



## 2018 Summary Report

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### Introduction

In 2017, the last year for which data is available, the value of Indiana's crops and green industry, exceeded 7 billion dollars (from USDA-NASS State Agriculture Overview). The Plant and Pest Diagnostic Laboratory (PPDL) is dedicated to helping protect that value 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.

### 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) relies on the PPDL as a source of unbiased diagnostic expertise. As a part of their official investigations, OISC inspectors submit samples to the PPDL for diagnosis of potential damage from herbicides, disease and insects.

### 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.

**Table 1. Departmental faculty and staff that assisted with sample diagnoses - 2018** <sup>[1]</sup>

<b>Faculty/Staff</b>	<b>Number of Samples</b>	<b>Faculty/Staff</b>	<b>Number of Samples</b>
<b>Agronomy</b>	<b>23</b>	<b>Entomology</b>	<b>227</b>
Jim Camberato	10	<b>Tim Gibb</b>	69
<b>Keith Johnson</b>	7	<b>Cliff Sadof</b>	67
Bob Nielson	5	John Obermeyer	55
Shaun Casteel	1	Rick Foster	16
		Larry Bledsoe	12
<b>Botany &amp; Plant Pathology</b>	<b>3176</b>	Doug Richmond	7
		Other	1
<b>Gail Ruhl</b>	1543 <sup>[2,3]</sup>		
<b>Tom Creswell</b>	1314	<b>Horticulture &amp; Landscape Architecture</b>	<b>126</b>
Joe Ikley	252		
Janna Beckerman	24	<b>Kyle Daniel</b>	52
Julie Young	19	Aaron Patton	28
Dan Egel	9	<b>Rosie Lerner</b>	18
Ian Thompson	4	Krishna Nemali	13
Rick Latin	3	Bruce Bordelon	8
Other	8	Other	7
<b>Forestry &amp; Natural Resources</b>	<b>9</b>	<b>Non-Purdue Specialist</b>	<b>49</b>
<b>Lindsey Purcell</b>	4	Jan Byrne, MSU	38 <sup>[4]</sup>
Matt Ginzal	3	Seed Lab	5
Eva Haviarova	2	Other	6

[1] Names in **BOLD** are Department Diagnostic Liaisons.

[2] 400 diagnoses were provided for *Phytophthora ramorum* nursery survey samples.

[3] 92 diagnoses were provided for Corn Phytosanitary field survey samples.

[4] 37 PCR negative diagnoses provided by MSU diagnostician certified for *P. ramorum* testing

## Diagnostic Highlights and Surveys

The PPDL continued our long-term partnership (2004-2018) 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 oaks. This nursery survey assists in protecting Indiana landscapes, forests and the timber industry. All 400 samples from the survey tested negative for *P. ramorum* (Table 2). Table 2 also shows that green industry professionals, an important segment of our clientele, submitted 52.2% of all non-regulatory samples last year, up from 45% in 2017.

<b>Table 2. Affiliation of persons submitting samples to the PPDL - 2018</b>		
<b>Affiliation</b>	<b>Number of samples</b>	<b>% of Total</b>
<b>Commercial</b>	<b>1444</b>	<b>52.2%</b>
Garden Center/Greenhouse/Nursery	467	16.9%
Agribusiness	237	8.6%
Crop Consultant	223	8.1%
Landscaper/Groundskeeper/Lawn & Tree Care	191	6.9%
Grower/Farmer	106	3.8%
Extension Educator	62	2.2%
Golf Course	61	2.2%
Arborist	25	0.9%
Pest Control	11	0.4%
Other	61	2.2%
<b>Non-Commercial</b>	<b>495</b>	<b>17.9%</b>
Homeowner	243	8.8%
Researcher/Specialist	128	4.6%
Extension Educator	124	4.5%
<b>Regulatory/Survey</b>	<b>828</b>	<b>29.9%</b>
IDNR (SOD <i>P. ramorum</i> nursery Survey)	400	14.5%
Office of the Indiana State Chemist	197	7.1%
IDNR/ICIA (Phytosanitary certification field inspection)	139	5.0%
IDNR (Nursery inspection)	92	3.3%
<b>Totals:</b>	<b>2767</b>	<b>100%</b>

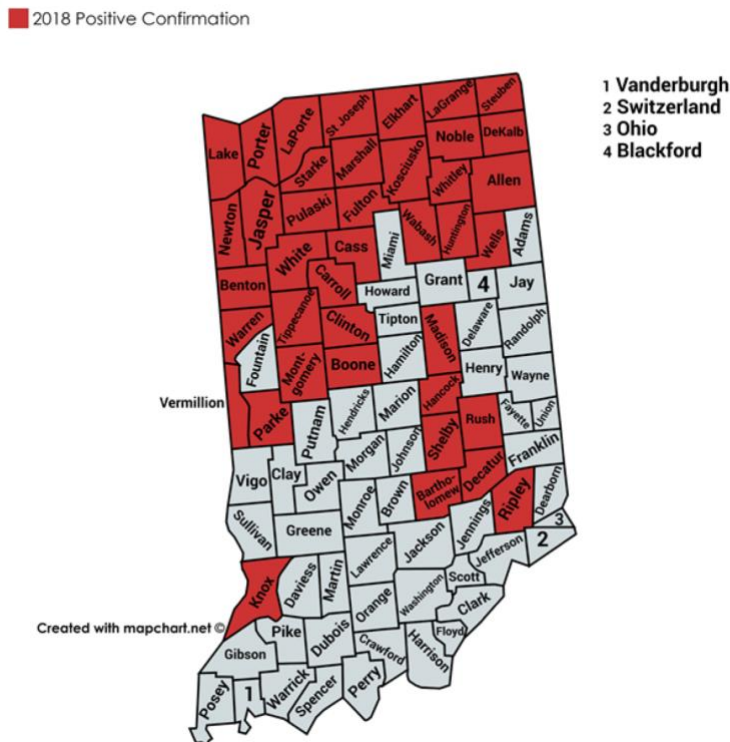
In collaboration with our Weed Science Specialists and their lab staff, the PPDL offered service for the third year for molecular identification of weeds and weed

seeds resistant to Glyphosate, PPO and ALS herbicides. Nineteen samples were submitted, with 50% found to be resistant to one or more of the herbicides tested.

**Corn Tar Spot Update:**

In 2015, we reported that Tar spot of corn, caused by *Phyllachora maydis*, was first confirmed in the United States by PPDL diagnosticians on a sample submitted to the PPDL from an Indiana corn field. Initially, this disease was thought to be of no economic significance in the United States since only the primary pathogen *Phyllachora maydis* was detected and not the secondary pathogen, *Monographella maydis*, which had been noted in Latin American literature to be a necessary component for yield reduction. In 2018, localized epidemics were quite severe in a number of counties in Northern Indiana with just the presence of *Phyllachora maydis* and it is estimated that in some areas yield losses reached 30 bu./A. (Darcy Telenko, personal communication). 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 proactive collaboration with research efforts to gain a better understanding of this disease of corn in Indiana, the PPDL provided diagnoses on 76 samples submitted from 38 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.

**Fig. 1. Tar Spot Distribution**



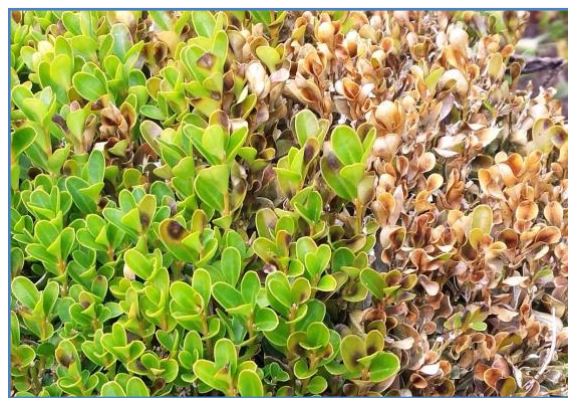
### **Exotic Corn Pathogens Survey:**

The PPDL participated for the 6th year (2013-2018) with the IDNR in an IN CAPS survey for Exotic Corn Pathogens. All 197 corn samples examined by the PPDL were diagnosed as 'not detected' visual/microscopic for the presence of three corn diseases designated with the potential for high consequence outbreaks including *Peronosclerospora maydis* (Java Downy Mildew) *P. philippinensis* (Philippine Downy Mildew) and *Sclerophthora rayssiae* (Brown Stripe Downy Mildew).

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.

### **Boxwood Blight:**

In October 2018, the PPDL confirmed *Calonectria pseudonaviculata*, the fungal causal agent of Boxwood Blight (see photos below), on boxwood plants collected by IDNR nursery inspectors from several stores of a home and garden retail chain. Traceback information confirmed an Oregon nursery as the source of the infected May shipment to 28 stores in Indiana as well as to stores in 11 other states (<https://www.purduelandscapereport.org/article/boxwood-blight-found-in-indiana/>). All boxwood plants in affected stores were removed and destroyed. In December 2018, the PPDL confirmed *Calonectria pseudonaviculata* on a boxwood from a landscape planting. 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. 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. 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 oral presentations.



## **Indiana's First Documented Drywood Termite Infestation** **- by Timothy J. Gibb, Ph.D.**

### *Identification:*

A sample of a termites purportedly infesting and causing damage to a residential structure in Kokomo, IN was submitted to Purdue University, Entomology for identification on May 8<sup>th</sup>, 2018. The sample was confirmed as an infestation of drywood termites (*Cryptotermes sp.*) and became the first verified report of a true 'infestation' of this species of termite in Indiana. Drywood termites have previously been found in Indiana, however, evidence has shown that these arrived on infested furniture or wooden engravings that were brought in but never actually re-infested a structure or other wooden items once here. Entomologists refer to these as 'incidences' rather than an 'infestations.' In this case the infestation went unrecognized for 2 years until the homeowner called in a Professional Pest Management company, samples were taken, sent to our laboratory, and confirmed. The pest management company eradicating them using recommended pesticides and follow-up inspections confirmed that the all colonies in the home were eliminated.

### *Importance:*

When drywood termites infest buildings, they can cause serious structural damage. In the United States, this termite causes damage in excess of \$100 million annually but its distribution is limited to the southern-most states, primarily those surrounding the gulf coast. Until now, general consensus among experts is that drywood termites would not reproduce in Indiana due to the cold. This is evidence to the contrary. Drywood termites differ from Indiana's subterranean termites due to the fact that they need no contact with the soil but rather live independently in sound, dry wood above ground level. The wood they digest provides the all the moisture they need to survive. Consequently, if subterranean termite control techniques are used against drywood termites, they will fail.

### *Prognosis:*

Given that detection of this infestation was delayed there is a possibility that it moved beyond just this one site. The professional pest manager will monitor neighboring homes closely and inspect when possible. What is important is that we now know that this species is capable of infesting structures in Indiana, although is unclear how aggressive it will be in current mid-western climates.

## Sample Overview

The Purdue University Plant and Pest Diagnostic Lab provided 4637 diagnoses on 2766 samples submitted in 2018 (Tables 2, 3, 4), with 13.2% of our samples originating from outside Indiana (Fig. 2).

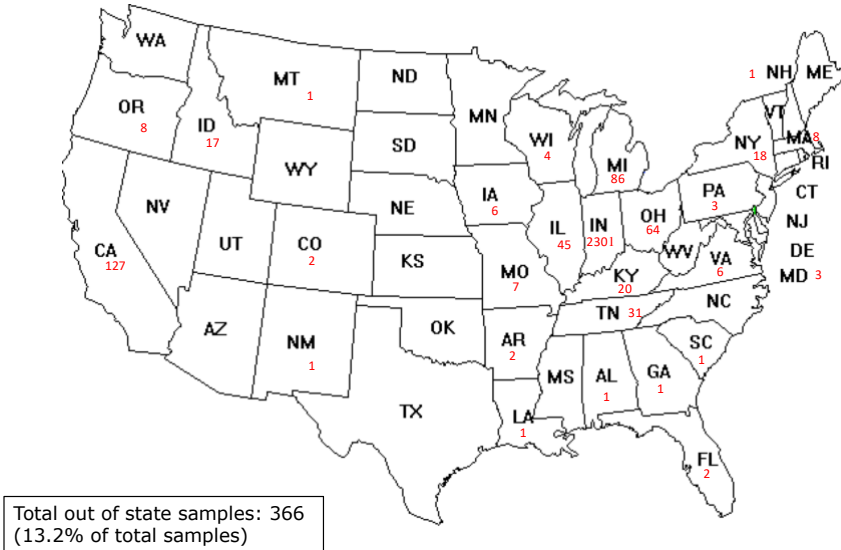
**Table 3. Diagnoses Sorted by Category - 2018**

<b>Category</b>	<b>Number of Diagnoses</b>	<b>% of Total</b>
<b>Pathogens</b>	<b>2888</b>	<b>62%</b>
Fungi	2394	52%
Viruses	345	7%
Bacteria	149	3%
<b>Abiotics</b>	<b>1084</b>	<b>23%</b>
Cultural/Environmental	481	10%
Chemical/Herbicide Injury	382	8%
Nutritional	61	1%
Other	160	3%
<b>Arthropods</b>	<b>394</b>	<b>9%</b>
Insects	293	6%
Mites	76	2%
Nematodes	17	<1%
Other	8	<1%
<b>Plants/Weeds</b>	<b>91</b>	<b>2%</b>
<b>Other</b>	<b>180</b>	<b>4%</b>
<b>Totals:</b>	<b>4637</b>	<b>100%</b>

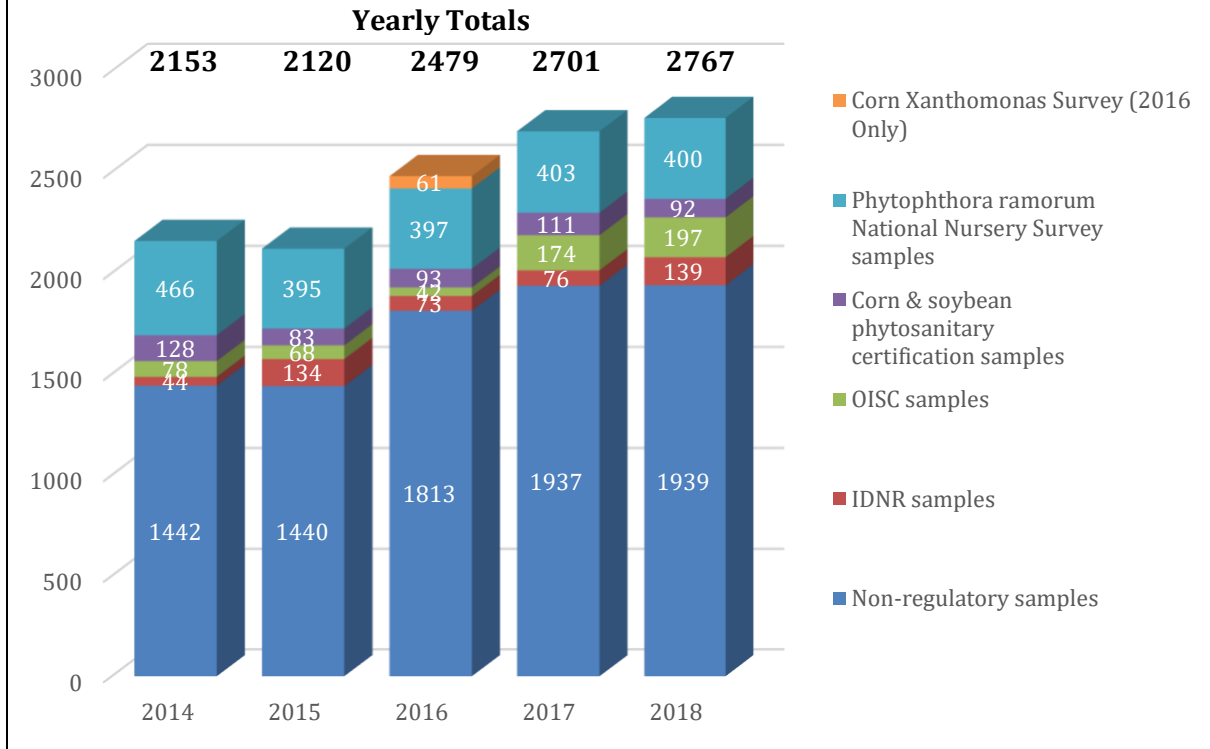
**Table 4. Regulatory vs. Non-Regulatory Samples - 2018**

<b>Sample Type</b>	<b>Number of Samples</b>	<b>% of Total</b>
Non-regulatory samples	1939	70%
Regulatory/survey samples	828	30%
<b>Total number of samples</b>	<b>2767</b>	<b>100%</b>

**Fig. 2 Origin of samples received by the Plant and Pest Diagnostic Laboratory – 2018**



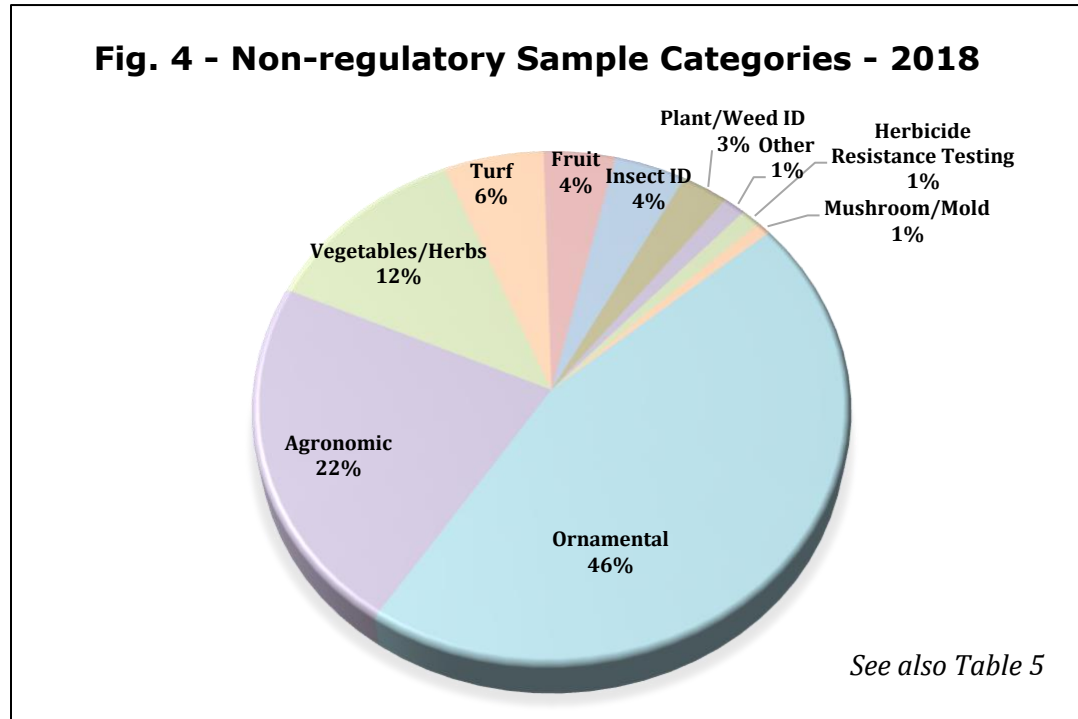
**Fig 3. - Five Year Sample Trend 2014-2018**



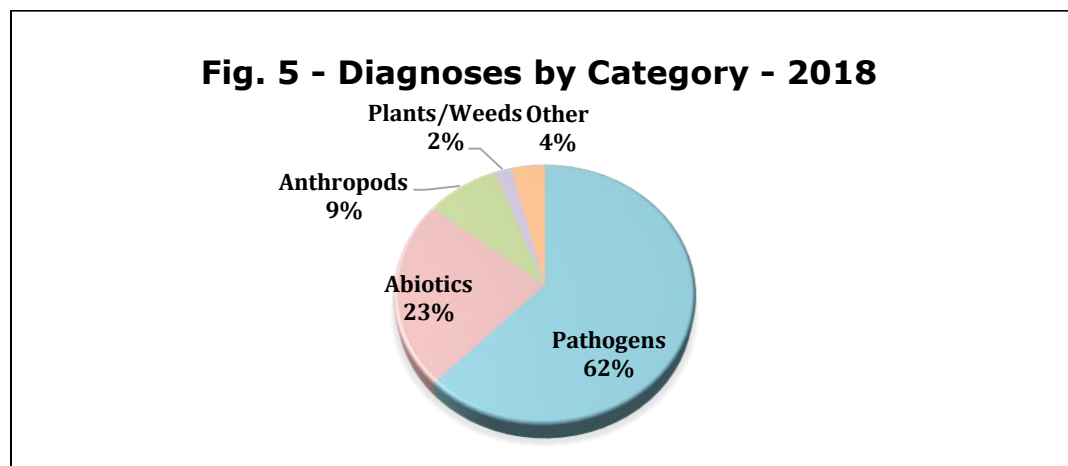
Sample numbers continued an upward trend for the 4<sup>th</sup> consecutive year, with regulatory samples providing most of the increase (Fig. 3).



Ornamental plants are consistently the largest category of non-regulatory samples (46%) highlighting the reliance of Indiana’s Green Industry on the expertise provided by the PPDL (Fig. 4). A more detailed list of sample types is given in Table 5.

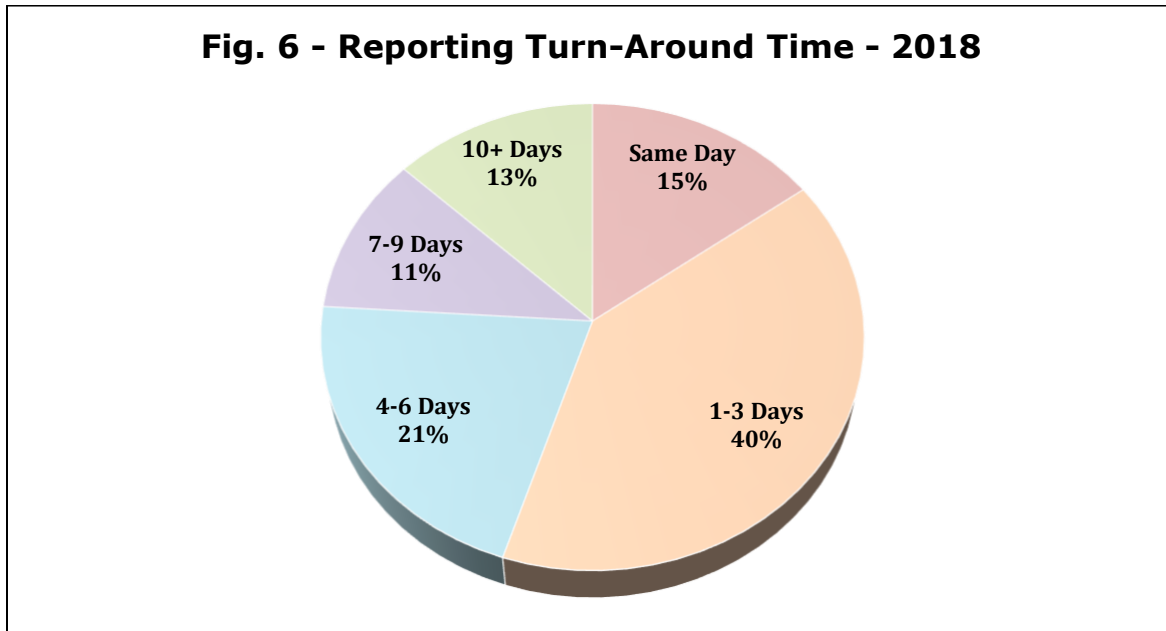


While diseases comprised 62% of our diagnoses last year, arthropod problems and damage due to non-living (abiotic) factors such as herbicide injury and weather extremes continue to be a significant segment of the problems diagnosed (Fig. 5 and Table 3).



<b>Table 5. Non-regulatory Samples by Category - 2018</b>		
<b>Category</b>	<b># of Samples</b>	<b>% of Total</b>
<b>Agronomic</b>	<b>430</b>	<b>22%</b>
Soybean	221	11%
Corn	170	9%
Small Grains	16	1%
Forage	13	1%
Other	10	1%
<b>Fruit</b>	<b>81</b>	<b>4%</b>
Fruit	47	2%
Small Fruit	34	2%
<b>Ornamentals</b>	<b>882</b>	<b>46%</b>
Woody ornamental -Deciduous	343	18%
Woody ornamental - Evergreen	204	11%
Perennials	197	10%
Annuals	124	6%
Other	14	1%
<b>Turf</b>	<b>113</b>	<b>6%</b>
<b>Vegetables/Herbs</b>	<b>235</b>	<b>12%</b>
Tomato	74	4%
Cucumber	39	2%
Herbs	31	2%
Lettuce	26	1%
Pepper	17	1%
Other	48	2%
<b>Miscellaneous</b>	<b>198</b>	<b>10%</b>
Insect ID	82	4%
Plant/Weed ID	53	3%
Herbicide Resistance Testing	22	1%
(Waterhemp, Palmer Amaranth, Giant Ragweed)		
Mushroom/Mold	16	1%
Other (Multiple Host, Aquatics)	25	1%
<b>Total Samples:</b>	<b>1939</b>	<b>100%</b>

The PPDL continues to strive to live up to our reputation of highest quality of service coupled with rapid turn-around time (15% the same day, 55% within 3 days), see Figure 6. Samples requiring in-depth laboratory analysis naturally take longer to complete and thus preliminary reports are provided to update clients on sample progress.



### **Woody Ornamentals:**

The most frequently diagnosed disease problem on woody ornamentals was *Botryosphaeria* dieback/canker, found across a range of hardwood trees and shrubs including: Maple, Magnolia, Crabapple, Redbud and Oak. The most commonly submitted leaf disease was [Tubakia leaf spot on oaks](#), found to be more severe on samples belonging to the red oak group. We also diagnosed our second recorded samples of Bur oak blight (*Tubakia iowensis*) in Indiana this year.

Although most spruce samples we receive are found to have [Rhizosphaera needle cast disease](#), in the last 2-3 years, we have diagnosed an increasing number of spruce samples with dieback caused by *Phomopsis* infections. This observation has also been documented in other Midwest diagnostic labs. Anthracnose leaf and twig diseases show up every year on maple, sycamore and oak in late spring and early summer and 2018 was no exception. This group of diseases are worse during rainy weather and in 2018 we saw emerging infections of anthracnose throughout the growing season. *Volutella* dieback of boxwood is common every year, with this year being no exception. New on boxwood in Indiana was our first diagnosis of [Boxwood blight](#) in a residential neighborhood (see pg. 5). Although [Bacterial leaf scorch](#) (caused by the systemic bacterium *Xylella fastidiosa*) was identified on just five oak samples this year and [oak wilt](#) was confirmed only three times in 2018, both of these diseases remain important diseases to watch for on oak, especially with the high probability of additional unreported occurrences.

### Journal Publications:

D. S. Egel, J. B. Jones, G. V. Minsavage, T. Creswell, G. Ruhl, E. Maynard, and C. Marchino., Distribution and Characterization of Xanthomonas Strains Causing Bacterial Spot of Tomato in Indiana. Plant Health Progress, November, 2018. <https://doi:10.1094/PHP-07-18-0041-BR>

Bratsch, S.A., Creswell, T., Ruhl, G. First report of Tomato necrotic spot virus infecting tomato in Indiana. Plant Health Progress 19 (3):224-225, 2018. <https://doi.org/10.1094/PHP-05-18-0019-BR>

Beckerman, J., Stone, J., Ruhl, G.E., Creswell, T. First Report of Pythium ultimum Crown and Root Rot of Industrial Hemp in the United States. 2018. Plant Disease. Posted online 8Aug 2018. <https://doi.org/10.1094/PDIS-12-17-1999-PDN>

Soumi, J., Akyazi, F., Habteweld, A.W., Mekete, T., Creswell, T., Ruhl, G., Faghihi, J. First Report of Cyst Nematode (Heterodera iri) in Ohio. 2018 Plant Disease 102:5. May 2018. <https://doi.org/10.1094/PDIS-11-17-1846-PDN>

### Extension Bulletins written or revised in 2018

Midwest Vegetable Production Guide for Commercial Growers 2018, ID-56 <https://ag.purdue.edu/btny/midwest-vegetable-guide/Pages/default.aspx>

Midwest Fruit Pest Management Guide 2018, ID-465 <https://ag.purdue.edu/hla/Hort/Documents/ID-465.pdf>

2018 Corn & Soybean Field Guide, ID-179 [https://edustore.purdue.edu/item.asp?Item\\_Number=ID-179](https://edustore.purdue.edu/item.asp?Item_Number=ID-179)

Boxwood Blight, BP-203-W [https://edustore.purdue.edu/item.asp?Item\\_Number=BP-203-W](https://edustore.purdue.edu/item.asp?Item_Number=BP-203-W)

Tree Diseases: Oak Wilt in Indiana, BP-28-W [https://edustore.purdue.edu/item.asp?Item\\_Number=BP-28-W](https://edustore.purdue.edu/item.asp?Item_Number=BP-28-W)

### 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. 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.

PPDL staff members participate annually in numerous educational events and programs. In 2018 some of these events included: Landscape and Nursery Programs (Green Expo, Professional Landscape School, Indiana Arborists Assn., IN Professional Lawn and Landscape Association), Category 1A Pesticide Training, Master Gardener Training and classroom training.