 50 flowers from nontreated control

trees, were collected for re-isolation of the pathogen. Forty flowers with stigma and style necrosis remaining on the RST-inoculated trees were tagged for further observation of symptom development. Using Snider and Raper's (1958) Complete Medium, re-isolation rates for *C. acutatum* from necrotic stigmas and styles were 56.7%, but no *C. acutatum* was isolated from flowers of nontreated control trees.

Persistent floral disks and calices that are characteristic of PFD are retained for many months after fruitlet abscission. They resemble a green button mounted on a petiole and are thus known as buttons (Fig. 1C). Fewer than 3% of the flowers on the RST-inoculated trees produced PFD buttons and numbers of fruit exceeded that of buttons by at least 5-fold from physiological drop through harvest. However, of the flowers tagged with stigma and style necrosis at bloom, 78% displayed PFD buttons (Fig. 1C) at 3 months after inoculation. None of the tagged flowers produced fruit. A survey was conducted to determine the extent of persistent buttons in RST-inoculated and nontreated trees. Foliage within five $40 \times 40\text{-cm}$ sample areas (frames) were assessed on each tree. Trees inoculated with RST mycelia averaged 1.83 buttons/frame, trees inoculated with RST spores averaged 5.02 buttons/frame, while nontreated trees had only 0.5 buttons/frame. Buttons on nontreated trees may have resulted from natural *C. acutatum* infection or inoculum from sprays that drifted during application.

These results suggest a relationship between stigma and style necrosis, failure to set fruit, and the presence of characteristic PFD buttons on the *C. acutatum* inoculated trees. It appears that stigma and style necrosis is symptomatic of postbloom fruit drop disease of citrus, at least on 'Temple' orange artificially inoculated with RST. To our knowledge, this is the first report that stigma and style necrosis is associated with PFD of citrus, although other researchers have sometimes observed this symptom (Timmer, personal communication), and a published photograph of PFD petal lesions also shows stigma and style necrosis (Browning et al., 1995). It is possible that stigma and style infection may actually be more important in preventing citrus fruit set than the commonly reported petal lesions. Indeed, there are unpublished reports of PFD button development on flowers that dis-

Fig. 1. Photographs of 'Temple' orange inoculated with *Colletotrichum acutatum*: (A) stigma and style necrosis observed on the tree at bloom; (B) range of water-soaking and tissue browning demonstrating progressive stigma and style necrosis; and (C) persistent floral disks and calices (buttons) characteristic of postbloom fruit drop, on flowers tagged with stigma and style necrosis.

played no evidence of petal lesions (Timmer, personal communication). More work is needed to determine whether overt stigma and style necrosis is a frequent but transient symptom of PFD in all susceptible citrus varieties, is present but only at microscopic levels in natural infections with lower inoculum rates, or is an occasional symptom under unusual conditions.

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