PURDUE UNIVERSITY
Extension

PLANT AND PEST DIAGNOSTIC LABORATORY

Tom Creswell, PhD, Lab Director

Gail Ruhl, MS, Senior Plant Disease Diagnostician

John Bonkowski, PhD, Plant Disease Diagnostician

2019
Plant & Pest Diagnostic Lab Annual Summary

PURDUE UNIVERSITY Extension

PLANT AND PEST DIAGNOSTIC LABORATORY

2019 Summary Report

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Introduction

The Plant and Pest Diagnostic Laboratory (PPDL) is dedicated to helping protect Indiana's crops and the green industry by providing rapid and reliable diagnostic services for plant disease and pest problems. We also provide unbiased pest management strategies, diagnostics training and we participate in the National Plant Diagnostic Network (NPDN), a consortium of Land Grant University diagnostic laboratories established to help protect our nation's plant biosecurity infrastructure.


Sudden Death Soybean
Photo Credit: K. Wise

Regulatory/State Collaboration

The PPDL serves as the state laboratory charged with assuring accuracy in disease diagnosis for phytosanitary certification for exports, administered by the Indiana Dept. of Natural Resources (IDNR). The PPDL provides insect identification and disease diagnosis for nursery inspection samples submitted by IDNR nursery inspectors. PPDL diagnosticians collaborate with the IDNR to carry out official state surveys (see below under diagnostic highlights and surveys). The PPDL serves as the lab of record for the Indiana Crop Improvement Association (ICIA) and provides hands-on disease identification phytosanitary training to field inspectors annually. The Office of the Indiana State Chemist (OISC) also relies on the PPDL as a source of unbiased diagnostic expertise. During their official investigations, OISC inspectors submit samples to the PPDL for diagnosis of potential damage from herbicides, disease and insects as a part of their official SOP.


Begonia Powdery Mildew
Photo Credit: PPDL

Extension Specialist Collaboration

The PPDL benefits greatly from the diagnostic expertise provided by specialists in other departments (Table 1). As in past years, faculty and staff from the Departments of Botany & Plant Pathology, Agronomy, Entomology, Horticulture & Landscape Architecture, and Forestry & Natural Resources very generously assisted with providing problem diagnoses involving their specialties. The PPDL team provides an ongoing point of connection between county-based Extension educators, the public and Extension specialists on campus; facilitating knowledge exchange and information about trends in lab samples to promote more informed recommendations for disease and pest management.


Calico Scale
Photo Credit: C. Sadof

Diagnostic Highlights and Surveys

Personnel Changes:

Gail Ruhl, Senior Plant Disease Diagnostician at Purdue University, retired from her position after 40 years of service. Her last day in her full-time capacity was April 28, 2019. Gail was founding director and sole

diagnostician of Purdue's "Plant Disease and Weed Identification Clinic" prior to its evolution into the integrated Plant Pest and Diagnostic Laboratory that it is today. Gail has a continuing affiliation with the PPDL as a visiting scholar extending into 2020.

John Bonkowski was hired to fill the vacancy after Gail's retirement as a Plant Disease Diagnostician. Originally from Delaware, John completed his Bachelor of Science in Plant Science at the University of Delaware before moving to Florida to pursue a doctoral degree in the Doctor of Plant Medicine Program at the University of Florida. While at UF, he worked as an assistant diagnostician at the UF Plant Diagnostic Center. After graduating, John accepted a position at the Missouri Department of Agriculture as a Plant Health Specialist, where he worked primarily as a plant problem diagnostician at the Missouri Dept. of Agriculture Plant Pathology Lab, but also performed inspections in nurseries and agronomic fields for phytosanitary certification and to assist other inspectors in their yearly nursery inspections. John began working at the PPDL on May 15, 2019.

Table 1. Departmental faculty and staff that assisted with sample diagnoses - 2019 [1]

Faculty/Staff	Number of Samples	Faculty/Staff	Number of Samples
Agronomy	**27**	**Entomology**	**233**
Keith Johnson	17	**Cliff Sadof**	108
Jim Camberato	5	**Tim Gibb**	103
Bob Nielson	5	John Obermeyer	10
		Larry Bledsoe	10
Botany & Plant Pathology	**3176**	Other	2
Tom Creswell	1663 [2,3]	**Horticulture & Landscape Architecture**	**41**
John Bonkowski	1030 [4,5]		
Marcel Zimmer	218	**Rosie Lerner**	17
Bill Johnson	119	**Kyle Daniel**	12
Gail Ruhl	99	Aaron Patton	7
Darcy Telenko	15	Bruce Bordelon	4
Julie Young	11	Other	1
Janna Beckerman	8		
Other	8	**Non-Purdue Specialist**	**113**
Forestry & Natural Resources	**3**	MSU Diagnostic Lab	109 [6]
		Seed Lab	1
Lindsey Purcell	3	Other	3

[1] Names in **BOLD** are Department Diagnostic Liaisons.
[2] 385 diagnoses were provided for *Phytophthora ramorum* nursery survey samples.
[3] 5 diagnoses were provided for Phytosanitary field survey samples.
[4] 12 diagnoses were provided for *Phytophthora ramorum* nursery survey samples.
[5] 96 diagnoses were provided for Phytosanitary field survey samples.
[6] 109 PCR diagnoses provided by MSU diagnostician certified for *P. ramorum* testing

Table 2. Affiliation of persons submitting samples to the PPDL - 2019

Affiliation	Number of samples	% of Total
Commercial	**1064**	**40.2%**
Garden Center/Greenhouse/Nursery	351	13.3%
Landscaper/Groundskeeper/Lawn & Tree Care	189	7.1%
Crop Consultant	159	6.0%
Agribusiness	100	3.8%
Grower/Farmer	81	3.1%
Extension Educator	80	3.0%
Pest Control	46	1.7%
Arborist	34	1.3%
Golf Course	16	0.6%
Other	8	0.3%
Non-Commercial	**610**	**23.1%**
Homeowner	274	10.4%
Researcher/Specialist	228	8.6%
Extension Educator	108	4.1%
Regulatory/Survey	**970**	**36.7%**
IDNR (SOD *P.ramorum* nursery Survey)	393	14.9%
Office of the Indiana State Chemist	274	10.4%
IDNR (Nursery inspection)	207	7.8%
IDNR/ICIA (Phytosanitary certification field inspection)	96	3.6%
Totals:	**2644**	**100%**

Contaminated nursery plants shipped to Indiana:

The PPDL continued our long-term partnership (2004-2019) with IDNR in the annual Cooperative Agriculture Pest Survey (CAPS) to test nursery samples for the presence of *Phytophthora ramorum*, causal agent of Ramorum Blight and Sudden Oak Death. This pathogen, transported on nursery stock, has the potential to infect and kill a wide range of ornamental woody plants, namely oaks. This nursery survey assists in protecting Indiana landscapes, forests and the timber industry.

The total number of anticipated samples had been reduced by 50% from the previous year due to the lack of *P. ramorum* detections since 2012. However, the first *P. ramorum* survey samples tested positive for the pathogen, which led to the first of at least 3 separate nation-wide trace forward events for infected nursery stock in 2019. News releases from the IDNR helped push this information out to the public (https://bit.ly/2ueQXnG and https://bit.ly/2ueQXnG).

Multiple introductions of *P. ramorum* infected nursery stock from different western states were detected in Indiana and other states in the North Central Plant Diagnostic Network region. Infected plants and susceptible plants from these shipments were recalled and destroyed. Supplemental funding beyond those provided for the CAPS survey was needed to complete testing for the trace-forward samples. In 2019, 44 of the 393 samples from the survey tested positive for *P. ramorum* (Table 2), while 2 were inconclusive (as determined by the USDA-APHIS-PPQ-CPHST laboratory in Beltsville, MD).

Boxwood Blight: In December 2018, the PPDL confirmed boxwood blight, caused by the fungus *Calonectria pseudonaviculata*, from a landscape planting for the first time. The source of infection on the newly planted shrub was traced back to an Ohio nursery who had sold infected plants to an Indiana retail outlet. Spores from this one 'Typhoid Mary' plant subsequently infected neighboring 2 to 8-year-old established boxwoods in this residential landscape. This first detection of boxwood blight in a landscape setting in Indiana is credited to the keen eye of a homeowner who had read about the symptoms of boxwood blight in an IDNR news release printed in a local newspaper. In 2019, IDNR Inspectors collected samples from unhealthy boxwood plants near the original landscape detection and sent them to the lab. The PPDL confirmed the sample as being boxwood blight positive. This confirmed the establishment, spread, and overwintering of boxwood blight in Indiana landscapes.

Figure 1 Boxwood with boxwood blight symptoms, black stems (left) and defoliation (right).

The PPDL addressed the first detection in Indiana of this devastating disease with a new publication on boxwood blight, an article on disease identification published in the Purdue Landscape Report and presentations at Master Gardener and green industry events.

Herbicide Resistance Testing:
In the 4th year of collaboration with our Weed Science Specialists and their lab staff, the PPDL offered molecular identification of weeds and weed seeds resistant to Glyphosate, PPO and ALS herbicides. Eleven samples were submitted for this specialized service, with 100% found to be resistant to one or more of the herbicides tested.

Corn Tar Spot Update:
In 2015, diagnosticians at the PPDL reported the first confirmation in the United States of Tar spot of corn, caused by *Phyllachora maydis*, on a sample submitted to the PPDL from an Indiana corn field. Initially, it was thought that the disease would not be economically significant in the absence of the secondary pathogen (*Monographella maydis*), which was assumed to be needed in order to have yield loss. Since then, it has been determined, through the work of Darcy Telenko and Christian Cruz, that *Phyllachora maydis* alone can cause yield reductions ranging from 20-60 bu./A in individual fields (Telenko 2020).

Unfortunately, there is limited information on the biology of the pathogen(s) that causes tar spot, as well as the epidemiology and management of this disease in North America. In collaboration with research efforts to gain a better understanding of this disease of corn in Indiana, the PPDL diagnosed tar spot on 103 samples submitted from 65 Indiana counties to confirm the distribution of corn tar spot in Indiana (Fig 1.). Diagnostic assistance by the PPDL will contribute to the understanding of the biology and epidemiology of this new disease and provide Indiana farmers with valuable information on how to manage tar spot disease in corn.

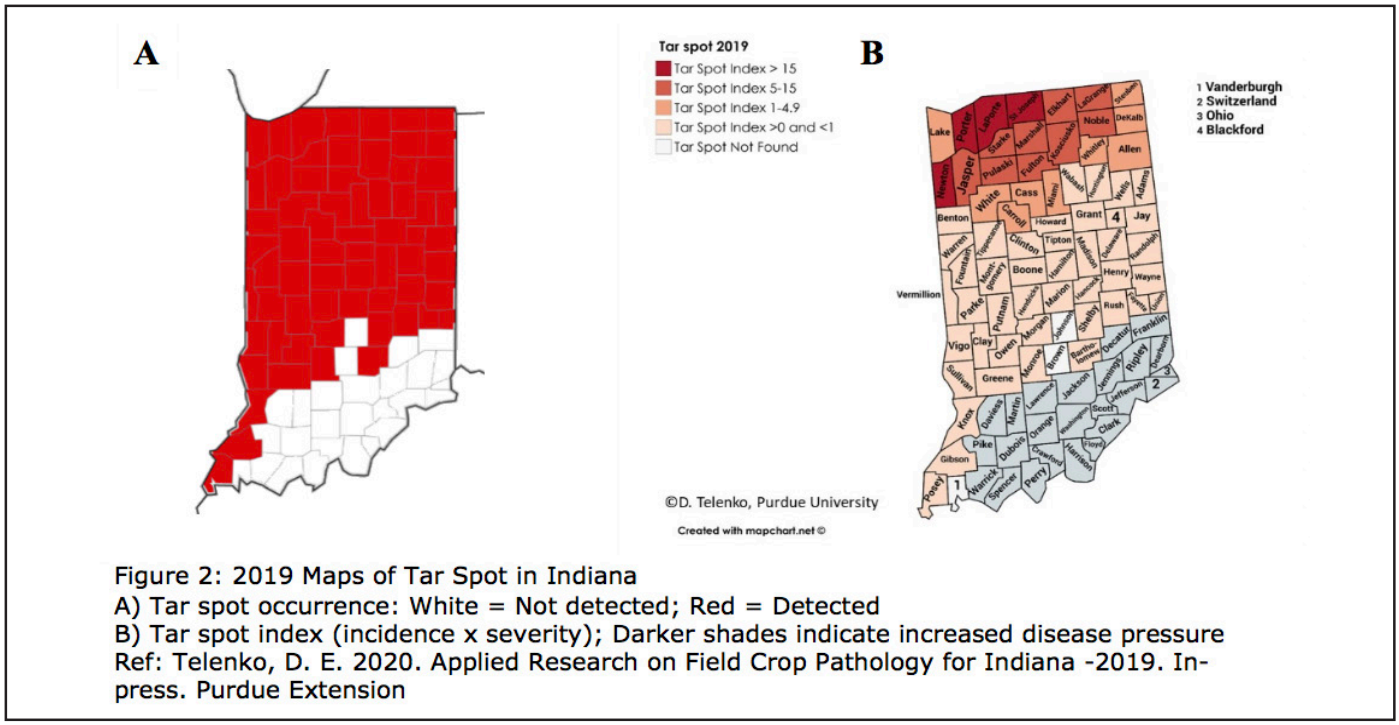


Figure 2: 2019 Maps of Tar Spot in Indiana
A) Tar spot occurrence: White = Not detected; Red = Detected
B) Tar spot index (incidence x severity); Darker shades indicate increased disease pressure
Ref: Telenko, D. E. 2020. Applied Research on Field Crop Pathology for Indiana -2019. In-press. Purdue Extension

Exotic Corn Pathogens Survey:

The PPDL participated for the 7th year (2013-2019) with the IDNR in an IN CAPS survey for Exotic Corn Pathogens. All 279 foliar corn samples received by the PPDL were diagnosed as 'not detected' visually/ microscopically for the presence of three corn diseases with potential for high consequence outbreaks including *Peronosclerospora maydis* (Java Downy Mildew) *P. philippinensis* (Philippine Downy Mildew) and *Sclerophthora rayssiae* (Brown Stripe Downy Mildew). Tar spot, caused by *Phyllachora maydis,* was added to the survery for the first time this year. The PPDL confirmed the presence of tar spot on 103 samples.

Data gathered from IDNR/PPDL CAPS surveys are uploaded to the National Agricultural Pest Information System (NAPIS) database and the NPDN National Data Repository. This effort in documenting reliable diagnostic information helps researchers and regulatory agencies guide future research and monitoring efforts.

Java Downy Mildew
Not found in Indiana
Photo Credit: R. Williams

Philippine Downy Mildew
Not found in Indiana
Photo Credit: B. Kemerait

Brown Stripe Downy Mildew
Not found in Indiana
Photo Credit: C. De Leon

Corn Tar Spot
Found in Indiana
Photo Credit: K. Wise

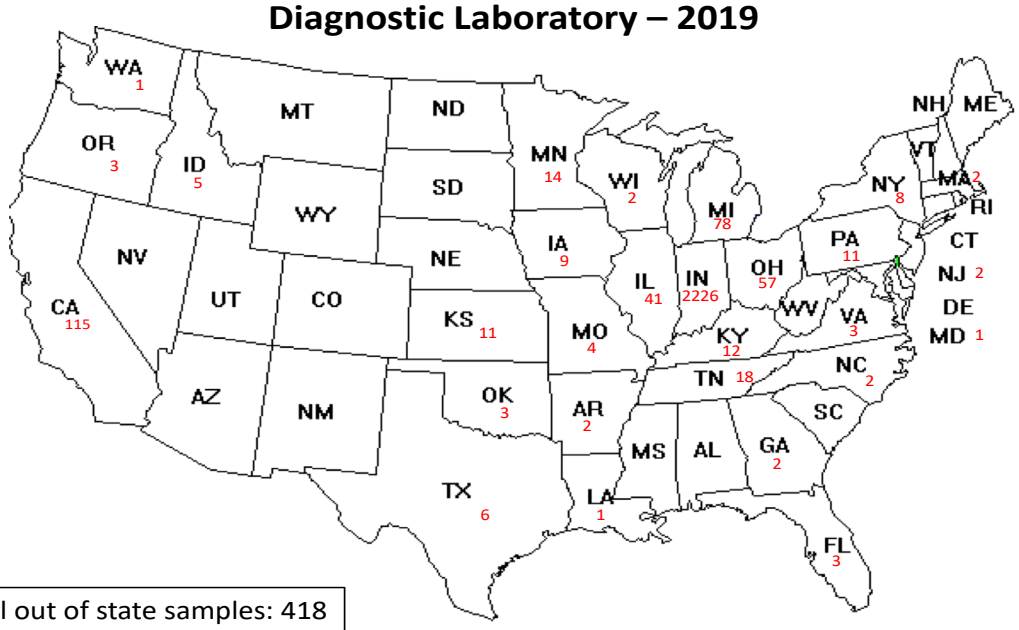
Sample Overview

The Purdue University Plant and Pest Diagnostic Lab provided 4507 diagnoses on 2644 samples submitted in 2019 (Tables 3, 4), with 15.8% of our samples originating from outside Indiana (Fig. 3).

Table 3. Diagnoses Sorted by Category - 2019

Category	Number of Diagnoses	% of Total
Pathogens	**2892**	**64%**
Fungi	2501	55%
Viruses	267	6%
Bacteria	124	3%
Abiotics	**998**	**22%**
Cultural/Environmental	453	10%
Chemical/Herbicide Injury	389	9%
Nutritional	68	2%
Other	88	2%
Arthropods	**357**	**8%**
Insects	266	6%
Mites	70	2%
Nematodes	14	<1%
Other	7	<1%
Plants/Weeds	**104**	**2%**
Other	**156**	**3%**
Totals:	**4507**	**100%**

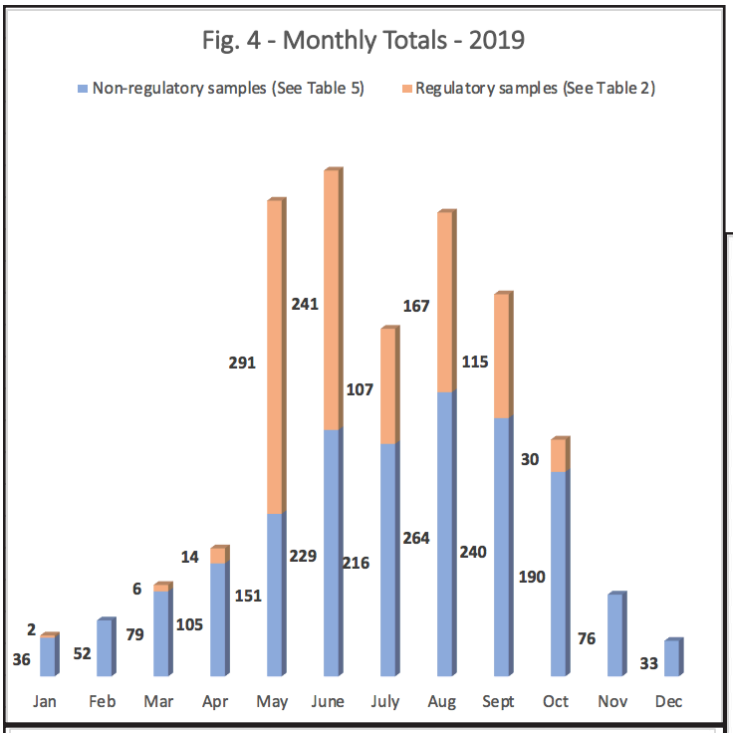
Fig. 3 Origin of samples received by the Plant and Pest Diagnostic Laboratory – 2019

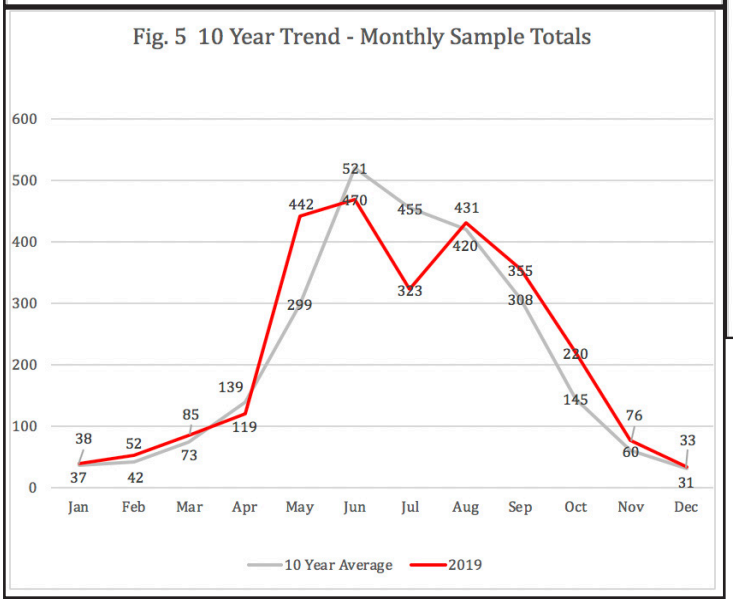


Total out of state samples: 418
(15.8% of total samples)
2 Photo only out of country

Table 4. Regulatory vs. Non-Regulatory Samples - 2019		
Sample Type	**Number of Samples**	**% of Total**
Non-regulatory samples	1674	63%
Regulatory/survey samples	970	37%
Total number of samples	**2644**	**100%**

Sample numbers were lower than the previous two years with 300 fewer non-regulatory samples than 2018, which is thought to be due to the very wet spring leading to wide-spread prevented planting in the agronomic sector Table 4 and Figure 4, 5, 6). IDNR and OISC samples both increased by roughly 70 samples each.





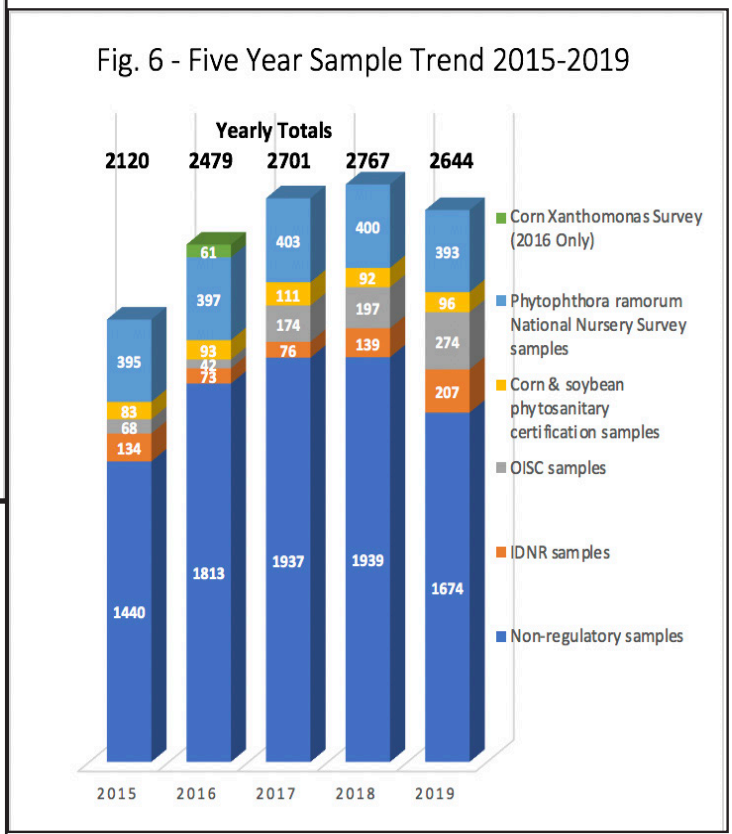
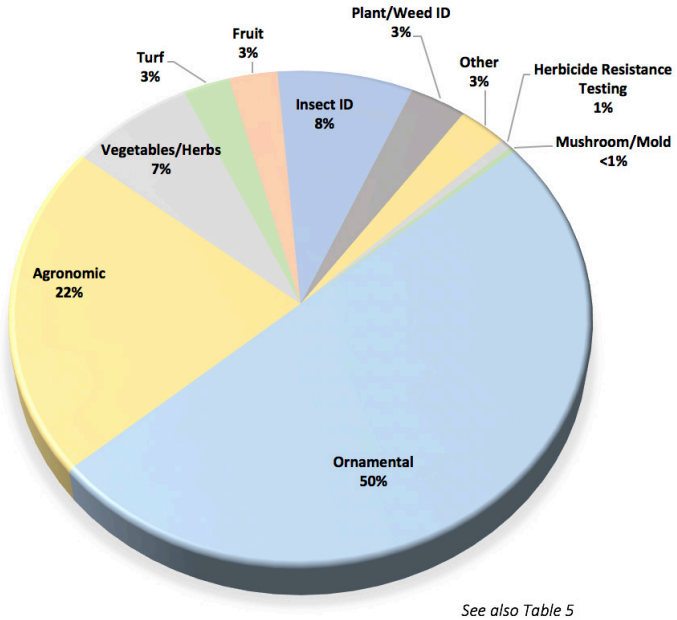


Fig. 7 - Non-Regulatory Sample Categories - 2019



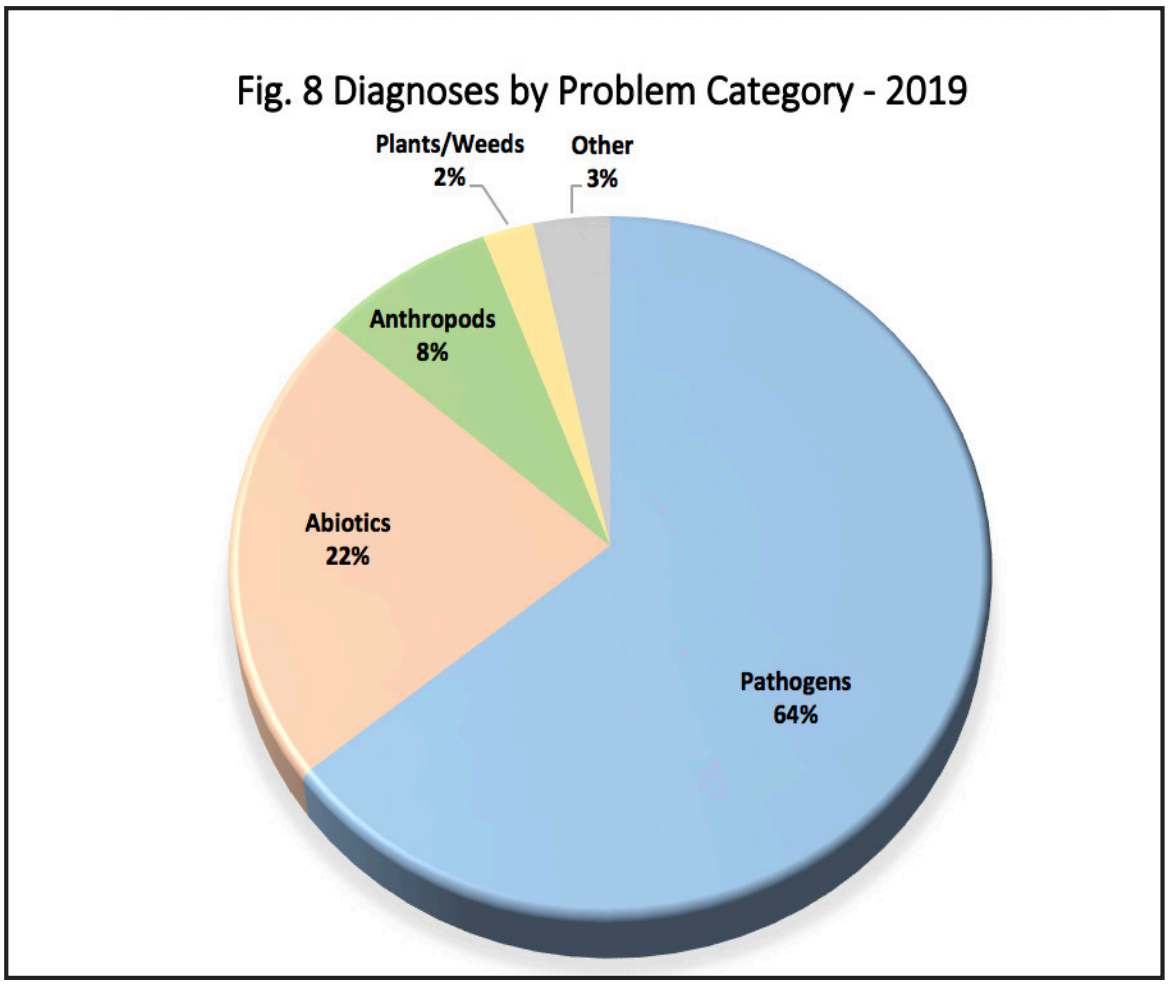
See also Table 5

Ornamental plants are consistently the largest category of non-regulatory samples (50%) highlighting the reliance of Indiana's Green Industry on the expertise provided by the PPDL (Fig. 7). A more detailed list of sample types is given in Table 5.

While diseases comprised 64% of our diagnoses last year, arthropod problems and damage due to non-living (abiotic) factors such as herbicide injury and weather extremes continue to be a significant segment of the problems diagnosed (Fig. 8 and Table 3).

Table 5. Non-regulatory Samples by Category - 2019

Category	# of Samples	% of Total
Agronomic	**362**	**22%**
Corn	230	14%
Soybean	73	4%
Small Grains	22	1%
Other	20	1%
Forage	17	1%
Fruit	**48**	**3%**
Fruit	29	2%
Small Fruit	19	1%
Ornamentals	**839**	**50%**
Woody ornamental -Deciduous	379	23%
Woody ornamental - Evergreen	237	14%
Perennials	135	8%
Annuals	71	4%
Other	17	1%
Turf	**46**	**3%**
Vegetables/Herbs	**124**	**7%**
Tomato	32	2%
Cucumber	27	2%
Herbs	24	1%
Lettuce	10	1%
Other	31	2%
Miscellaneous	**255**	**15%**
Insect ID	134	8%
Plant/Weed ID	56	3%
Herbicide Resistance Testing	11	1%
(Waterhemp, Palmer Amaranth, Giant Ragweed)		
Other (Multiple Host, Aquatics)	48	3%
Mushroom/Mold	6	<1%
Total Samples:	**1674**	**100%**



The PPDL continues to strive to live up to our reputation of highest quality of service coupled with rapid turn-around time, processing 51% of all samples in 3 days or less. Samples requiring in-depth laboratory analysis naturally take longer to complete and thus preliminary reports are provided to update clients on sample progress.

Extension and Teaching Activities

The PPDL annually provides a two-hour hands-on phytosanitary corn and soybean disease diagnostics workshop to train Indiana Crop Improvement Association (ICIA) field inspectors. This year the talk was provided by Dr. Darcy Telenko with John Bonkowski assisting. In Indiana, ICIA field inspectors and the PPDL assist the IDNR by providing the IDNR with disease diagnoses of crops being grown for export so that they may issue appropriate Phytosanitary export certificates. Dissemination of pertinent diagnostic information by the PPDL promotes high standards of plant inspection work.

The PPDL provides 'first detector' educational programs to Indiana stakeholders with the realization that awareness is key to safeguarding our landscapes from the spread of invasive pathogens and pests.

PPDL staff members participate annually in numerous educational events and programs. In 2019 these events included Indiana Green Expo, Small Farm Education and Field Day, Professional Landscape School, Turf and Landscape Field Day, Indiana Arborists Association meeting, Indiana Professional Lawn and Landscape Association Summer field day, Category 1A Pesticide Training, Master Gardener events, webinars and classroom training.

Journal Publications:

Extension Bulletins written or revised in 2019

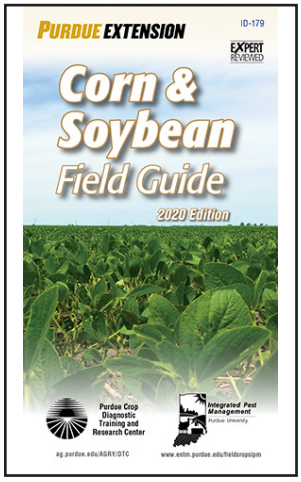
Midwest Vegetable Production Guide for Commercial Growers 2019, ID-56
https://ag.purdue.edu/btny/midwest-vegetable-guide/Pages/default.aspx

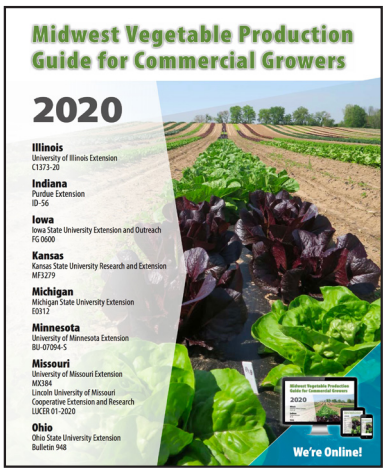
Midwest Fruit Pest Management Guide 2019-20, ID-465
https://ag.purdue.edu/hla/Hort/Documents/ID-465.pdf

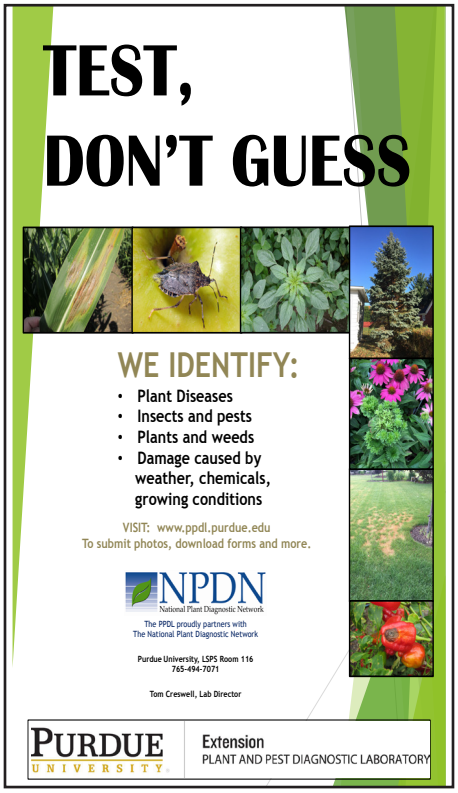
2019 Corn & Soybean Field Guide, ID-179
https://edustore.purdue.edu/item.asp?Item_Number=ID-179

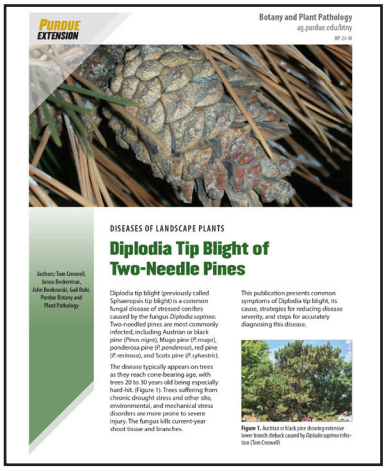
Diplodia Tip Blight of Two-Needle Pines, BP-24-W
https://edustore.purdue.edu/item.asp?Item_Number=BP-24-W

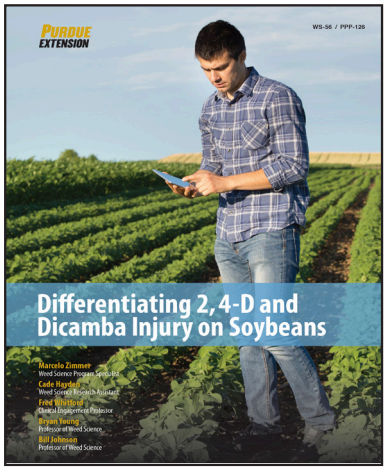
Differentiating 2,4-D and Dicamba Injury on Soybeans, PPP-126
https://ppp.purdue.edu/wp-content/uploads/2019/05/PPP-126.pdf











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