Plant & Pest Diagnostic Laboratory

Annual Report 2006

Purdue University Cooperative Extension Service

PURDUE UNIVERSITY

TABLE OF CONTENTS

TABLES AND FIGURES

ACKNOWLEDGMENTS

Purdue's Plant and Pest Diagnostic Lab (P&PDL) is recognized as a source of unbiased, quality, diagnostic information. This recognition is a result of the hard work and dedication of P&PDL diagnosticians and volunteer faculty and staff. A special thanks to all of you.

We are indebted to our computer support specialist for his database expertise, to our departmental extension Administrative Professional for her webmaster and database assistance and to our P&PDL secretary whose patience and friendly phone etiquette provides a welcome introduction to our clientele.

To the administration at Purdue University, we thank you for recognizing the vital role of the P&PDL in addressing Indiana's plant and pest diagnostic needs, especially during this time of heightened agro-biosecurity concerns.

Gail E. Ruhl and Karen K. Rane
P&PDL Co-Directors

"…to enable people to improve their lives and communities through learning partnerships that put knowledge to work" (Extension mission as per the National Association of State Universities and Land Grant Colleges, 2001)

MISSION

The Plant and Pest Diagnostic Laboratory (P&PDL) at Purdue University is an interdisciplinary laboratory that was established in 1990 with funding from the Crossroads initiative to integrate the existing plant disease and weed diagnostic lab in the Department of Botany & Plant Pathology (est. 1979) with the identification services provided by the Departments of Entomology, Horticulture and Landscape Architecture, Agronomy and Forestry. The mission of the P&PDL is to provide accurate and rapid identification of plants, pests, and plant problems; suggest management strategies, when requested; and serve as a source of unbiased information for plant and pest related problems.

The Laboratory provides technical expertise to specialists and county extension educators of the Purdue University Cooperative Extension Service (CES); to University research faculty and staff; to the Office of the State Chemist; to the Director of the Entomology and Plant Pathology Division of the Indiana Department of Natural Resources (IDNR) and associated nursery inspectors. The laboratory also provides routine pest and plant problem diagnoses for private businesses and citizens of Indiana.

HOMELAND SECURITY AND THE NATIONAL PLANT DIAGNOSTIC NETWORK

As a result of the 9-11-01 terrorist attacks on the World Trade Centers and the Pentagon, Congress created a new U.S. Department of Homeland Security. With heightened awareness and concern for potential acts of bioterrorism directed at U.S. food and agricultural systems, the Department of Homeland Security provided funds for USDA/CSREES to develop the National Plant Diagnostic Network (NPDN). Land grant university plant diagnostic laboratories comprise the backbone of the system. The nation is divided into five regions, with a regional center designated for each region. The P&PDL, as part of the North Central Plant Diagnostic Network (NCPDN) region has been working with counterparts at other land grant institutions to prepare for plant disease and pest introductions that might pose a threat to American agriculture. Part of this response includes providing training protocols for threat pathogens for the "first detectors." First detectors typically include individuals such as county extension educators, growers, crop consultants and regulatory field inspectors. Once trained, first detectors are on the look-out for unusual or new diseases to submit to the diagnostic laboratories. This greatly reduces the time between introduction of plant pests and diseases and their detection.

The P&PDL conducts IP video training sessions for ANR educators with the intent of improving their surveillance capabilities for invasive plant diseases and pests in Indiana. The training in 2006 included updated information on Soybean Rust (SBR), Ramorum blight, and how to submit secure samples.

The P&PDL, as part of another NPDN initiative, was involved with the reporting of SBR sentinel plot surveillance data, to the National Plant Diagnostic Network data repository. No soybean rust was reported from 2006 IN sentinel plot surveillance.

FIRST TIME DETECTIONS OF *PHYTOPHTHORA RAMORUM* AND ASIAN SOYBEAN RUST IN INDIANA

Phytophthora ramorum, a regulated plant pathogen, was confirmed for the first time in Indiana on a sample of viburnum collected in July by an IDNR inspector from a retail garden store in Portage, IN. The sample of *V. plicatum* 'Mariesii' was collected as part of a trace forward survey of nursery stock shipped from an Oregon supplier. This is the first time *P. ramorum* has been detected in Indiana, where surveys as part of the National *Phytophthora ramorum* Nursery Survey program have been conducted by the Indiana Department of Natural Resources (IDNR) and the Purdue University Plant and Pest Diagnostic Laboratory since 2004. Customers who purchased host plants this spring and summer from the retail store were encouraged, through newspaper articles and the local Cooperative Extension office, to submit symptomatic samples to the Plant and Pest Diagnostic Laboratory for testing. Four additional suspect samples were submitted by homeowners and all tested negative for the presence of any Phytophthora sp. The IDNR press release on this find of *P. ramorum* in Indiana may be viewed at: http://www.in.gov/serv/presscal?PF=dnr&Clist=11&Elist=86998

No soybean rust was detected during the regular 2006 IN sentinel plot surveillance period, however following the late season October confirmation of SBR in Kentucky, the P&PDL issued a request to Extension educators to collect and submit any and all green soybeans that could still be found in Indiana. A rust pustule was found on a leaf collected on October 12, 2006 from the Purdue Southwest Ag Center in Knox County. Following USDA-APHIS protocol, this sample was sent to the USDA National Mycologist in Beltsville, MD for species verification, and confirmation was received on October 17, 2006. Asian soybean rust was subsequently found on samples submitted from five additional counties: Pike, Posey, Tippecanoe, Vanderburgh and Warrick. Disease incidence and severity was very low in each of these areas. The Indiana soybean crop was mature and harvest well underway when the disease was first found, so there was no damage to the 2006 crop.

P&PDL AND THE INDIANA DEPARTMENT OF NATURAL RESOURCES

The Plant and Pest Diagnostic Laboratory serves as the plant disease diagnostic facility for the Indiana Department of Natural Resources (IDNR). The IDNR and the Purdue Plant and Pest Diagnostic Laboratory work together during outbreaks of diseases of regulatory concern.

The P&PDL provided disease diagnosis on: corn and soybean samples for the IDNR Phytosanitary Certification Program, as well as confirmation of *Peronospora tabacina* on tobacco samples as a part of the 2006 Tobacco Blue Mold Field Survey, disease diagnosis of foliar pathogens on corn for entry into the National Agricultural Plant Information System (NAPIS) database, and diagnosis of 59 ornamental samples submitted by IDNR Nursery Inspectors.

STAFF

Purdue faculty and staff from the departments of Agronomy, Botany and Plant Pathology, Entomology, Forestry and Natural Resources, and Horticulture and Landscape Architecture serve as diagnosticians for the P&PDL on a part-time basis as a portion of their total commitment to their respective departments. Staffing responsibilities in the P&PDL and the department to which they belong, are listed below.

Botany and Plant Pathology	
Co-Directors	Gail Ruhl, Karen Rane
Secretary and Receptionist	Janet Whaley
Webmaster and Extension Administrative Professional	Amy Deitrich
Disease diagnosis and control	Gail Ruhl, Karen Rane
Weed identification, control, and diagnosis of herbicide injury on field crops	Glenn Nice
Computer support	Robert Mitchell
Entomology	
Invertebrate and other pest identification and control	Timothy Gibb, Clifford Sadof
Horticulture & Landscape Architecture	
Identification of horticultural plants and plant problems	B. Rosie Lerner
Agronomy	
Fertility, soil and environmentally related problems of corn	Robert Nielsen
Turfgrass management	Zac Reicher, Glenn Hardebeck
Forestry & Natural Resources	
Tree identification	Rita McKenzie

The P&PDL is fortunate to have the support and assistance of numerous faculty and staff in the School of Agriculture. During 2006, more than 30 additional faculty and staff members assisted with sample diagnoses **(Table 1)**. The P&PDL also employs a student hourly worker throughout the year to help with logging in samples, sample distribution, filing and other general laboratory duties.

Table 1. Departmental faculty and staff that assisted with diagnoses of samples submitted to the Plant and Pest Diagnostic Laboratory during 2006.[1]

Faculty/Staff	Number of Diagnoses	Faculty/Staff	Number of Diagnoses
Agronomy	**132 (4%)**	**Entomology**	**269 (7%)**
S. Conley	23	L. Bledsoe	10
G. Hardebeck[2]	43	J. Faghihi	4
K. Johnson	8	R. Foster	6
R. Nielsen	26	**T. Gibb**	197
Z. Reicher	32	C. Krupke	1
		J. Loven	1
		C. Pierce	1
Botany & Plant Pathology	**3139 (84%)**	J. Obermeyer	12
		C. Oseto	3
T. Bauman	7	**C. Sadof**	33
J. Beckerman	11	A. York	1
D. Egel	3		
E. Helliwell	127[3]	**Horticulture & Landscape Architecture**	**140 (4%)**
D. Huber	3		
L. Johal	782[3]	B. Bordelon	4
R. Latin	6	M. Dana	40
C. Lembi	12	P.A. Hammer	25
D. Lubelski	5	**R. Lerner**	37
G. Nice	92	M. Mickelbart	7
K. Rane	793	S. Weller	27
G. Ruhl	1285[4]		
G. Shaner	6	**Other**	**48 (1%)**
I. Thompson	7	J. Byrne, Michigan State Univ.	39
		L. Czederpilz, USDA-FS	1
		DeVries	1
		C. Gunter, Horticulture-SWPAC	3
		Hernandez	1
		J. McKemy, USDA	1
		M. Palm, USDA	2
		Total Diagnoses	**3728**

[1] The total number of diagnoses exceeds the total number of samples due to multiple problems/diagnoses per sample. More than one person may assist with a diagnosis.
[2] Names in bold type were designated by departments as 2006 P&PDL diagnosticians.
[3] Diagnoses were for Asian soybean rust sentinel plots only.
[4] 801 additional sample diagnoses were provided for *P. ramorum* nursery survey samples.

ADVISORY COMMITTEES

The inter-departmental nature of the P&PDL demands frequent and free-flowing exchange of information among the participating departments. This communication takes place on at least three different levels.

The Steering Committee

The Steering Committee provides a forum to discuss matters that relate to the daily operation of the P&PDL. Input from the diagnosticians is considered essential for smooth functioning of the Lab. The Committee meets as needed and reports periodically to the Operations Committee. The Committee is chaired by the Co-Directors of the P&PDL and is composed of diagnosticians, the Extension Administrative Professional and the P&PDL secretary.

The Operations Committee

The Operations Committee provides a forum for discussion of operational matters and facilitates communication among diagnosticians and other specialists. The Committee meets as needed and reports periodically to the Management and Policy Committee. The Committee is chaired by the Co-Directors of the P&PDL and is composed of the Steering Committee, one Extension specialist from each participating department and the Department Head charged with administrative overview of the laboratory. Departmental Extension Specialists are appointed on a three-year rotating basis.

The Management and Policy Committee

The Management and Policy Committee provides administrative overview for the P&PDL. The Committee is composed of the Heads of the participating Departments and administrators from the Cooperative Extension Service and the Agricultural Experiment Station, and the Co-Directors of the P&PDL. The Committee is chaired by the P&PDL Co-Directors. The Committee meets as needed.

2006 COMMITTEE STRUCTURE

The Steering Committee: Gail Ruhl (Co-Chair, Co-Director of P&PDL; plant disease diagnosis and control), Karen Rane (Co-Chair, Co-Director of P&PDL; plant disease diagnosis and control), Glenn Nice (Weed identification and control, and diagnosis of herbicide injury on field crops), Tim Gibb and Cliff Sadof (Arthropod identification and control), B. Rosie Lerner (Identification of horticultural plants), Bob Nielsen (Fertility and soil-related problems of corn), Zac Reicher and Glenn Hardebeck (Turfgrass management), Rita McKenzie (Forestry), Bob Mitchell (Database programming, web page management and computer support), Janet Whaley (Receptionist and accounts), Amy Deitrich (Webmaster and Extension Administrative Professional)

The Operations Committee: Gail Ruhl and Karen Rane (Chairs, Co-Directors of P&PDL), Steering Committee members, Peter Goldsbrough (Head, Department of Botany and Plant Pathology) (administrative overview), Keith Johnson (Agronomy), Greg Shaner (Botany and Plant Pathology), Rick Foster (Entomology), Rita McKenzie (Forestry and Natural Resources), Mike Dana (Horticulture and Landscape Architecture)

The Management and Policy Committee: Gail Ruhl and Karen Rane (P&PDL Co-Chairs, Co-Directors), Dave Petritz (Director of CES & Agriculture and Natural Resources), Tom Jordan

(Assistant Director of CES & Agriculture and Natural Resources), Marshall Martin (Associate Director of Agriculture Research Programs), Craig Beyrouty (Head, Department of Agronomy), Peter Goldsbrough (Head, Department of Botany and Plant Pathology), Steve Yaninek (Head, Department of Entomology), Bob Jolly (Head, Department of Horticulture), Dennis LeMaster (Head, Department of Forestry and Natural Resources), and Gail Ruhl and Karen Rane (Chairs, Co-Directors of P&PDL)

LABORATORY OPERATIONS

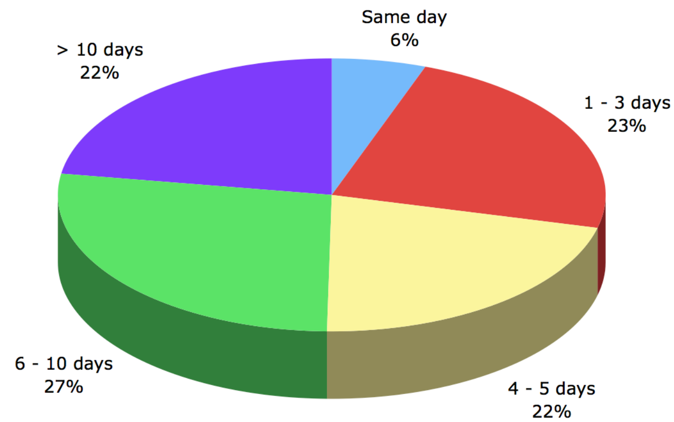
County offices of the Cooperative Extension Service (CES) are provided with a supply of sample submission forms, alcohol vials and mailing boxes to facilitate the submission of plant specimens and insects to the P&PDL. Submission forms are available online and may be downloaded from the P&PDL web page. Completed submission forms are to accompany all sample submissions. Digital images may be submitted, from the P&PDL web page (http://www.ppdl.purdue.edu).

Diagnosis Process

Information from the sample submission form is logged into the P&PDL computer database as well as the NPDN Plant Diagnostic Information System (PDIS), and the sample is assigned a unique number in both databases. Samples are then distributed to the appropriate diagnostician. If the diagnosis requires pathogen isolation or some other lengthy procedure (determined by the diagnostician), a preliminary reply, including a tentative diagnosis and projected final completion date, is returned to the client. When the diagnosis has been completed the identification and management recommendations (when requested) are entered into the database, printed, and the final response along with any supporting information is returned to the client and/or submitter via electronic mail and/or FAX, and US mail (as requested by the submitter on the submission form).

Turn-around time
Turn-around time is the length of time between when a sample is received and when the final diagnosis is returned. Same day service was provided for 6% of the samples received during 2006 and 29% of the samples were completed in three days or less. A total of 51% of the samples received during 2006 were diagnosed within five working days and 78% of all samples received were answered within 10 working days. An extended turn-around time of greater than 10 days (22% of samples) was documented for those samples requiring more extensive culture work and laboratory testing **(Figure 1)**. Preliminary reports were sent for samples requiring additional time for pathogen confirmation.

Figure 1. Turn around time for routine samples received in 2006*



*Excludes *P. ramorum* National Nursery Survey, NAPIS survey, Phytosanitary inspection, and Asian Soybean Rust sentinel samples

Sample Breakdown

As per Table 2, approximately six percent (93) of the total number of routine samples diagnosed by P&PDL diagnosticians in 2006 were submitted electronically, as digital samples. In addition to the 1572 routine samples diagnosed, 801 nursery samples were tested for the presence of *Phytophthora ramorum* as part of the Sudden Oak Death (Ramorum blight) National Survey. A total of 87 corn and soybean samples were submitted for disease diagnosis for phytosanitary certification (ICIA and IDNR) and 52 additional corn samples were submitted for disease diagnosis to contribute to the collection of Indiana data for the NAPIS database.

Table 2. Breakdown of total samples for 2006

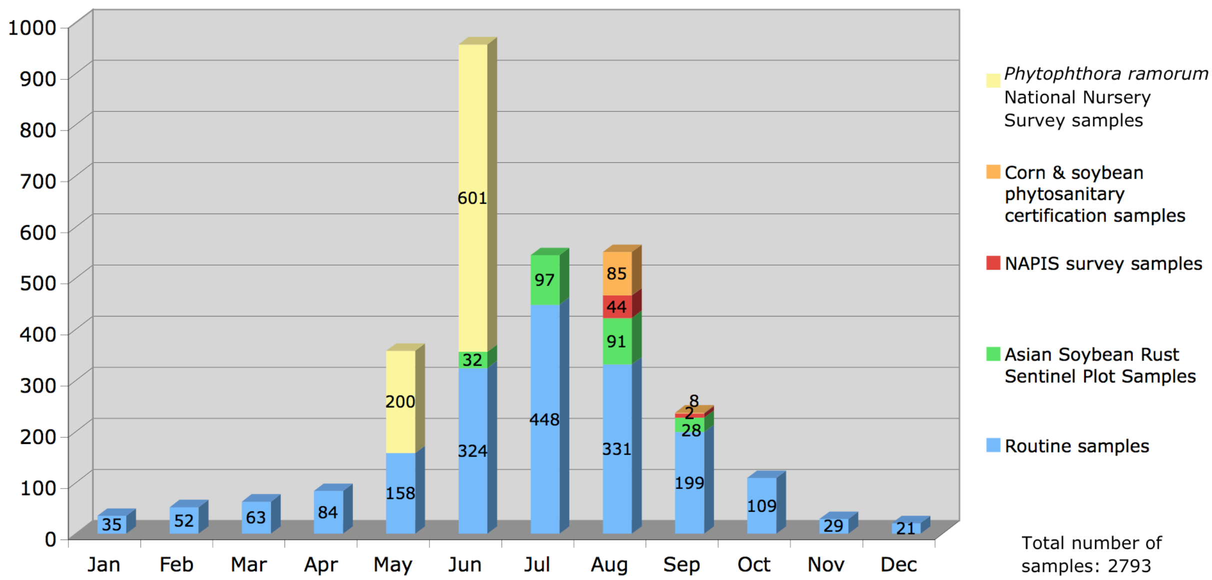
Routine samples	**1572**
Physical samples	*1479*
Digital samples	*64*
Digital samples with physical follow-up	*29*
Regulatory/survey samples	**1221**
Asian Soybean Rust sentinel samples	*248*
P. ramorum national survey samples	*801*
P. ramorum trace samples	*31*
Phytosanitary certification samples (IDNR/ICIA)	*87*
NAPIS corn survey (IDNR)	*52*
Tobacco Blue Mold samples	*2*
Total number of samples	**2793**

DIAGNOSES AND SAMPLES

Monthly Activity

During 2006, the Laboratory diagnosed a total of 1572 routine samples. As illustrated in Figure 2, more than half of the year's routine samples were processed in the lab during the three months of June, July and August. The majority of the 2006 *Phytophthora ramorum* National Nursery Survey samples were submitted during June for diagnosis of the presence or absence of *P. ramorum*, the causal agent of Ramorum blight. During the month of August, ICIA and IDNR field inspectors submitted corn and soybean foliar samples to the P&PDL for disease diagnosis required for phytosanitary certification of seed. Corn samples were submitted in August for collection of NAPIS information.

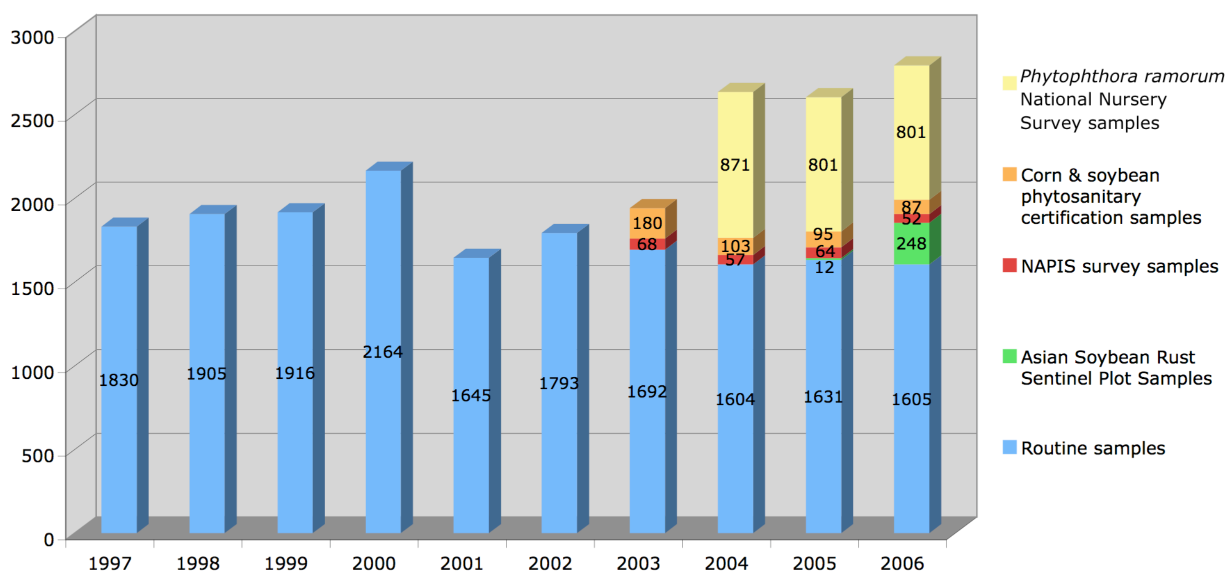
Figure 2. Number of samples received per month in 2006



Long-Term Trends

Sample submissions have remained relatively stable for the past nine years. Participation of the P&PDL in the National Nursery Survey for *P. ramorum*, as well as Soybean Rust sentinel samples, resulted in an increase in the total number of samples diagnosed in 2006 **(Figure 3)**.

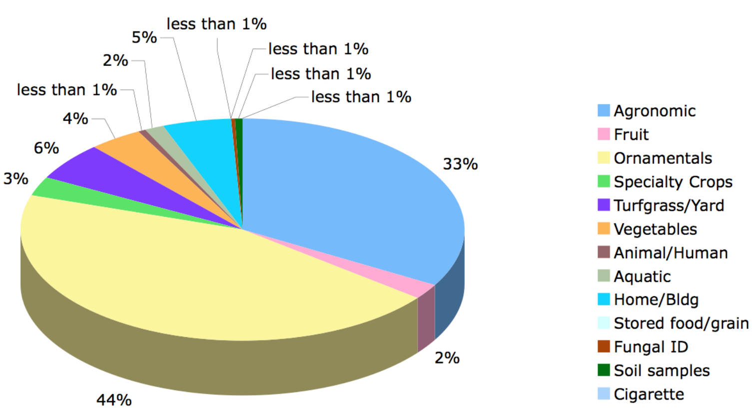
Figure 3. Long-term trends in clinic activity



Commodities Diagnosed

Figure 4 and **Table 3** show the number of specimens submitted in each commodity group, for 2006. The majority of samples submitted for diagnosis (44%) were from the ornamentals commodity group. In descending order, agronomic crops (33%), turfgrass/yard (6%), insects infesting homes and other buildings (5%), and vegetables (4%) comprised the other major commodities submitted for routine diagnosis. Several other minor commodity groups comprised the remaining 8% of the submitted samples **(Figure 4** and **Table 3)**.

Figure 4. Samples sorted by commodity group in 2006*

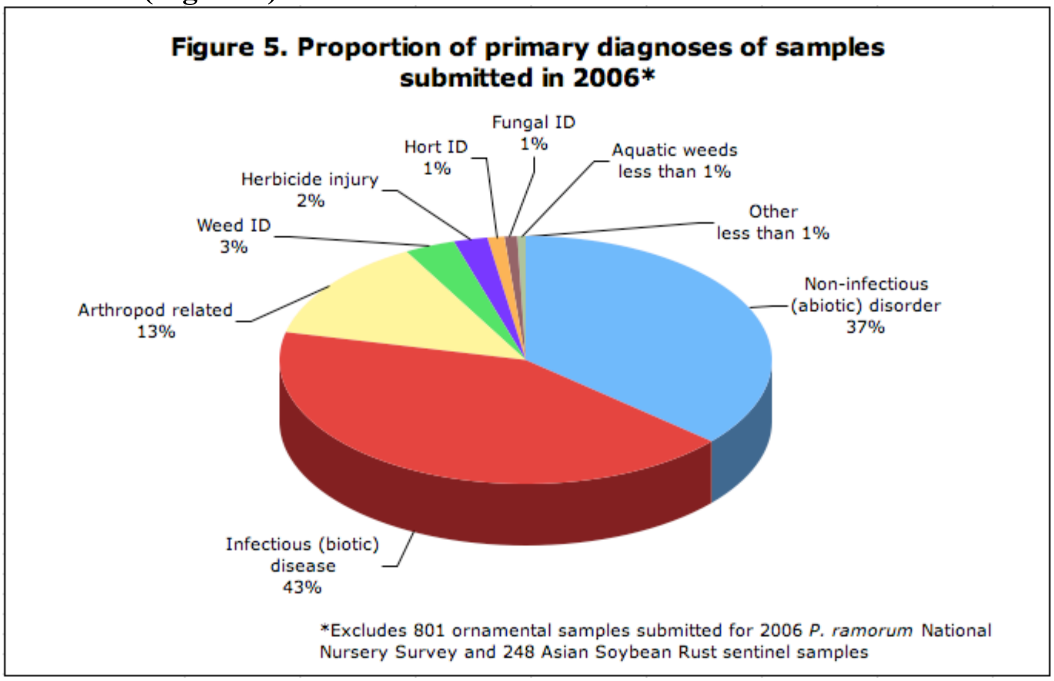


*Excludes 801 ornamental samples submitted for 2006 *P. ramorum* National Nursery Survey

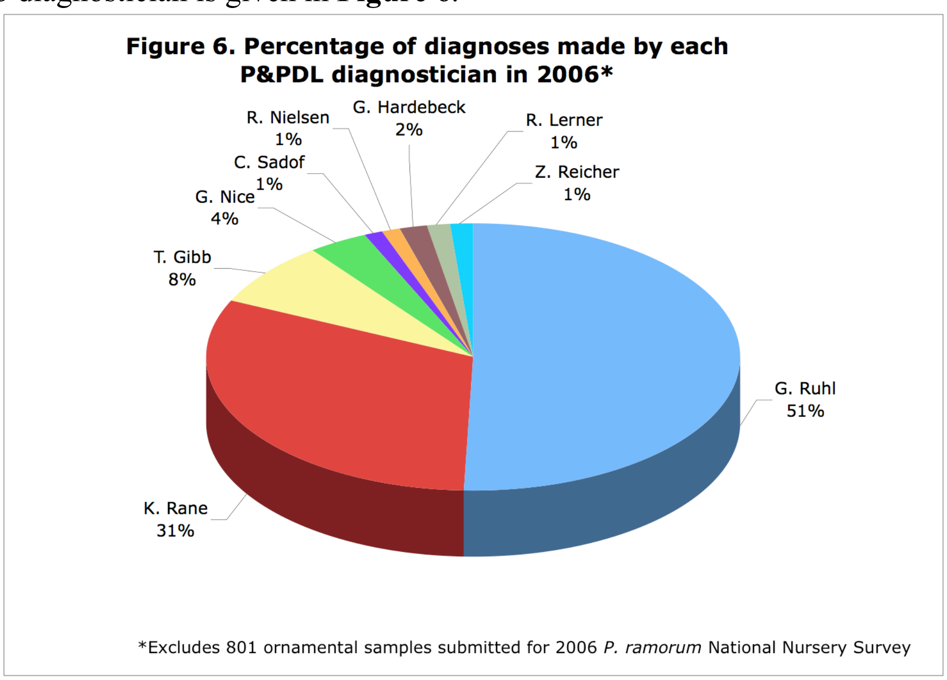
Table 3. Samples sorted by commodity group[1]		
	2006	
Commodity	**Number of Specimens**	**%[2]**
Agronomic	**666**	**33**
Alfalfa	4	*
Barley	3	*
Clover	1	*
Corn	252	13
Wheat	40	2
Soybeans	335[3]	17
Pasture	15	1
Forage	4	*
Plant ID	12	1
Fruit	**45**	**2**
Small Fruit	18	1
Tree Fruit	27	1
Ornamentals	**882**	**44**
Flowers	203	10
Interior Plants	20	1
Grnd Cvrs/Vines	28	1
Shrubs	224	11
Trees	407	21
Specialty Crops	**57**	**3**
Field	13	1
Hort	44	2
Turfgrass/Yard	**112**	**6**
Vegetables	**74**	**4**
Miscellaneous	**157**	**8**
Animal/Human	10	*
Aquatic	31	2
Home/Bldg	96	5
Stored Foods/Grains	1	*
Fungal ID	8	*
Soil samples	9	*
Cigarette	1	*
Total Specimens	**1992**	**100%**

[1] Excludes 801 ornamental samples submitted for 2006 *P. ramorum* National Nursery Survey
[2] Percent of total samples submitted during the year
[3] 248 samples were submitted for Asian soybean rust sentinel plots
* Less than 1%

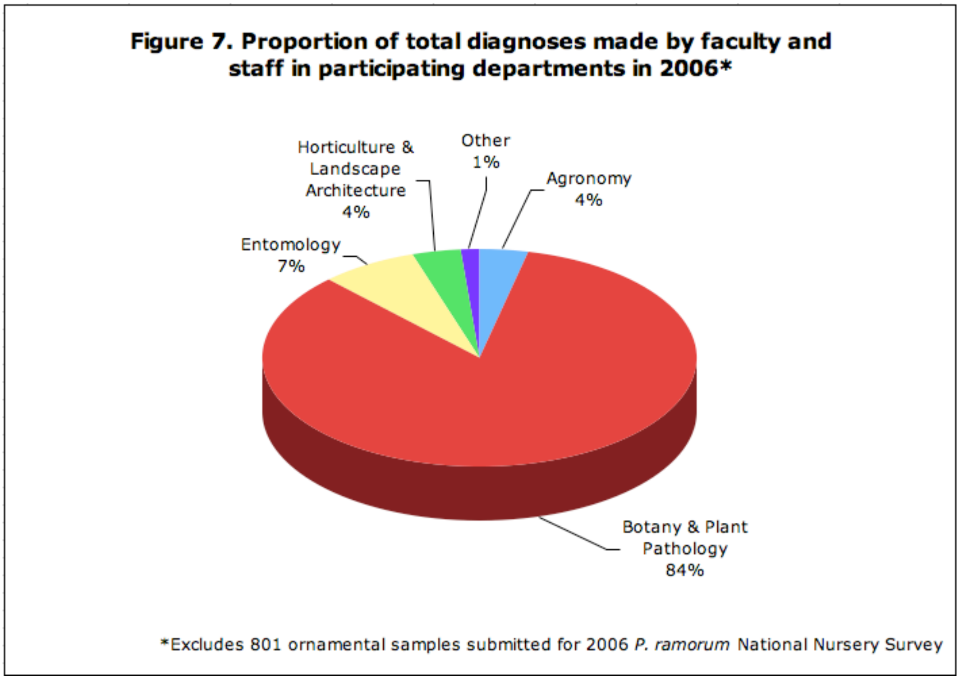
Type of Diagnosis
Many of the 2006 samples received multiple diagnoses due to the presence of more than one causal agent. The most frequently diagnosed group of causal agents, determined by the type of diagnoses made, were infectious diseases (43%), followed by noninfectious (abiotic) disorders (37%), arthropods (13%), and weeds (3%). Herbicide injury, horticultural and fungal ID, and soil related problem diagnoses each comprised 2% or less of the primary diagnoses of samples submitted in 2006 **(Figure 5)**.



Diagnoses per Diagnostician
A comparison of the proportion of total 2006 diagnoses of routine (non-survey) samples made according to diagnostician is given in **Figure 6**.



Diagnoses per Department
A comparison of the proportion of total 2006 diagnoses made according to participating departments is shown in **Figure 7**. The faculty and staff in the Department of Botany & Plant Pathology diagnosed the majority (84%) of samples.



SAMPLE ORIGIN

Clientele Groups

Samples are submitted to the P&PDL by commercial and non-commercial clientele as well as by IDNR/USDA/APHIS personnel for regulatory and survey work **(Table 4).**

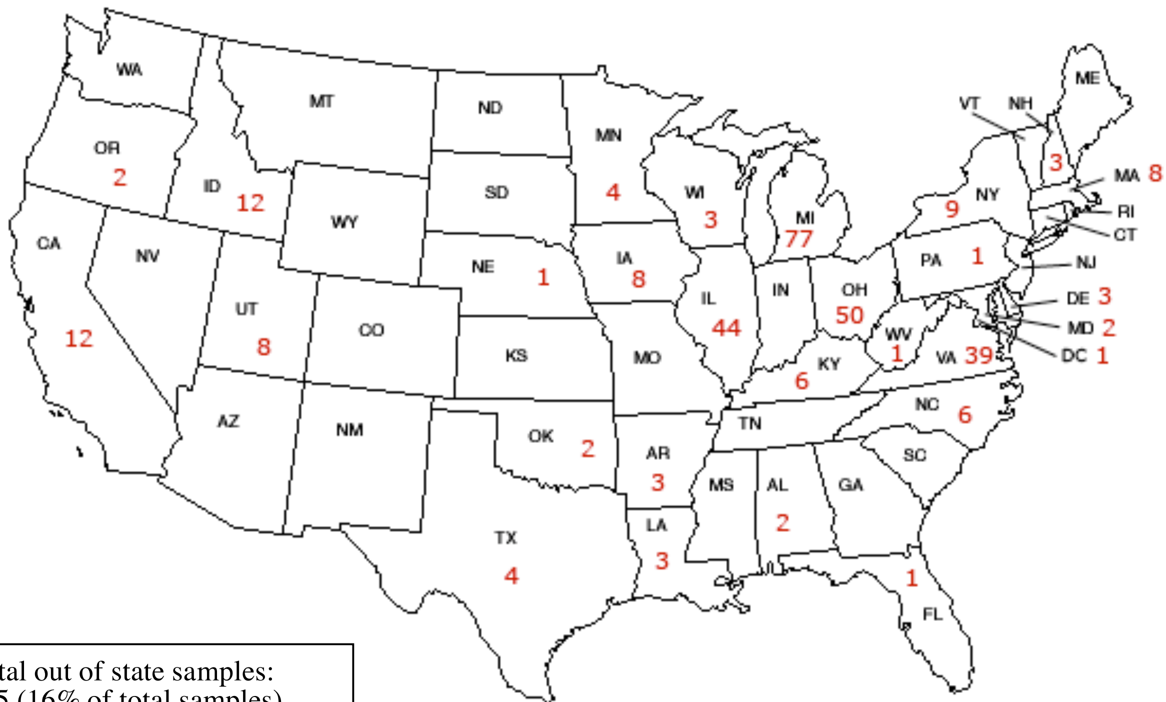
Table 4. Affiliation of persons submitting samples to the P&PDL in 2006

Affiliation	Number of samples	%
Commercial	**903**	**45**
Consultant	118	6
Dealer/Industry Rep	216	11
Garden Center	11	*
Golf Course	28	1
Greenhouse	158	8
Growers – Agronomic	11	*
Growers – Fruit/Vegetables	36	2
Growers – Ornamentals/Turf	20	1
Insurance Adjuster	2	*
Landscaper	44	2
Lawn/Tree Care[1]	135	7
Nursery	71	4
Pest Control	51	3
Veterinary Clinic	2	*
Non-Commercial	**707**	**36**
Extension Educator	330	17
Homeowner	198	10
Purdue – not Educator	171	9
University – not Purdue	7	*
US Army	1	*
Regulatory/Survey	**382**	**19**
ICIA	142	7
IDNR	210	11
IDNR – Forestry	2	*
State Chemist	28	1
Totals	**1992**	**100%**

[1] Includes lawn/tree care companies and museum/park grounds departments
* Less than 1%

Out of State Submissions
The Laboratory was established to serve residents of Indiana, however, due to the P&PDL's national reputation, diagnostic services were also provided for 315 samples (16% of total samples) submitted from 28 other states during 2006*.

Figure 8. Distribution of samples received from outside Indiana by the Plant and Pest Diagnostic Laboratory in 2006*.



Total out of state samples:
315 (16% of total samples)

* The P&PDL has a permit issued by USDA/APHIS/PPQ to receive out-of-state samples for diagnosis from the lower 48 states. No out-of-country samples are accepted.

AN INFORMATION SOURCE

The P&PDL staff not only provide accurate and timely diagnosis of samples, but also serve as a resource of information for plant and pest-related problems. The team cooperates with university personnel to provide accurate and up-to-date information to clientele.

Webpage

The Virtual Plant and Pest Diagnostic Laboratory, the P&PDL World Wide Web Home Page, (URL: http://www.ppdl.purdue.edu) was put "on-line" in June of 1995. The web server, now maintained by Bob Mitchell, IT manager for the Dept. of Botany and Plant Pathology and Amy Deitrich as webmaster, serves as an invaluable educational tool accessible not only to the citizens of Indiana, but people throughout the United States and the world. The P&PDL web site provides information and links on species invasive to Indiana, up to date soybean rust information, a "Picture of the Week," information on "What's Hot" in the P&PDL, and many featured links. There is a keyword searchable database, a digital library and a link for submitting digital samples to the P&PDL. Web server statistics for the Plant and Pest Diagnostic Laboratory reported an average of 12,575 requests per day for P&PDL web pages from January 1 through December 31, 2006 –more than double the daily 'hits' from 2005.

Extension Activities

P&PDL staff members participate in a variety of Purdue University sponsored events and educational programs. Some of these programs in 2006 included Turf Field Day, Master Gardener Training, Turf and Ornamentals Workshops, presentations at the Crop Diagnostic Training Center, IDNR Nursery Inspector *P. ramorum* Survey Training and training of IDNR and Indiana Crop Improvement Association (ICIA) inspectors for Phytosanitary Field Inspection of corn and soybeans.

APPENDIX A: COMMODITY RELATED SUMMARIES

Field Crop Insects, *Christian Krupke, Department of Entomology*

First stage corn rootworm (CRW) larvae were first detected in Tippecanoe County in corn roots on June 1, 2006. It is probable that egg hatch began two or three days earlier in central Indiana and a week earlier in southern counties. Infestation levels and rootworm pressure and damage in the state overall could be best categorized as "typical" with some areas suffering limited lodging particularly when soils were saturated in late June.

Low incidence of first generation European corn borer (ECB) infestations again followed a pattern that has persisted for several years. The reasons for this sharp decline are unclear, but is likely due to a combination of highly effective pest management strategies (B.t. Corn) and unfavorable climate trends in some areas of the insects' range.

Corn earworm moth captures in pheromone and black light traps were higher than normal from late July through mid-September. Many fields of late planted and/or developing corn sustained noticeable damage to developing ears. Interestingly, many larvae (and damage) were mistakenly attributed to the western bean cutworm (see below).

Western bean cutworm, a native of the eastern US corn belt, was found in Indiana pheromone and light traps. This represented the first year of monitoring effort for this pest. No damage/larvae were reported from Indiana cornfields however.

The soybean aphid continued the cyclical nature of infestation that has been evident for the past several years. There were no confirmed reports of soybean aphid numbers reaching threshold and requiring treatment and the vast majority of fields monitored had no aphids found throughout the season. Predatory insects (multicolored Asia lady beetle, syrphids, and Orius) were rare to uncommon in soybean fields. SBA were unexpectedly abundant on its over-wintering host (*Rhamnus* spp.) in the fall of 2006.

Japanese beetle and bean leaf beetle numbers were generally low, however local outbreaks occurred in a few regions of the state.

Potato leaf hopper colonization of alfalfa state-wide was probably delayed and subsequently generally reduced by a period of atypically cold and wet conditions that occurred from early to mid May.

Fruit Diseases, *Janna Beckerman, Department of Botany & Plant Pathology*

It was a good year to be a fruit pathologist in Indiana! The moderate winter temperatures of 2005 resulted in an above normal carry over of apple powdery mildew and increase in mildew infection, especially on Jonathan and other mildew-prone varieties. The moderate winter became a really wet spring in parts of the state, resulting in what seemed to be one continuous scab infection period from late March through May. This resulted in a bad year for apple scab, with fruit infection very high in those orchards lacking a good, early spray program for scab. This higher than normal infection rate has resulted in greater grower concern about resistance issues. Our preliminary data suggests two things: 1) these concerns are well founded, but 2) timing of sprays could have been better. In the northern part of the state, unusually dry weather prevented serious scab development, but powdery mildew was higher than normal.

Wet weather in the central and southern part of the state brought a much higher incidence of cedar-apple (leaves and fruit), cedar-hawthorn (leaves only), and cedar-quince (fruit only) rust. The extremely wet weather this spring made for orange blobs, instead of the usual cute, or at least interesting "kooshballs" we usually see on junipers. Squishing the telial spore horns that release the spores that infect the apple leaves and fruit just wasn't as much fun as in previous years - in fact, it was downright gross.

The situation with fire blight is quiet. I haven't heard any reports of worse-than-usual outbreaks of fire blight, and in looking at orchards, I don't see them, either. Now I know the fire blight bacterium doesn't read the books, but with all the wet weather, and severe hail of 2006, it seems that this should be a bigger problem than it appears. It certainly is a bigger problem in the landscape! Come spring, be extra careful, and do a thorough scouting of cankers, just to be on the safe side. And in the spring, don't forget that dormant application of copper, too.

Sooty blotch and flyspeck of apple intensified as the wet weather continued throughout the summer. At harvest, both diseases were severe in orchards that had not maintained an adequate spray program. The strobilurins, used in combination with captan gives excellent control of this disease complex. Management of the other rots (bitter rot, white rot and black rot) remains tricky. Reports continue to come in on bitter rot control, particularly with respect to the 77-day PHI when using EBDCs. Current work is underway to address EBDC usage and Reregistration Eligibility Decision (RED) document.

You would've thought that the early wet weather would cause an increase in reports of Phytophthora crown rot on both apples and stone fruit. We thought so, too - and we were wrong. The constant moisture never caused any of the drought stress needed for symptom development. When that drought stress does occur, I suspect we will see an unusually bad year for phytophthora root and crown rot. For this reason, it is important to continue your treatment in the spring, with either Ridomyl, or phosphorous acid based fungicide (Aliette, AgriFos).

We had peaches this year! We also had tremendous outbreaks of every peach pathogen, due to the unusually wet conditions. I saw a lot of leaf curl on peach, but even more misdiagnosed peach scab. Many growers confused the symptoms of scab with bacterial spot. Peach scab primarily occurs on the shoulders, and doesn't cause foliar symptoms. Peach bacterial spot occurs on the fruit, leaves, and new growth. If the spots didn't get your peaches, brown rot might have, especially where mid and late season fungicide sprays had not been maintained. Fungicide resistance is an emerging issue with this disease as well.

Plum pox virus (PPV) was found in Michigan and New York this summer. In Michigan, the good news is that the one and only positive tree has been destroyed, and no additional trees have been found. The bad news is that the source of the PPV in the positive tree at SWMREC is still unknown. PPV is a plant disease infecting stone fruits, including plums, peaches, nectarines and apricots. The strain of PPV found in North America, PPV strain D, is less virulent than other strains, does not infect cherry trees and is not seedborne. Because the strain is not seedborne, it is not necessary to regulate the movement of fruit to prevent the spread of the disease. Several aphid species can serve as carriers of the virus. Symptoms of PPV infection include distortion and discoloration of fruit, yield reduction, and shortened lifespan of an already short-lived tree. The virus was first detected in Canada back in 2000, and was found in Pennsylvania in 1999.

Ornamentals: Noninfectious Problems, *Mike Mickelbart, Department of Horticulture & Landscape Architecture*

Many samples submitted this year were coniferous species exhibiting chlorosis, browning, or dieback. Spruce trees in Indiana landscapes often exhibit symptoms of needle discoloration and needle drop without any readily discernable disease pathogen or insect/animal agent at work. This situation is most likely due to damage to the roots due to less than ideal planting site characteristics. In general, spruce trees have shallow roots and require fertile, well-drained soil to thrive. It is very difficult to precisely identify the causal factor in such situations.

However, there are several common causes. Excessive moisture in the root zone (from rainfall, irrigation, placement in a low spot, etc.) is often a problem. The effects of excessive water are often seen in late winter/early spring even in suitable planting sites, because winter rains saturate the soil, and conifers are not tolerant of waterlogged soils. Furthermore, nitrogen reallocation to new growth often exacerbates the chlorosis. Compacted soils resulting in poor aeration and excess moisture are also a potential cause for these symptoms. Excessive dryness in the root zone (from soil type, exposure, drought, etc.) can result in chlorosis, but most conifers are very tolerant of dry soils, so this is only a problem in extremely dry soils. Finally, extremes of soil pH (too alkaline or too acidic) can cause these symptoms. Typically in Indiana (especially the northern two-thirds of the state), the problem is high pH. Other factors that may be leading to chlorosis and dieback in conifers include rirdling roots, mis-application of herbicide, planting trees too deep, physical damage to the trunk from lawn care equipment, or root-zone disruption from construction, etc.

Many cases of micronutrient deficiencies were also observed. Although it is impossible to determine the specific deficiency without a tissue analysis, the most likely deficiencies are manganese and/or iron. This is because most soils in Indiana have a pH above 6.5. At a soil pH above this, manganese and iron are not taken up by the plant, resulting in the observed deficiency.

With the warm early winter in 2006, there were also some cases of desiccation of evergreen leaves. Dry weather, high light levels, and relatively warm conditions resulted in the drying out of leaves. In all but the most extreme cases, this does not result in long-term damage to the plant.

Small Fruits, *Bruce Bordelon, Department of Horticulture & Landscape Architecture*

Blueberries

Indiana produced a large crop this year, estimated to be 3.5 to 4.0 million pounds and prices were at an all-time high. Fruit size and quality were good due to plentiful rain. No major disease or insect problems were reported. Phomopsis shoot blight and mummyberry continue to be the major disease problems. Cranberry fruit worm, Japanese beetles, and blueberry maggot are the major insect pests.

Brambles

Winter kill was not a big problem this year on blackberries. Japanese beetles are a major problem, especially on flowers of Arkansas Primocane Fruiters. Heat during the season lead to a high incidence of white druplet disorder in blackberries. Rainfall in August lead to severe gray mold problems in fall-bearing red raspberries. Raspberry leaf spot was mild this year compared to 2005.

Strawberries

The strawberry crop was good this year. Gray mold was a problem in some areas and the heat spell in June shortened the harvest season. Black root rot complex continues to be a problem on heavier soils.

Grapes

The 2006 vintage will not be as good as the excellent 2005 vintage due to excessive fall rains that coincided with harvest in many areas. Fruit rots were the biggest problems. Rots caused by Phomopsis viticola were particularly bad due to an extended period of cool, wet conditions early in the season. Black rot was also quite common. The excessive summer heat lead to “uneven ripening” disorder in Concord grapes in the southern part of the state. Late season downy mildew was severe in some areas. Japanese beetles and leaf phylloxera continue to be significant insect pests. Multicolored Asian lady beetles were not a problem this year.

Vegetable Diseases, *Dan Egel, Region Pest Management Specialist, SWPAC*

Late April and early May 2006 was very cool and wet (See Table 1). The result was that a significant number of muskmelon and watermelon growers reported transplants dying in the field (Figure 1). Many growers had to replant entire fields since the original plants had died or were severely damaged by the cool, wet weather. Although a few damping-off fungi could be found in isolations of these plants, most transplant loss was due to the abnormal weather. After growers located replants and the weather warmed up, the replants grew well.

A few varieties of watermelon transplants were observed with Fusarium wilt while still in the transplant trays. Symptoms of Fusarium wilt of watermelon in the field usually peak around Memorial Day. In 2006, early season observations of Fusarium wilt were less than normal. This might be because once the weather in May warmed up, it became very warm. Thus, most watermelon seedlings began growing in very warm late May temperatures. However, there was an increase in observations of mature plants with Fusarium wilt in the mid to late season.

Downy mildew of cucurbits was present in Indiana for the fourth year in a row. In 2006, downy mildew was observed in Michigan on 9 June. On 20 July, downy mildew was reported on cucumbers in Kosciusko County, Indiana. On 14 August, downy mildew was reported in Knox County on pumpkins. It is unknown whether the downy mildew infections observed in Indiana came from the Michigan source or a source further south.

Many pumpkin growers complained of either Phytophthora blight or Fusarum fruit rot causing yield losses. Most of the growers with these problems were from the northern part of the state where more rains fell. The fruit rots were part of a regional problem that extended from Indiana to the New England States. The national press picked up on this problem and Purdue expertise was featured prominently.

Table 1: Weather data is presented to show the cool, wet weather in May 2006 that was responsible for the early season death of many cucurbit transplants in southwest Indiana.

	Precipitation (inches)*	Temperature (Fahrenheit)
May 2006	5.28	59.9
111 year ave.	4.24	61.5
111 year rank	87**	40

* Weather information is courtesy National Climate Data Center/National Oceanic Atmospheric Association.

** The wettest month would be ranked 111; the hottest month would be ranked 111.

Figure 1: Watermelon seedlings collapsed due to the cool, wet weather in May 2006 forcing growers to replant using new transplants.

Weed Science, *Glenn Nice, Weed Diagnostician, Botany & Plant Pathology*
Bill Johnson, Assistant Professor, Botany & Plant Pathology
Tom Bauman, Professor, Botany & Plant Pathology

The year of 2006 proved to be an interesting year including new occurrences of herbicide resistant weeds, increased occurrences of an invasive plant and some problematic weeds, and a few incidences of tank contamination that left confusion and questions.

Tank Contaminations: There were several cases of tank contamination this year. This is not a new situation, but one that can occur in the busy spraying season. In a few cases growth regulators were involved, in others it was glyphosate and there were a few that involved ALS herbicides. To avoid tank contamination, many applicators have segregated their equipment out into corn (growth regulators) and soybean (glyphosate) rigs. Although this will reduce the potential for surprises, a few perplexing cases still occurred where glyphosate or a growth regulator will find its way into the wrong field. In these cases a little detective work is often required by observing both crop symptoms and the symptoms seen in the surrounding vegetation.

Giant Ragweed and Glyphosate: Indiana now has documented two weeds that are resistant to glyphosate. In 2002, we identified glyphosate resistant horseweed (*Conyza canadensis* also known as "marestail"), which now infests a significant portion of the state. In 2006 we identified giant ragweed in NE Indiana. Glyphosate resistant populations of giant ragweed (*Ambrosia trifida*, also known in Indiana as "horseweed" to make things confusing) have been found in both Indiana and its neighboring state of Ohio. Purdue University, in association with Ohio State University, have been screening populations of giant ragweed in both the greenhouse and field for resistance. So far there has only been the one population in Noble county identified as resistant; however giant ragweed, along with common lambquarters, are often found at harvest season to be centennials to a possibly increasing problem in glyphosate tolerant crops. ALS resistant giant ragweed is no stranger to Indiana. Resistance to the herbicides in the ALS class of herbicides were identified in 1998 (http://www.weedscience.org).

For more information on the control of giant ragweed and common lambsquarters in Roundup Ready systems please read "Management of Giant Ragweed in Roundup Ready Soybean Fields with a History of Poor Control" (http://www.btny.purdue.edu/weedscience/2006/GiantRagweed06.pdf) and "Control of Lambsquarter in Corn and Soybean" (http://www.btny.purdue.edu/weedscience/2006/Lambsquarters06.pdf)

Shattercane and Johnsongrass and ALS herbicides: ALS resistant shattercane and johnsongrass were documented in Indiana in 2006. The ALS resistant shattercane was found in Shelby county and the ALS resistant johnsongrass in Knox and Washington counties. The shattercane populations were reported to have zero percent control to a 5x rate of Accent and Option in a greenhouse screen (http://www.btny.purdue.edu/weedscience/2006/shattercaneALS06.pdf), and the johnsongrass from both sites survived 5x rate of Accent.

Toxic Plants Always Around: We received a few clinical samples from the animal ADDL – toxicology lab and Indiana animal owners where suspected poisoning was diagnosed. Several plants, such as yew (*Taxus cuspidate*), which is highly toxic to horses and other livestock can find their way into pastures or hay. For more information on the toxic plants that can be found in Indiana, I invite you to see the "Indiana Plants Poisonous to Livestock and Pets" (http://www.vet.purdue.edu/depts/addl/toxic/cover1.htm) or the "Indiana Crop Improvement Association Certified Forage Program Toxic Plant Guide" (http://www.btny.purdue.edu/weedscience/2006/ToxicWeedsCertFor06.pdf).

Invasive Plants: 2006 continues to see an increase in concern regarding invasive plants. Two such invasive plants that appear to be on the increase in Indiana are Japanese hops (*Humulus Japonicus*), a member of the hemp family, and Japanese knotweed (*Polygonum cuspidatum*), a rather large smartweed. Samples of the vine Japanese hops are often sent in by homeowners who find it in wooded areas or on the edges of the wood creeping into their gardens. One such sample was submitted from Morgan county growing on the banks of a river. I have personally also seen it along the banks of the Wabash here in Lafayette. Calls on Japanese knotweed also often come from homeowners who have it growing in their yards. Often an origin of where the plant came from can't be given, but it often appears to have been connected with the movement of soil. For more information on these two plants, please see the following articles. "Japanese Hops (Humulus Japonicus) – One of Indiana's Rising Problematic Weeds" (http://www.ppdl.purdue.edu/PPDL/weeklypics/2-13-06.html) and "Japanese Knotweed Alliance" (http://www.cabi-bioscience.org/html/japanese_knotweed_alliance.htm)