

Rapid diagnosis and fungicide resistance monitoring of major and emerging strawberry diseases

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Summary

In total, 289 strawberry samples were processed during the 2021-22 season, of which 117 exhibited crown and root symptoms and 94 leaf spot symptoms. Populations resistant to at least one fungicide group were found for *Botrytis cinerea*, *Phytophthora* spp., and *Colletotrichum acutatum*.

Methods

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

With the in-kind donation of a Light Cycler 480 system by the FSREF, a rapid diagnostic assay for the most common strawberry diseases has been implemented in the plant diagnostic clinic and became part of our standard diagnostic procedures for strawberry samples, particularly with crown rot and leaf spot symptoms. Nevertheless, all samples are still cultured to confirm results from the molecular assays and to identify any other organisms that could potentially be involved but not included in the rapid molecular assay.

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

In total, 156 pure colonies of *Botrytis cinerea* were recovered from symptomatic fruit tissue from five different strawberry commercial sites. All isolates were tested using the conidial germination method against the SDHI fungicides isofetamid, fluopyram, and pydiflumetofen (Kenja[®], Luna[®] Tranquility, Miravis[®] Prime) and fludioxonil (Switch[®]). Sensitivity was evaluated based on the number of conidia

germinated and their germ tube elongation and categorized as sensitive (S), moderately resistant (MR), or highly resistant (HR). *Colletotrichum acutatum* and *Phytophthora cactorum* isolates were recovered from samples received in the diagnostic clinic and challenged against azoxystrobin and mefenoxam, respectively, using the mycelial growth assays.

Results

Objective 1

During the 2021-2022 strawberry season, the plant diagnostic clinic received and processed 289 samples. Of the total, 117 samples showed root and crown rot infections, whereas 94 samples exhibited leaf spot symptoms (Appendix, Table 1). With the aid of HRM assay, preliminary diagnostic results were provided to growers within 24 to 48 h upon receipt of samples, followed by final reports validated by standard culture procedures in the clinic. Rapid diagnosis can largely improve the decision-making for the timely deployment of effective disease management practices.

Objective 2

In the 2021-22 season, only 2% of the strawberry samples (n = 6) received by the diagnostic clinic at GCREC were positive for *C. acutatum*. Among which, ten out of twelve 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 20% (n = 59) of the samples received in the diagnostic clinic (n = 289). Among the 59 PhCR samples, only one was resistant to

mefenoxam/metalaxyl. During this season, 156 isolates of *Botrytis cinerea* were recovered from symptomatic fruit. For isofetamid, 67 isolates were considered sensitive (43%), 82 isolates were moderately resistant (53%), and 7 isolates were highly resistant (4%). Compared to the previous season, while the percentage of HR isolates remained the same, the number of MR isolates increased by 38%. Regarding the sensitivity level for fluopyram, it followed the trend from last year with 97% of isolates categorized as HR. Pydiflumetofen had 85% of isolates categorized as S, whereas 13% were MR and 2% were HR to this fungicide. There was an increase of 30% in MR isolates to Fludioxonil compared to the previous season. In total, 69% were considered MR, 31% S and none of the isolates was considered HR. Of the total number of isolates, only two isolates were sensitive to all tested products (Figure 1).

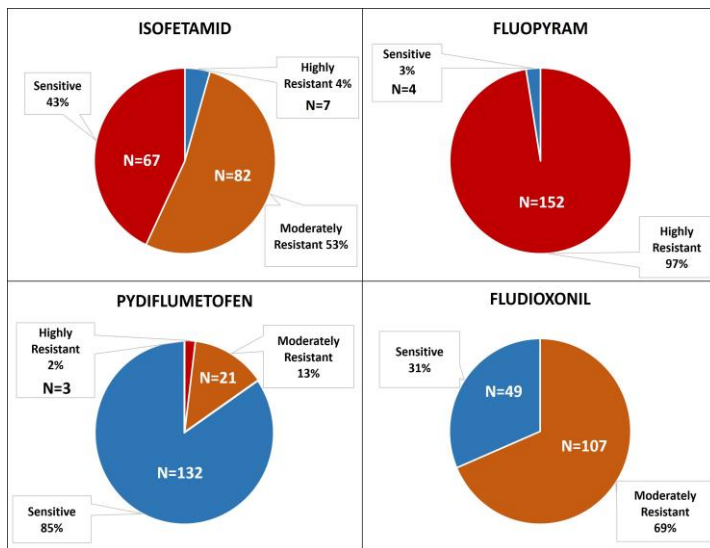


Figure 1. Sensitivity profile of *Botrytis cinerea* isolates to isofetamid (Kenja®), fluopyram (Luna® Tranquility), pydiflumetofen (Miravis® Prime), and fludioxonil (Switch®) during the 2021-2022 strawberry season in Florida. S=Sensitive; MR=Moderately Resistant; HR=Highly Resistant.

Summary and recommendations

Based on our results, it is recommended that Switch®, Miravis®, and Kenja® to be saved for Botrytis fruit rot for periods when weather conditions are highly favorable, particularly during peak bloom. It is important to note that both Switch® and Miravis® contain fludioxonil, and no more than 4 applications of fludioxonil should be made in one season. In addition, the Miravis® label is limited to two applications per season. Pydiflumetofen, the other ingredient of Miravis® is in the Group 7 fungicide class, the same as Kenja®, Luna®, Fontelis®, and Merivon® and no more than 4 applications of Group 7 fungicides altogether should be used in a season. To minimize resistance, multi-site fungicides such as thiram and captan should be used during periods of moderate or low disease pressure. For the diseases caused by *Colletotrichum* spp. (anthracnose fruit rot and crown rot), preventive captan applications are recommended since resistance to Abound® and other QoI fungicides could limit their efficacy. Finally, Ridomil® applications are still recommended for control of *Phytophthora*, but samples should be submitted for resistance testing if a failed control has been observed.

Disclaimer

The use of trade names in this publication is solely for the purpose of providing specific information. UF/IFAS does not guarantee or warrant 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 1

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

Table 1. An overview of the strawberry samples processed during the 2021-22 season by disease and pathogen diagnosed.

Disease	Pathogen	Number of samples
Leaf spot		
	<i>Botrytis cinerea</i>	8
	<i>Diplocarpon earliana</i>	7
	<i>Gnomonia sp.</i>	26
	<i>Mycosphaerella fragariae</i>	1
	<i>Phomopsis sp.</i>	4
	<i>Podosphaera apahanis</i>	2
	<i>Xanthomonas fragariae</i>	11
	<i>Neopestalotiopsis sp.</i>	32
	<i>Colletotrichum acutatum</i>	1
	<i>Pseudomonas sp.</i>	1
	<i>Alternaria sp.</i>	1
Crown rot		
	<i>Colletotrichum gloeosporioides</i>	35
	<i>Macrophomina phaseolina</i>	9
	<i>Pytophythium helicoides</i>	1
	<i>Phytophthora spp.</i>	59
	<i>Neopestalotiopsis sp.</i>	8
	<i>Colletotrichum acutatum</i>	5
Fruit rot		
	<i>Botrytis cinerea</i>	1
Nematodes		
	Sting nematode	1
Insects		
	Mites	3
	Thrips	2
No pathogen found		
	NPF	87
Total number of samples		289