Ohio Vegetable & Small Fruit Research & Development Program

Final Report

2021

Project Title: Vegetable and Fruit Disease Diagnosis

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Why was this project funded? This diagnostics project is primarily a service to commercial vegetable and fruit growers in Ohio. We request funding each year to help support OSU Vegetable and Fruit Pathology Laboratory efforts to assist growers in diagnosing crop diseases, particularly in the case of unusual or difficult-to-diagnose cases and diseases that have explosive potential and require early detection on a regional scale.

Project outline. For the first part of 2021, we continued to use a digital first approach to diagnostics. We requested that clients send digital images first and if we were unable to diagnose the problem, we arranged for a contactless sample drop-off. For the second part of the year, starting from July 2021, we were able to allow in person sample drop-off. We then utilized a range of traditional and modern, state-of-the-art diagnostic methods. These included light microscopy to identify fungal and oomycete (*Phytophthora*, *Pythium*, downy mildew) pathogens based on morphology, culturing followed by microscopic or other identification, biochemical and plant tests for bacterial identification, serological assays, mainly for virus and bacterial identification, specific polymerase chain reaction (PCR and quantitative PCR) assays and next generation genomic sequencing. When a sample was received digitally, by courier, US mail, or in person, it was immediately catalogued and given a unique number. After initial evaluation, the submitter was contacted within 24 hours by phone or email and provided with a preliminary diagnosis and management recommendations. In many cases this was also the final diagnosis. If culturing or other labor intensive tests were required, final results may not have been available for several days to one week.

Take-home messages. This year the vegetable and fruit diagnostic programs were again impacted by restrictions due to the Covid-19 pandemic. However, the second part of the year ran more smoothly and was similar to previous years in regard to the number of samples processed. Commercial growers rely, and have relied, on this service for more than 15 years. Information from the lab was shared with the growers directly and through our blogs and Tweets: VeggieDisease.News blog (u.osu.edu/miller.769), the VegNet Newsletter (vegnet.osu.edu), Twitter (@OhioVeggieDoc and @OHFruitPathology), Ohio Fruit News (OFN; https://u.osu.edu/fruitpathology/fruit-news-2/), the fruit pathology Facebook page (@fruitpathology), the Ohio Grape IPM Facebook page (@ohiograpeipm), and directly to county Extension educators. The sources (grower name, address) of the diagnostic samples are never revealed to the public. Grower communication in 2021 was predominantly through phone calls, email, video calls and by sharing pictures representative of the problem on social media platforms, websites and in newsletters. This year we were able to attend a few crop walks, in-person field days and on-farm visits when COVID-19 mitigation protocols were followed. However, most trainings and communications were carried out remotely (zoom meetings and webinars). One new fungal disease on strawberry was reported in the state - Neopestalotiopsis disease, and Pythium root rot of pawpaw was also observed and confirmation of the disease is in progress.

Impacts. In 2021, we diagnosed 318 samples versus the 285 diagnosed in 2020. Even with the higher sample volume in the second half of the year, there was still an overall reduction in sample volume (23%) versus pre-pandemic years.

The estimated cost of providing the basic service to growers, considering labor and supplies, is $60 per physical sample. This does not include the cost of advanced diagnostics necessary in some cases or overhead costs. We estimate that the cost of diagnosing electronic samples is $20/sample. In 2021 we diagnosed 283 physical and 32 electronic fruit and vegetable samples. Therefore, the value of this service in 2021 to Ohio fruit and vegetable growers is at least $17,620. ***This represents a 3.7:1 return on grower's investment in this project.***

Sample Type	**Commodity**		**Estimated Value ($)**
	Vegetable	**Fruit**	
Physical	241	44	$17,100
Electronic	20	13	$660
Total	**261**	**57**	**$17,760**

What was discovered?

The 2021 growing season was characterized by heavy rains and high humidity. These conditions favored the spread of bacterial diseases on several crops (cole crops, peppers, and tomatoes). Average max temperature between the 1st of June and the 1st of July was 72°F, while the min average temperature was 62°F. These cool temperatures, together with the rain, favored the spread of Pseudomonas leaf spot on several crops (collards, kale, parsley, and peppers) for a total of 10 samples diagnosed in month of June.

For both tomatoes and peppers the other most frequently diagnosed bacterial disease was bacterial spot (caused by *Xanthomonas* spp.). Bacterial canker was only diagnosed once in Coshocton County. Fusarium wilt continued to be a problem in both peppers (N=2) and tomatoes (N=10). Tomato spotted wilt virus (TSWV; Tospovirus) was diagnosed in tomato (N=4). As for the past seasons, we did not diagnose any cases of Tomato brown rugose fruit virus (ToBRFV; Tobamovirus). This virus is mechanically transmitted and is causing severe damage to greenhouse tomato global production worldwide (Europe, Turkey, Jordan, Mexico, and China), and the movement of tomato and pepper seeds, fruits and transplants is strictly regulated by APHIS to prevent the spread of this viral disease.

For vine crops, we pinpointed the first appearance of downy mildew in cucumbers, melons, pumpkins and squash in 12 counties in the state. All first reports were submitted to the multistate cucurbit downy mildew forecasting site (Cucurbit ipmPIPE; http://cdm.ipmpipe.org/). This year we were able to establish and monitor more sentinel plots than usual across multiple counties thanks to a Citizen Science project in collaboration with Master Gardner volunteers. Downy mildew was also reported on basil in Wayne County. This year downy mildew in cucurbits appeared in early July. Downy mildew (N=12), Phytophthora fruit rot (N=6) and Plectosporium blight (N=5) were the most frequently reported diseases among cucurbits.

Damage caused by herbicide drift was reported on tomatoes, peppers, cabbages, and broccoli. Cole crops were mainly affected by bacterial diseases caused by *Xanthomonas* (bacterial leaf spot) and *Pseudomonas* (peppery spot)

The major disease diagnosed on leafy greens grown in hydroponic facilities was Pythium root rot (N= 22). The predominant species identified was *P. dissotocum*. Most of these facilities rely on organic management options, and a prompt diagnosis becomes a key-point to effectively control this disease.

Neopestalotiopsis disease of strawberry, caused by *Neopestalotiopsis spp*. was identified for the first time in Ohio. The diagnostic sample was submitted to the OSU Diagnostic laboratory by an OSU educator in Washington County. *Neopestalotiopsis* on strawberry has been reported in Canada, in several US states (Florida, Georgia, and

North Carolina), in Argentina, Ecuador and in two European Country (Spain and Italy). The disease appears to be destructive, and many strawberry cultivars are susceptible according to the study carried out in Florida (https://edis.ifas.ufl.edu/publication/PP357). Growers, crop consultant and Educators should be on the lookout for symptoms of Neopestalotiopsis disease beginning in early spring and throughout the entire season, including post-harvest.

One pawpaw orchard in Athens County was affected by blue stain, which can be caused by soilborne pathogens or abiotic factors. The analyses of the diagnostic samples identified two different *Pythium* species (*P. aphanidermatum* and *P. attrantheridium*) associated with the symptomatic tissue.

The most frequently diagnosed disease for strawberry grown hydroponically was Fusarium root and crown rot. Botrytis grey mold was recently diagnosed on strawberry produced hydroponically in Butler county (not included in tables in this report).

A. Vegetable Diagnostics Final Report

A total of 241 samples (221 physical and 20 electronic) were diagnosed in 2021. Most of the samples were submitted by or on behalf of commercial vegetable producers in Ohio (**Figure 1**).

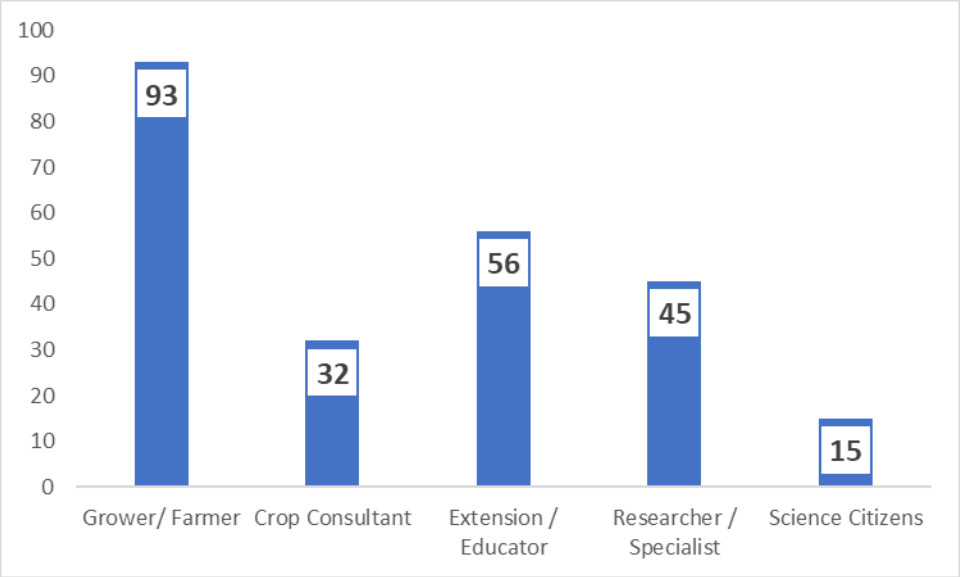

Figure 1. Sources of samples submitted to the OSU Vegetable Pathology Laboratory during 2021.

Vegetable samples were received from 41 Ohio counties and four samples came from outside the State of Ohio (Kentucky and Colorado) (**Figure 2**). The number of counties for this year was

higher when compared to the number recorded in 2020 and 2019 (42 and 35 counties, respectively). A higher number of samples were submitted by hydroponic facilities, 22 vs 12 of the previous year. The Citizen Science project also contributed to the increment of the sample and the counties covered for the reporting of downy mildew. The highest number of samples were submitted from Huron County, Wayne County, Hamilton County, and Sandusky County (48, 31, 24, and 21, respectively), many in collaboration with the Muck Crops Agricultural Research Station in Willard, Wayne OSU Extension IPM Scouting program, and the North Central Agricultural Research Station in Fremont.

Figure 2. Number of vegetable samples received for diagnosis by the OSU Vegetable Pathology Laboratory, by Ohio county.

Most of the samples received were solanaceous crops (tomatoes, peppers, and eggplant) followed by cucurbits (cucumbers, melons, watermelon, zucchini, squash and pumpkins) (**Figure 3**). Among the solanaceous crops tomatoes were the most frequently received (**Table 1),** followed by peppers (**Table 2**), while among the cucurbitaceous crops, cucumbers were predominant (**Table 3**). The remaining samples included legumes and leafy greens, while the "other" category included beets, rhubarb, tomatillo, and weeds (honeysuckle weed, and pig weed). We also tested plugs and recirculation water for the presence of oomycete propagules.

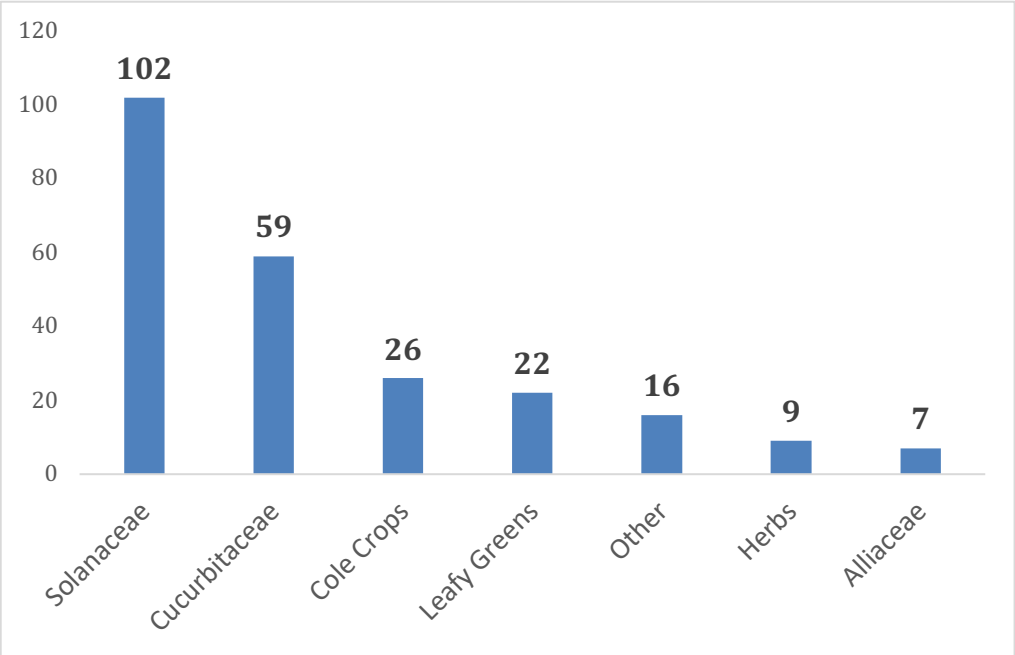

Figure 3. Number of vegetable samples received for diagnosis by the OSU Vegetable Pathology Laboratory in 2021.

Table 1. Major diseases and abiotic disorders diagnosed on tomato samples in 2021. We received a total of 56 tomato samples. These samples were from fields (N=45), greenhouses (N=3), and high tunnels (N=8). Some samples had more than one disease

Diagnosis	Number of Samples	Counties
Bacterial spot	12	Lake, Putnam, Sandusky, Seneca, Wayne
Bacterial speck	1	Hardin
Bacterial canker	1	Coshocton
Septoria leaf blight	1	Wayne
Leaf mold	1	Adams
Early blight	1	Lake
Anthracnose	1	Columbiana
Corky root rot	2	Adams, Jefferson
Pythium root rot	1	Franklin
Fusarium wilt	10	Adams, Columbiana, Hamilton, Holmes, Sandusky
RKN	2	Adams, Jefferson
Insect damage	2	Pickaway, Holmes
INSV	1	Wayne
TSWV	4	Erie
TMV	1	Hardin
Herbicide	4	Pickaway, Licking
Other abiotic stresses	10	Holmes, Hamilton, Holmes, Sandusky, Wayne

Table 2. Diseases and abiotic disorders diagnosed on pepper samples (N=37) in 2021

Diagnosis*	Number of Samples	Counties
Pseudomonas Leaf Spot	3	Hardin, Wayne
Bacterial Leaf Spot	18	Hardin, Huron, Seneca, Wayne
Bacterial Canker	1	Wayne
Anthracnose	3	Columbiana
Fusarium Wilt	1	Columbiana
Broad Mites	1	Butler
Herbicide	10	Huron
Other Abiotic Stresses	2	Huron, Sandusky

*Some samples had more than one disease.

Table 3. Diseases and abiotic disorders diagnosed on cucurbit samples (N=56) in 2021.

Diagnosis	Number of Samples	Counties
Angular Leaf Spot	2	Huron, Wayne
Bacterial Leaf Spot	3	Franklin, Huron, Wayne
Alternaria Leaf Spot	3	Lake, Hardin, Wayne
Anthracnose	5	Columbiana, Hardin, Huron,
Gummy Stem Blight	1	Medina
Fusarium Fruit Rot	1	Franklin
Powdery Mildew	3	Hardin, Sandusky, Wayne
Plectosporium blight	4	Hardin, Huron, Tuscarawas, Wayne
Downy Mildew	12	Belmont, Champaign, Coshocton, Fulton, Geauga, Jefferson, Hardin, Huron, Muskingum, Sandusky, Seneca, Wayne
Phytophthora Fruit Rot	6	Geauga, Huron, Montgomery, Wayne
Squash Mosaic Virus	1	Jackson
Potyviruses	1	Huron, Wayne
Insect damage	5	Holmes, Wayne
Abiotic Stresses	9	Adams, Franklin, Ross

B. Fruit Diagnostics Final Report

Fifty-seven fruit samples (44 physical and 13 electronic) were received for diagnosis We received 30 fruit tree samples (including grape), 22 small fruit samples and five hop samples (Figure 4). Samples were received from 18 counties in Ohio (Figure 5). The majority of the samples analyzed were affected by fungal diseases (55%). Abiotic injuries (mostly chemical damage and nutrient deficiency) represented the 26% of the diagnosis, the remaining samples were: 7% insect related injuries, 5% bacterial disease, and 7% had injuries or symptoms that could not be identified (Table 4 and Table 5).

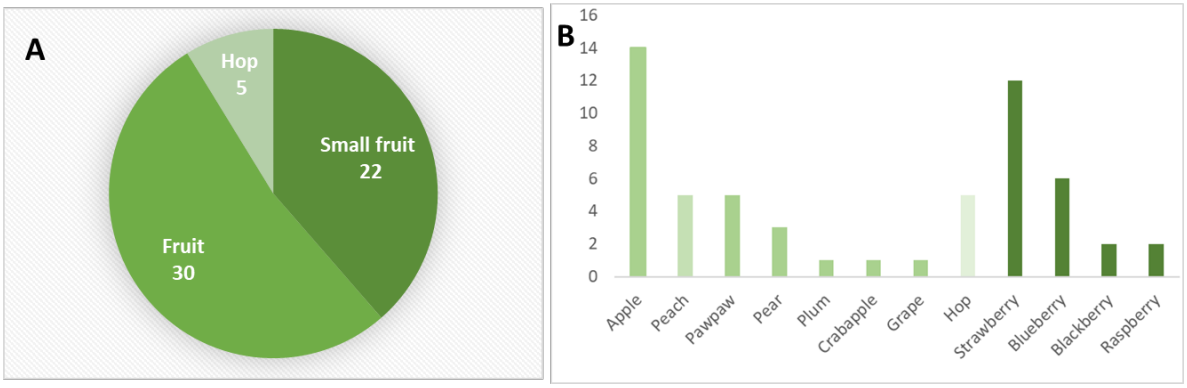

Figure 4. Number of samples for disease diagnoses processed by The Ohio State University, CFAES-Wooster, Fruit Pathology Program in 2021: A) by commodity, B) by individual crop.

Figure 5. Number of fruit samples received for diagnosis by the OSU Fruit Pathology Laboratory, by Ohio county

Table 4. Diseases, abiotic disorders, and insect pests diagnosed on fruit and hop samples submitted to the Fruit Pathology Program in 2021

op (No. samples)	Diagnosis	Number of Samples	County
ple (14)	Crown gall, Sooty blotch and Flyspeck	2	Unknown
	Apple rust, Glomerella leaf spot, Sooty blotch	1	Licking
	Bitter rot, Pythium root rot	2	Columbiana
	Elsinoe leaf spot	1	Portage
	Fire blight	1	Holmes
	Suspected root pathogen	3	Greene
	Spray damage	1	Tuscarawas
	Undetermined	1	Greene
	Suspected *Agrobacterium vitis* (non-detected)	1	Wayne
	Undetermined	1	Lucas
abapple (1)	Apple scab	1	Licking
wpaw (5)	Blue stains, undetermined fruit rot	5	Athens
ach (5)	Undetermined-suspected Coryneum blight	2	Unknown
	Peach scab	1	Mahoning
	Powdery mildew	1	Greene
	Abiotic - wet feet/ possible bacterial spot	1	Montgomery
ar (3)	Undetermined	1	Unknown
	Cicadas damage	1	Hardin
	Plum curculio	1	Unknown
um (1)	Black knot	1	Wayne
ape (1)	Downy mildew	1	Adams
ps (5)	Diaporthe blight, Abiotic-nutritional	3	Athens
	Spider mites, Undetermined-sample in poor conditions	2	Shelby
TAL (35)		**35**	

Table 5. Diseases, abiotic disorders, and insect pests diagnosed on small fruit samples (not including grape) submitted to the Fruit Pathology Program in 2021

op (No. samples)	Diagnosis	Number of Samples	County
awberry (12)	Anthracnose, Colletotrichum crown rot	1	Warren
	Anthracnose	1	Wayne
	Black root rot	1	Columbiana
	Black root rot complex, Neopestalotiopsis disease	1	Washington
	Fusarium root and crown rot	2	Hamilton
	Fusarium root and crown rot	1	Lucas

op (No. samples)	Diagnosis	Number of Samples	County
	Fusarium wilt and crown rot, Pythium root rot	2	Hamilton
	Abiotic- Nutrient deficiency	1	Hardin
	Abiotic - Sunscald	1	Tuscarawas
	Undetermined – sample in poor conditions	1	Holmes
ackberry (2)	Abiotic - Glyphosate damage	1	Holmes
	Abiotic - Chemical injury	1	Wayne
ueberry (6)	Nutrient deficiency, Phomopsis, Cane Anthracnose	5	Medina
	Abiotic - Chemical injury	1	Wayne
spberry (2)	Abiotic - Chemical injury	1	Holmes
	Suspected downy mildew (non-detected)	1	Jefferson
TAL (22)		**22**	