

Continued Efforts for Rapid Diagnosis and Monitoring of Fungicide Resistance of Major and Emerging Strawberry Pathogens

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Summary

During the 2022-23 season, we processed 245 strawberry samples, mostly showing crown, root, and leaf spot symptoms. Regrettably, populations resistant to at least one fungicide groups were detected in *Botrytis cinerea*, *Phytophthora* spp., and *Colletotrichum acutatum*. Altogether these results are crucial for practical management recommendations.

Methods

Objective 1. To provide rapid and accurate diagnosis for strawberry diseases and monitor emerging pathogen populations in strawberry fruit production.

Implementing a rapid diagnostic assay for the most common strawberry diseases in the plant diagnostic clinic has been achieved through the gracious in-kind donation of a Light Cycler 480 system by the FSREF. This diagnostic procedure has been incorporated into our standard protocols for handling strawberry samples, particularly those with crown rot and leaf spot symptoms. However, it is essential to emphasize that apart from the adoption of the molecular assays, all samples still undergo culturing to validate the results and to identify any additional organisms that may be potentially involved but not encompassed by the rapid molecular assay.

Objective 2. To continue monitoring the resistance of *Botrytis cinerea*, *Colletotrichum acutatum*, and *Phytophthora* isolates to commonly used fungicides.

A total of 117 pure colonies of *Botrytis cinerea* was isolated from symptomatic fruit tissue collected from

various strawberry commercial sites. These isolates were subjected to testing using the conidial germination method to assess their sensitivity to the SDHI fungicides fludioxonil (Switch®), isofetamid (Kenja), and pydiflumetofen (Miravis® Prime). Sensitivity levels were categorized as sensitive (S), moderately resistant (MR), or highly resistant (HR), which were determined based on the number of germinated conidia and the elongation of their germ tubes. Furthermore, *Colletotrichum acutatum* and *Phytophthora cactorum* isolates from samples received at the diagnostic clinic were challenged with azoxystrobin and mefenoxam, respectively, using mycelial growth assays.

Results

Objective 1

In the 2022-2023 strawberry season, the plant diagnostic clinic received 245 samples. Among these, 96 had root and crown rot infections, 91 exhibited leaf spot symptoms, and 7 showed fruit rot symptoms (see Appendix). Utilizing our HRM (High-Resolution Melting) assay, we provided growers with preliminary diagnostic results within 24 to 48 hours receiving the samples. Final reports were generated after validating the results through standard culture procedures. This rapid diagnostic approach significantly enhanced decision-making, enabling the timely implementation of effective disease management practices.

Objective 2

In the 2022-23 season, only 6% of the strawberry samples (n = 15) received by the diagnostic clinic at GCREC were positive for *C. acutatum*. Unfortunately, 10 of 10 isolates recovered from these samples were resistant to the strobilurin fungicides (FRAC group 11), such as Abound, Cabrio, etc. Samples diagnosed as *Phytophthora* crown rot (PhCR) represented 16% (n = 40) of the samples received in the diagnostic clinic. Among 35 *P. cactorum* isolates, 5 were resistant to mefenoxam/metalaxyl (Ridomil). Fungicide resistance screening of 117 isolates of *B. cinerea* revealed that 66%, 15%, and 3% of the isolates were at least moderately resistant to fludioxonil (Switch®), isofetamid (Kenja), and pydiflumetofen (Miravis® Prime), respectively (Figure 1).

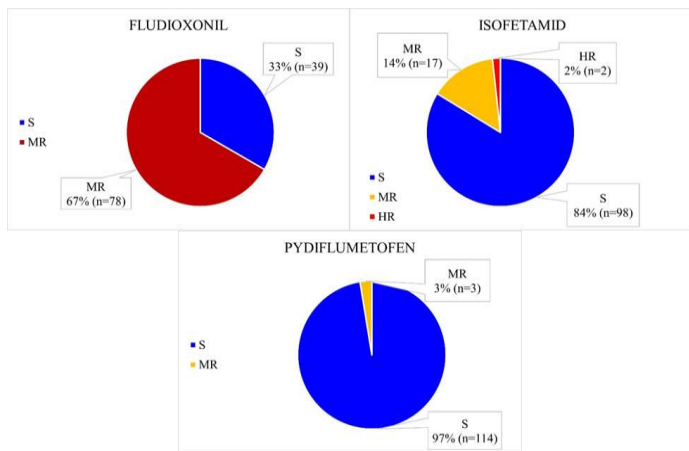


Figure 1. Sensitivity profile of *Botrytis cinerea* isolates (n=117) to fludioxonil (Switch®) isofetamid (Kenja), and pydiflumetofen (Miravis® Prime) during the 2022-2023 strawberry season in Florida. S=Sensitive; MR=Moderately Resistant; HR=Highly Resistant.

Takeaways

Based on our findings, it is still recommended the use of Switch®, Miravis®, and Kenja® for *Botrytis* fruit rot when weather conditions are highly favorable for disease development, especially during peak bloom as advised in the Strawberry Advisory System (SAS, <http://www.agroclimate.org/tools/sas/dashboard/disease>). It is important to remember that both Switch® and Miravis® contain fludioxonil and no more than 4 applications of fludioxonil should be made in a single season. Therefore, no more than 4 applications of

Switch and Miravis combined should be applied. Moreover, the Miravis® label only permits a maximum of two applications per season. Pydiflumetofen, the other active ingredient in Miravis®, belongs to the Group 7 fungicide class, similar to Kenja®, Luna®, Fontelis®, and Merivon®, no more than 4 applications of Group 7 fungicides should be used collectively within a season. In practice that means two applications of Miravis, two applications of Switch, and two applications of Kenja would be reasonable per season. To mitigate the increase of resistant strains, multi-site fungicides like thiram and captan are recommended during moderate or low disease pressure periods. For diseases caused by *Colletotrichum* spp. (anthracnose fruit rot and crown rot), preventive captan applications are recommended since resistance to Abound® and other QoI (quinone outside inhibitor) fungicides has limited their efficacy. Lastly, for the control of *Phytophthora*, Ridomil® applications continue to be recommended. However, in the event of a control failure, it is advisable to submit samples for resistance testing. Orondis Gold® has recently been registered as a good alternative for early season applications.

Disclaimer

The use of trade names in this publication is solely for the purpose of providing specific information. UF/IFAS does not guarantee or warranty the products named, and reference to them in this publication does not signify our approval to the exclusion of other products of suitable composition.

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APPENDIX

REPORT ON STRAWBERRY SAMPLES PROCESSED IN THE DIAGNOSTIC LABORATORY (GCREC)

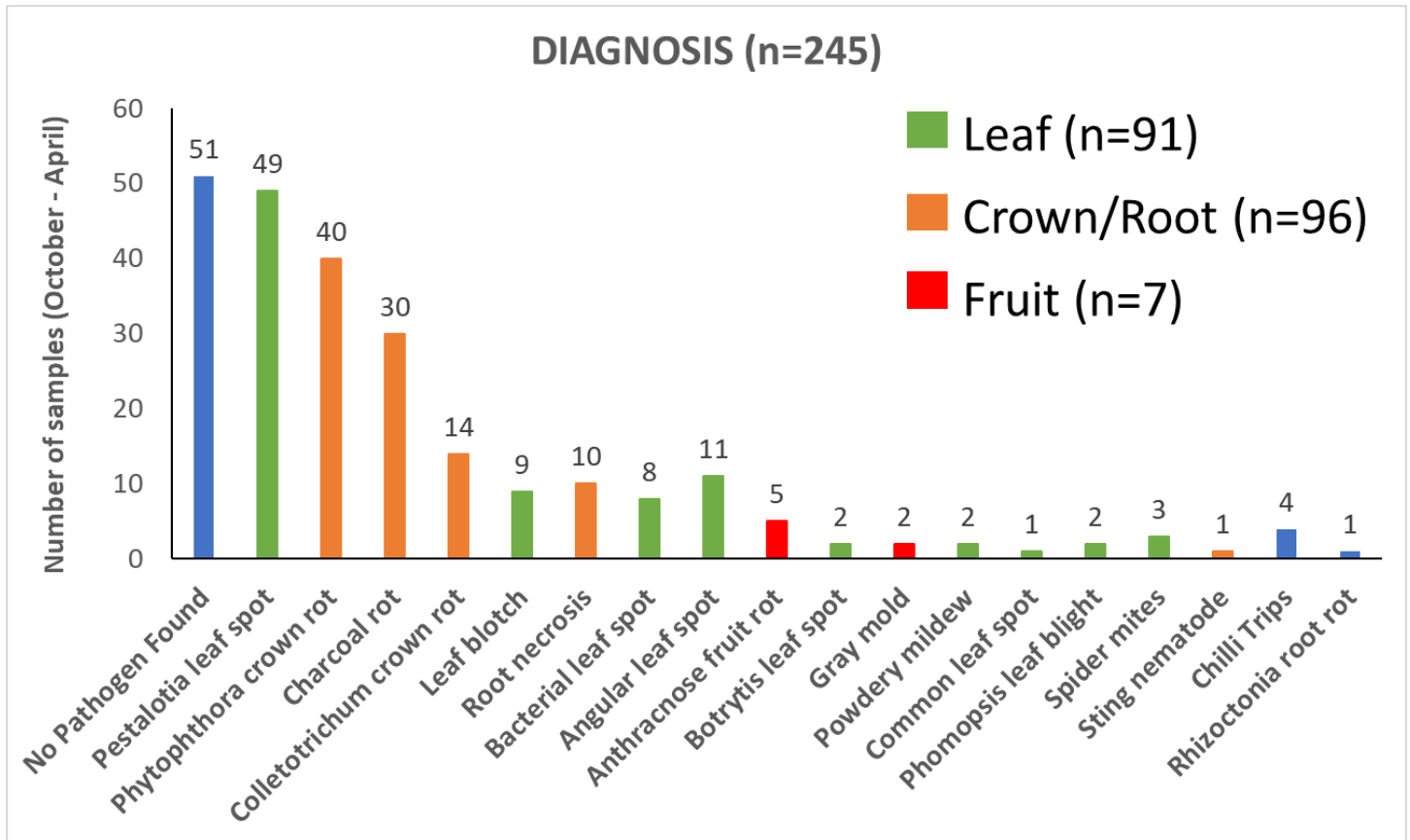


Figure 1. Overview of strawberry samples processed in the diagnostic laboratory at GCREC during the 2022-23 season by diagnosis.