"Web Application and Smartphone-Supported Disease Management in Strawberry Fields"

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Botrytis cinerea, the causal agents of gray mold disease, is one of the most important plant-pathogenic fungus affecting strawberry. During the last decade, control of the disease in the southeastern United States has largely been dependent on the use of thiram, captan and at-risk fungicides with single-site modes of action; despite that *B. cinerea* is considered a high-risk pathogen for resistance development. Strawberry growers from North and South Carolina reported the appearance of gray mold, in spite of applications of fungicides, especially during highly favorable conditions, enhancing concerns about the presence of fungicide-resistant isolates of *B. cinerea* in the region. For this reason, 216 *B. cinerea* isolates were collected from strawberry fields in the Carolinas and determined *in vitro* fungicide sensitivity to seven different classes of fungicides, currently used for gray mold control in the Southeastern United States during 2011. About 60% of all isolates were resistant to boscalid, pyraclostrobin and thiophanate-methyl and more than 40% and 15% were resistant to cyprodinil and fenhexamid, respectively. None of the isolates were resistant to fludioxonil and iprodione. Isolates were resistant to one, two, three, four and up to five different classes of fungicides (Fig.1).

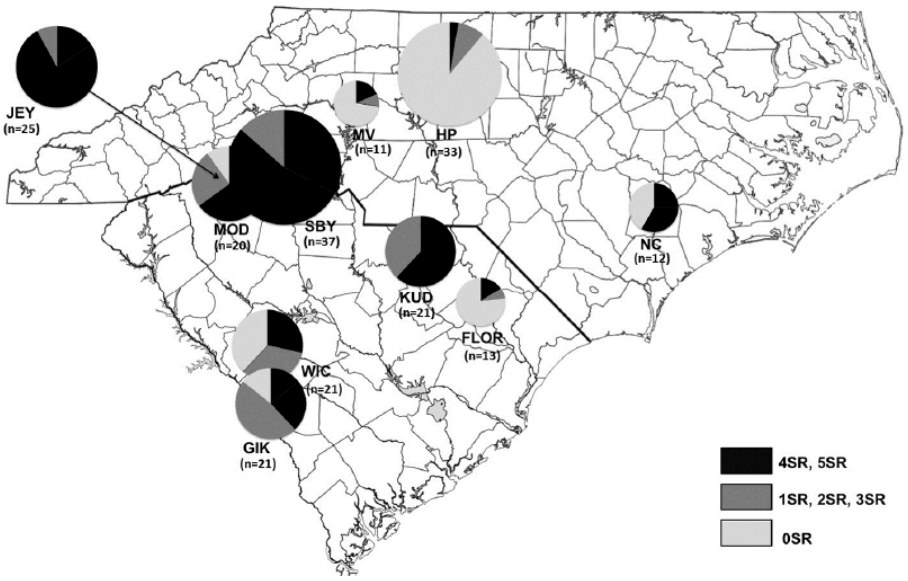

Fig. 1. Occurrence and prevalence of single resistance (SR) in *Botrytis cinerea* isolates in North and South Carolina strawberry fields. The circle diameter corresponds to the number of isolates tested in each location, which is also indicated in parenthesis (Source: Li et al., 2014).

A regional resistance-monitoring program was implemented to help growers determine location-specific resistance profiles. The assay was developed at first for brown rot of peach (Schnabel et al., 2012) and then for gray mold of strawberry (Fernández-Ortuño et al., 2014), which detects resistance regardless of the mechanism fast and reliably based on mycelium growth on fungicide-amended artificial growth media using a single discriminatory concentration (Fig. 2). Although we may not be able to determine the mechanism of resistance, this screening technique will provide information of practical relevance.

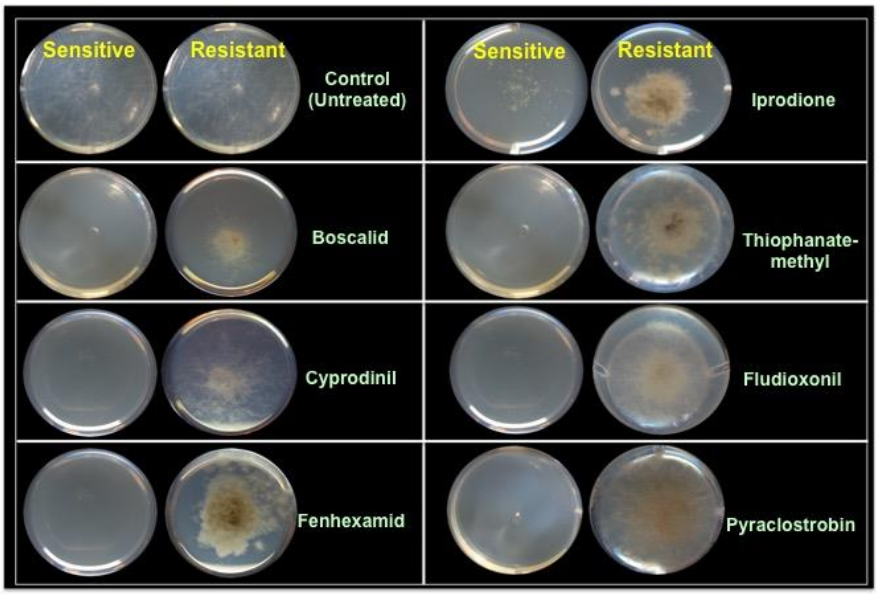

Fig. 2. *Botrytis cinerea* isolates sensitive (lack of growth on the fungicide-amended medium) or resistant to boscalid, cyprodinil, fenhexamid, iprodione, thiophanate-methyl, fludioxonil, and pyraclostrobin at one discriminatory concentration.

The monitoring program was originally used to serve South Carolina and Georgia growers, but the service soon became so popular among specialists and growers that, in 2014, growers from 10 states, including Maryland, Pennsylvania, Virginia, West Virginia, North Carolina, South Carolina, Florida, Georgia, Arkansas, and Connecticut used the service. In addition, a web application was developed to accelerate communication transfer and ensure a quick turnaround of results. The service provides precise information that has not been available before, enables producers to adjust spray

programs before fungicide resistance causes crop loss, and reduces the risk for continued selection of resistant populations. The implementation of this program saved peach producers an estimated $7 to 10 million in 2009 and 2013, and it is estimated that strawberry growers using this service prevent yield loss of about 10% on average every year due to improved gray mold control. A poll among users indicated that, besides improved disease management, growers benefited also from the educational component of the program.

On the other hand, Professor Schnabel developed a smartphone application, named MyIPM. This application provides Integrated Disease Management (IPM) information for conventional and organic production of strawberries and peaches in the Southeastern United States (Fig. 3).

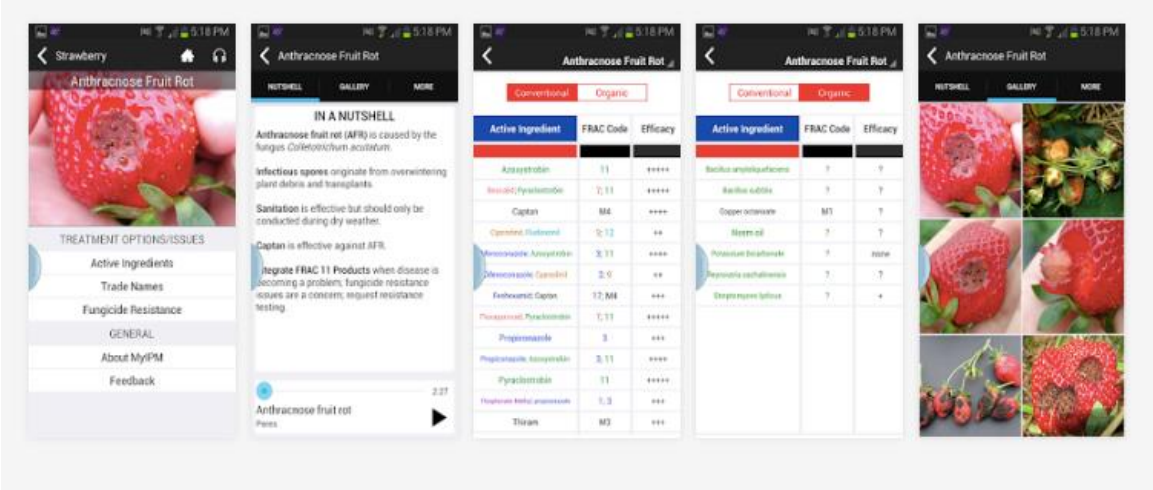

Fig. 3. Strawberry and peach Integrated Pest Management app (MyIPM) provides IPM information for strawberries and peaches. MyIPM is available in Google Play for Android phones and in the Apple Store for iPhone devices.

For strawberries the app features several diseases such as Angular Leaf Spot, Anthracnose Crown Rot, Anthracnose Fruit Rot, Botrytis Crown Rot, Charcoal Rot, Gray Mold, Leaf Blight/Spots/Scorch, Leather Rot, Phytophthora Crown Rot, Powdery Mildew, Red Stele, and Verticillium Wilt. For peaches the app features Alternaria Fruit Rot, Anthracnose Fruit Rot, Armillaria Fruit Rot, Bacterial Spot, Blossom Blight, Brown Rot, Constriction Canker, Gummosis, Leaf Curl, Peach Scab, Peach Tree Short Life, Rhizopus/Gilbertella Rot, and Rusty Spot. Disease-specific information can be obtained

by tapping on the disease picture of the main page. In addition, the user can find information about the disease and its causal organism (including disease cycle and symptoms and signs), chemical control information, fungicide resistance information, and non-chemical control information (including biological control options, cultural control options, and resistant varieties).

References:

1. Fernández-Ortuño D, Grabke A, Bryson PK, Amiri A, Li X, Peres N, Schnabel G (2014) Fungicide resistance profiles in *Botrytis cinerea* from strawberry fields of seven southern U.S. States. Plant Dis 98:825–833

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3. Schnabel G, Amiri A, Brannen PM (2012) Field kit- and internet-supported fungicide resistance monitoring. In: Thind TS (ed) Fungicide Resistance in Crop Protection: Risk and Management. CAB International, Oxfordshire, pp 116–132