RUTGERS
New Jersey Agricultural Experiment Station
PLANT DIAGNOSTIC LABORATORY

Plant Diagnostic Laboratory

2023 Fiscal Year Report

(July 1, 2022 to June 30, 2023)

Mr. Richard J. Buckley
Director
Plant Diagnostic Laboratory

Ms. Sabrina Tirpak
Principal Laboratory Technician
Plant Diagnostic Laboratory

2023 Fiscal Year
Rutgers Plant Diagnostic Laboratory
Annual Report

Prepared by:
Mr. Richard J. Buckley
Ms. Sabrina Tirpak

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Introduction

Rutgers Soil Testing and Plant Diagnostic Services are provided by Rutgers Cooperative Extension (RCE), the outreach component of the New Jersey Agricultural Experiment Station (NJAES) and the School of Environmental and Biological Sciences (SEBS). Located on the Cook Campus, these laboratories provide New Jersey citizens with chemical and mechanical analyses of soil and diagnoses of plant problems. Their mission is to provide such services in an accurate and timely manner to meet the increasing agricultural and environmental needs of the State. These goals are achieved in cooperation with extension and research faculty and staff at NJAES. This report summarizes the activities of the Plant Diagnostic Laboratory during the 2023 fiscal year.

History

The Rutgers Plant Diagnostic Laboratory and Nematode Detection Service (PDL) was established in 1991 by the dedicated efforts of RCE faculty members Dr. Ann B. Gould and Dr. Bruce B. Clarke, Specialists in Plant Pathology, Dr. Zane Helsel, former Director of Rutgers Cooperative Extension, and Dr. Karen Giroux, past Assistant Director of NJAES. The laboratory was housed in the former USDA post-harvest research laboratory and then Martin Hall on the Cook College campus until 2000 when it was relocated to the Ralph Geiger Turfgrass Education Center at Horticultural Research Farm II in North Brunswick, NJ. The Geiger Center was made possible through the vision and financial backing of Mr. Ralph Geiger and a large group of University and turf industry cooperators.

The PDL accepted its first samples on June 26, 1991, and has since examined 63,138 samples submitted for plant problem diagnosis, nematode analysis, or identification. The laboratory has become an integral part of RCE and SEBS/NJAES programs by providing diagnostic and educational services in support of the teaching, research, and outreach efforts of SEBS/NJAES.

Staff and Cooperators

PDL

Mr. Richard Buckley is the director of the Plant Diagnostic Laboratory. He was hired as a program associate in 1991 and has been in his current position since 1994. Mr. Buckley received his M.S. in Turfgrass Pathology from Rutgers University in 1991. He has a B.S. in Entomology and Plant Pathology from the University of Delaware. He also received special training in nematode detection and identification from Clemson University. Mr. Buckley has work experience in diagnostics, soil testing, and field research, and is currently responsible for sample diagnosis, soil analysis for nematodes, and the day-to-day operation of the PDL. He also participates in research, teaching, and outreach activities.

Ms. Sabrina Tirpak, Principal Laboratory Technician, has worked for the PDL since 1998. She received her B.S. in Plant Science, with an emphasis in horticulture and turf industries as well as a minor in entomology, from Rutgers University in May 2000. She also attended Clemson University for special training in nematode detection and identification. Ms. Tirpak has primary responsibility for insect and weed identification, rapid screening of disease samples using enzyme-based test kits, and assisting in all other aspects of laboratory operations. She also participates in research, teaching, and outreach activities.

Other Support

The PDL regularly employs Rutgers undergraduate students to assist in sample preparation, data entry, and clean-up. As the students help with many of the basic day-to-day tasks, they also gain invaluable laboratory experience that will contribute to career success after graduation.

The laboratories also benefit from the assistance of faculty in several departments, Centers, and Institutes at Rutgers University/SEBS. We owe a great deal of our success to the expertise of faculty in the departments of Plant Biology, Entomology, Ecology, Evolution and Natural Resources, and Agricultural and Resource Management Agents. We would also like to thank the staff of the Rutgers Office of Continuing Professional Education for their support and assistance with our educational programming.

Laboratory Policies

The PDL receives samples from a varied clientele. Sample submission forms, sampling instructions, and fee schedules are available on the NJAES website (www.njaes.rutgers.edu/services). Samples are submitted via United States Postal Service or by private delivery services directly to the laboratory. Many clients walk samples directly into the laboratory.

Samples are processed on a “first come, first served” basis. Detailed records are kept on all samples. A written response including the sample diagnosis, management and control recommendations, and other pertinent information is sent by email to the client.

Fiscal Year 2023 Report

Operations

During the 2023 fiscal year (July 1, 2022 to June 30, 2023), the PDL examined 1,602 specimens submitted for diagnosis, identification (insects, weeds, or fungi), or nematode assay (Table 1), representing a 12% decrease (or 220 samples) from FY22. Samples (Figure 2) submitted for diagnosis (-37) and nematode analysis (-164) both declined in FY23. There was also a decrease in insect identifications (-19) mostly from Cooperative Agricultural Pest Survey (CAPS) and NJ State Forestry Services trap catches (-33). In general, sample submissions remained steady for most of the year, peaking in the summer and declining during the winter. It is our view that 1,500 to 2,000 samples represent peak laboratory capacity, so at 1,602 sample submissions, the PDL was operating at the capacity of the laboratory to function efficiently.

The specimens submitted to the PDL by sample type are presented in Figure 2. Most samples, 67% (1,077), were plant samples submitted for diagnosis, 19% (306) of the samples were insect, mold, or plant identifications and 14% (219) of the samples were for nematode analysis.

Figure 1.

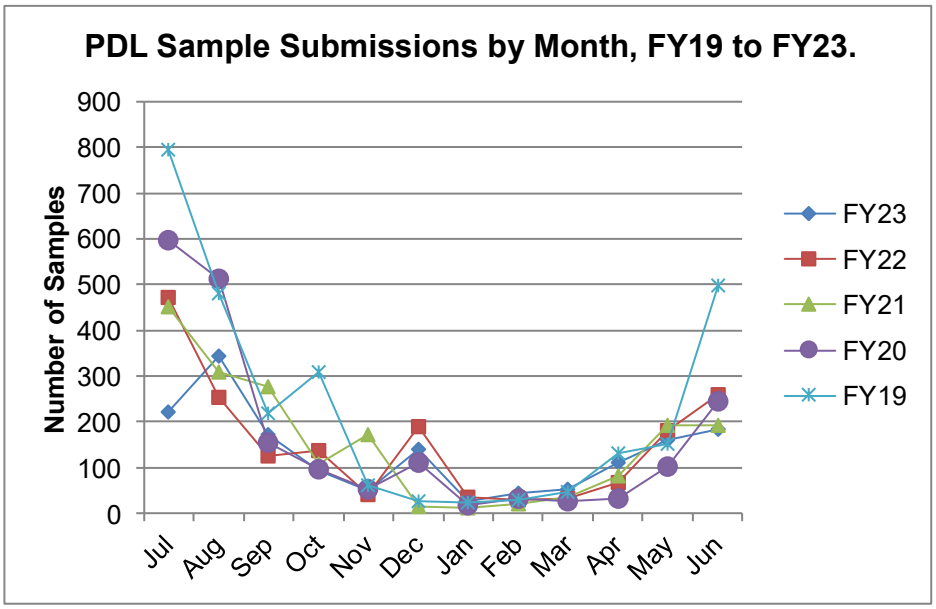
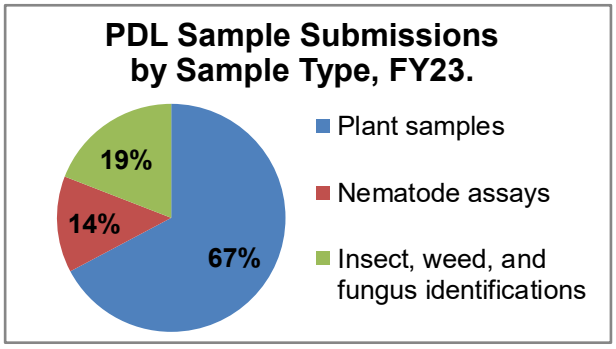


Table 1. PDL sample submissions by month, FY19 to FY23.

Month	FY19	FY20	FY21	FY22	FY23
July	795	596	451	471	223
August	481	513	308	254	345
September	219	156	276	126	172
October	309	96	107	136	93
November	62	52	171	41	50
December	27	112	16	190	140
January	25	18	11	34	27
February	29	32	22	29	44
March	46	27	36	33	52
April	131	33	82	68	112
May	152	103	193	180	160
June	497	246	192	260	184
Total	2773	1984	1865	1822	1602

Figure 2.



In Figure 3, samples submitted to the laboratory are presented by origin. In FY23, 85% of the plant submissions were from commercial clientele, 11% were from residential clientele, and 4% were submitted from research faculty at Rutgers University. Commercial plant managers benefit more financially from our services thus they submit the majority of samples to the laboratory. This distribution is consistent with other years.

In FY23, 89% of samples submitted for plant or insect identification were from commercial clients, 10% were residential in origin, and 1% (4 samples) were from research (Figure 3). Household or nuisance pests are the primary issues of concern for residential clients.

Of the nematode assays submitted, 95% of the samples were from commercial clients, with 5% (10 samples) from research, and 0% (1 sample) from residential clientele. We expect that the number of nematode samples submitted from residential clients will remain low or nonexistent, since much of this clientele is not familiar with nematode pests.

Samples from research programs represent a relatively small percentage of the total number of plant and soil samples received. However, research samples are an extremely important component of our submissions. Research samples allow the diagnosticians to cooperate with University faculty on problems of great importance to the State of New Jersey.

Turfgrass and ornamentals represent the largest agricultural commodities in New Jersey. In support of New Jersey as an urban agriculture state, it follows that the vast majority of samples (89%) were either turfgrass or ornamental plants (Figure 4). The wide variety of turf and ornamental species grown under diverse environmental conditions in our state results in a large number of problems not readily identifiable by growers or county faculty with these crops. Furthermore, extension faculty and staff who deal primarily with turfgrass and ornamental plants as commodities, as well as plant managers in the turf and ornamentals industries, readily adopted the user fee-based delivery of service. Alternatively, commercial growers of traditional agricultural crops have been slow to adopt a fee-for-service system. Certain RCE faculty and staff members in New Jersey's southern counties continue to provide free diagnostic services and do not advertise laboratory services to these growers. Inroads are being made with these commodity groups through the Vegetable and Fruit IPM groups, and it is our hope that sample submissions from traditional agricultural crops will increase in future years.

Traditionally, most of the soil samples submitted to the laboratory for nematode analysis were from golf turf managers; however, nematode samples from growers establishing vineyards were also very common. A large portion of the nematode samples in FY23 were submitted to the laboratory through the Rutgers Fruit IPM program from blueberry growers. Golf turf represents most of the nematode samples from turfgrass clientele. Problems in golf turf, particularly with nematodes, are more severe during seasons with considerable heat and drought stress, and it is those years that carry the highest submission totals.

Figure 3.

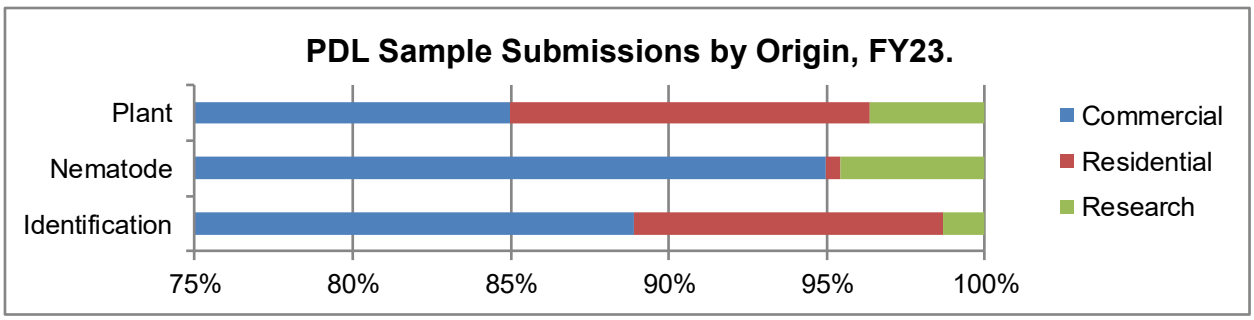


Figure 4.

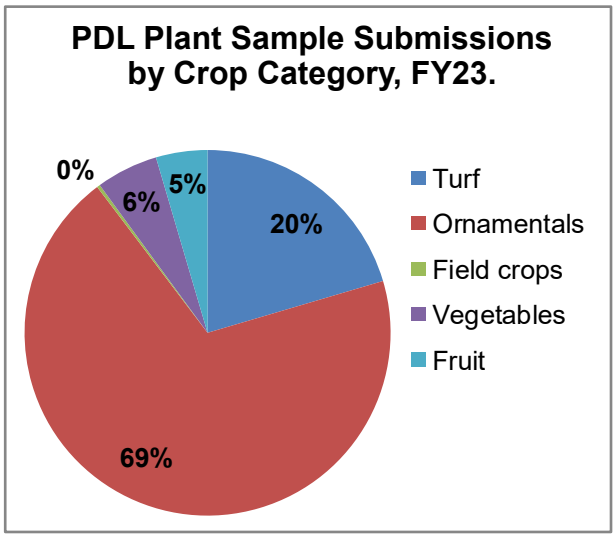
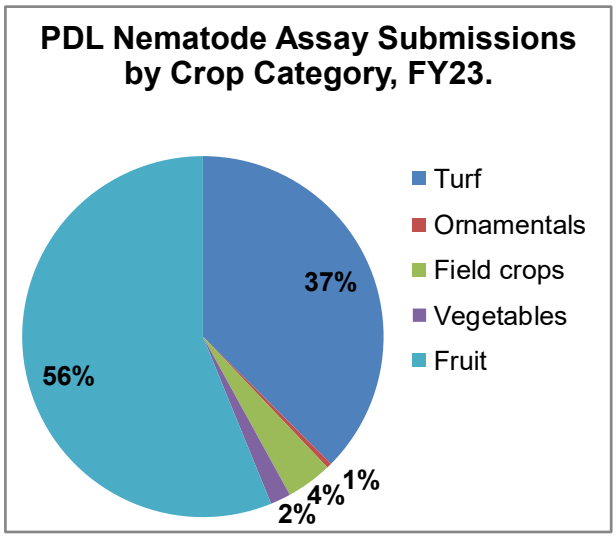


Figure 5.

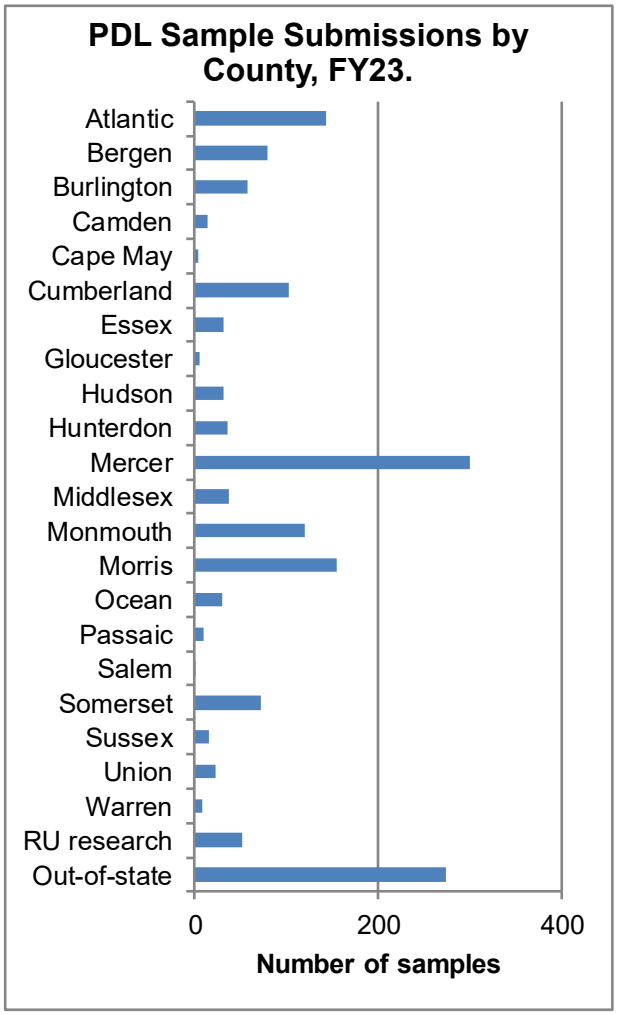


Samples were submitted to the PDL from all counties in New Jersey (Figure 6). The majority of samples, however, were submitted from counties in close proximity to the laboratory. The probable explanation for this is that many citizens in central New Jersey contact Rutgers University directly for assistance with plant-related problems and are referred to the laboratory by the campus information service and through various academic departments. Samples were also abundant from counties with dense populations that have disease problems associated with turf and ornamentals in residential landscapes or on golf courses. In addition, county profiles are also influenced by the presence or absence of staff in those offices. To some degree, the profile also identifies county faculty, staff and Master Gardener programs that promote and utilize PDL services.

Approximately 17% of the samples submitted for diagnosis to the laboratory were from out-of-state. The percent of out-of-state samples decreased (3%; 86 samples) from the previous FY22. Of particular note, 47% of all turf samples were from out-of-state. Golf turf samples were submitted to the laboratory from 16 states in FY23. Turf samples were received from states as far away as California, Connecticut, Delaware, Illinois, Kentucky, Massachusetts, Maryland, New York, Oregon, Pennsylvania, Texas, Utah, Virginia, Washington, and West Virginia. New York and Pennsylvania provided the largest number of out-of-state samples.

Many golf turf professionals at other universities refer their clients to Rutgers for second opin-

Figure 6.



ions or when they are on leave. Dr. John Inguagiato at the University of Connecticut and Dr. Paul Vincelli at the University of Kentucky, both Rutgers graduates, refer clients to the PDL. Dr. Frank Rossi of Cornell University is also a great supporter of our program. He advocates and advertises laboratory services in his ShortCutt newsletter, which reaches more than 2,700 turf managers in New York State. Lastly, Mr. Buckley's association with the Professional Golf Turf Management School allows for contact with as many as 90 potential new clients each year. Many of the students turn into regular patrons of the laboratory services. The charge for out-of-state samples is substantially higher to help defray the cost of in-state samples.

Of the samples submitted to the PDL for diagnosis or identification, 34% were associated with biotic disease-causing agents (Figure 7). Abiotic disease-causing factors (e.g., environmental extremes, nutrient deficiencies, poor cultural practices, poor soil conditions, etc.) accounted for another 27% of the laboratory diagnoses. Insect pest damage was diagnosed on 6% of the submissions. Identifications comprised 19% of the total number of samples submitted; of these, 16% (264) were arthropods, 1% (14) fungi, and 2% (28) were plants. Nematode detection accounted for the other 14% of submissions. The overall breakdown in sample submissions is typical of that reported by other diagnostic laboratories and reflects the normal seasonal totals for submissions to the Rutgers laboratory.

Insect samples account for most of the organisms identified by the laboratory. Many residential clients submit samples of stored product or nuisance pests that are found within the household. The number of these samples has declined as the Department of Entomology has added an urban entomologist who offers the service free-of-charge. Arthropod identifications decreased in FY23 be-

Table 2. PDL sample submissions by county, FY19 to FY23.

In-state	FY19	FY20	FY21	FY22	FY23
Atlantic	73	61	24	23	143
Bergen	88	67	70	90	80
Burlington	68	75	77	61	58
Camden	32	11	10	4	14
Cape May	13	7	5	12	4
Cumberland	86	33	54	54	102
Essex	17	24	16	34	32
Gloucester	62	12	22	10	5
Hudson	9	32	33	83	31
Hunterdon	60	22	20	45	35
Mercer	875	585	449	330	301
Middlesex	62	51	42	73	37
Monmouth	263	164	200	218	120
Morris	197	234	216	210	155
Ocean	50	39	33	28	30
Passaic	27	20	24	13	10
Salem	85	32	2	11	1
Somerset	115	91	56	64	72
Sussex	16	14	8	6	16
Union	53	25	27	32	22
Warren	14	17	8	9	8
RU research	83	60	91	52	52
In-state total	2348	1676	1487	1462	1328
Out-of-state	425	308	378	360	274
Total	2773	1984	1865	1822	1602

Figure 7.

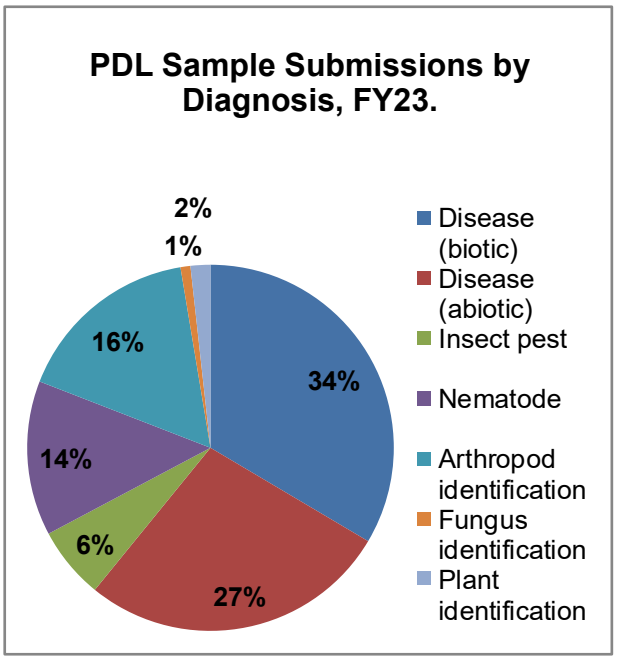
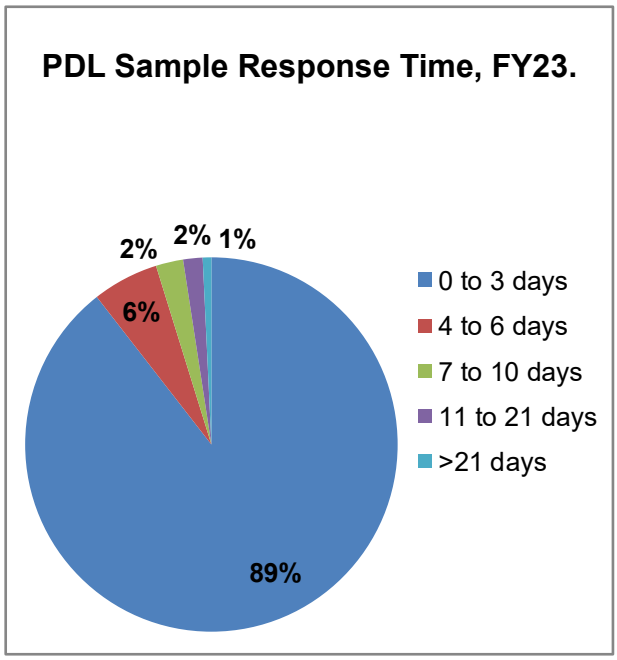


Figure 8.



cause the number of trap catch samples from the state's CAPS and NJ State Forestry Services programs decreased (-33).

Fungal identification is also a popular service for the laboratory. Samples from mold-infested houses remained steady in FY23 The submissions of samples for mold identification rise with media attention to the perceived health issues associated with mold-infested homes and the incidence of local flooding.

In FY23, a laboratory response was prepared in less than three days for most (89%) of the samples submitted (Figure 8), and 95% of our clients received a response in less than a week. A number of the samples (39) took longer than 10 days to diagnose. In these cases, special consultation (i.e. culturing or other lab tests) was required for an accurate diagnosis, and the clients were advised of progress throughout the period. Since nematode samples deteriorate rapidly in storage, virtually all of the nematode processing was finished in less than three days. The rapid response time is attributed largely to the expertise of our competent staff. Adequately trained staff is essential to the continued growth and efficient operation of the laboratory.

Teaching and Outreach

In addition to providing diagnostic services and soil analysis, the staff of the PDL provides significant educational and outreach services to RCE, SEBS/NJAES, and other agencies (Appendix 3). Many of these activities generated additional income for the laboratories. Collectively, Mr. Buckley and Ms. Tirpak presents 182 lectures in FY23 (Table 3).

Table 3. PDL Lectures by Audience, FY23.

Audience	Buckley	Tirpak	Total
RCE & OCPE	89	27	116
Industry	37	8	45
Master Gardener	10	10	20
SEBS	1	0	1
Total	137	45	182

Richard Buckley

Mr. Buckley is an instructor in the Rutgers Professional Golf Turf Management School. He taught four courses (Diseases of Turf; Diseases and Insect Pests of Ornamental Plants; Insect Pests in Fine Turf; and Principles of Pest Management on the Golf Course) in both the spring and fall ses-

sions. This twice a year, 10-week teaching commitment consists of a total of 140 hours of contact time per year. The teaching efforts by the PDL staff in the Professional Golf Turf Management School generate significant income for the laboratory. This income and client development source also helps support the PDL.

Mr. Buckley participated in several other OCPE short courses in FY23. These courses included: The Golf Turf Management School: Three Week Preparatory Course; Landscape IPM: An Intelligent Approach; and the Emergency Pesticide Credit Recertification Short Course.

Mr. Buckley served as the course coordinator and lecturer for the Pest Management in Landscape Turf Short Course. This was the 30th year for this one-day program. Mr. Buckley also coordinated and taught the Advanced Topics in Professional Grounds Maintenance: Turf Disease Short Course. This was the 25th time he planned and coordinated that short course.

Mr. Buckley was an invited speaker in several RCE programs. Lectures were given in support of the Mercer, Monmouth, Morris, Ocean, and Somerset Counties. He also participated in the Certified Gardener Training Program in Camden and Gloucester Counties.

Mr. Buckley participated as a guest speaker in one undergraduate course at Rutgers: Weeds, Diseases, and Insects of Plants (11:776:391).

Mr. Buckley was also an invited speaker for: Illinois Landscape Contractors Association: Turf Education Day; Golf Course Superintendents Association of America: Western Washington Chapter; Joshua Tree Experts Education Day; SiteOne University; New Jersey Shade Tree Federation: Annual Conference; West Virginia Golf Course Superintendents: Annual Turf Conference; Golf Course Superintendents Association of America: Eastern Shore Chapter Annual Conference; Nassau County Cooperative Extension; Penn State Professional Pest Managers School; New Jersey Green Expo—Turf and Landscape Conference; International Society of Arboriculture of PA/DE/NJ Pest Bull Session; Golf Course Superintendents Association of America: Maine Chapter; Golf Course Superintendents Association of America: Hudson Valley Chapter; North Jersey Ornamental Horticulture Conference—Landscape Day; New Jersey Nursery and Landscape Association—Total Pro Expo and Conference; PLANT WNY: Trade Show and Education Conference; Lawn Care Association of Pennsylvania; Penn State Turf and Ornamentals Conference; Lawn Doctor National Training; SynaTek Winter Seminar; Central Jersey Turf and Ornamentals Institute; New York State Turf Association; Reed and Perrine Turf and Ornamental Seminar; New Jersey Landscape Contractors Association—Annual Tradeshow and Conference; Davey Tree Company; Morris Arboretum School of Arboriculture; Licensed Tree Expert Prep Course; and Somerset County Library System Webinar Series.

Sabrina Tirpak

Ms. Sabrina Tirpak is responsible for teaching Turf Diseases and Turf Insects laboratory practicums in the Rutgers Professional Golf Turf Management School. She has approximately 60 hours of contact time per year in the turf school.

Ms. Tirpak participated in additional OCPE short courses in FY23. These courses included: The Emergency Pesticide Credit Recertification Short Course; and the Pest Management in Landscape Turf Short Course.

Ms. Tirpak also presented programs in support of the Hunterdon; Mercer; Monmouth, Morris, and Ocean, and Somerset County Master Gardener Programs.

Ms. Tirpak participated as a guest speaker in one undergraduate landscape course at the County College of Morris.

Ms. Tirpak was also an invited speaker for: New Jersey Green Expo—Turf and Landscape Conference; SiteOne University; North Jersey Ornamental Horticulture Conference—Tree Day; Brooklyn Landscape Gardeners Association; New Jersey Chapter of the International Society of Arboriculture—Garden State Tree Conference; and the Somerset County Library System Webinar Series.

Extension Publications

Mr. Buckley is a contributor to the Plant & Pest Advisory. The print version of the newsletter was transformed for the 2013 growing season into a blog format. A special section on the blog site was designated for Plant Diagnostic Laboratory activities. Mr. Buckley and Ms. Tirpak write brief posts on the disease and insect pests problems submitted to the laboratory. The Plant Diagnostic Laboratory's PPA blog posts can be found at plant-pest-advisory.rutgers.edu/category/plant-diagnostic-lab.

In collaborations with other Rutgers research and extension faculty and staff, Mr. Buckley contributed to a Cooperative Extension Bulletin about emerging diseases of hemp in New Jersey (Appendix 4):

Rajmohan N, Komar S, Bamka W, Buckley R, Brown K, Infante-Casella M, Cabrera R, Gianfagna T, Simon J, Wyenandt A. *Emerging Diseases of Hemp in New Jersey* [Bulletin]. https://njaes.rutgers.edu/e374/

Service

The PDL staff provided tours of the Ralph Geiger Turfgrass Education Center and the Plant Diagnostic Laboratory to numerous groups in FY23.

Mr. Buckley is a member of the Nursery Working Group initiated by Dr. Timothy Waller, County Agent from RCE of Cumberland County.

Mr. Buckley and Ms. Tirpak are members of the Cooperative Agricultural Pest Survey (CAPS) team. The CAPS program is a pest surveillance program managed by USDA-APHIS and state departments of agriculture. They are also members of the Forest, Landscape, and Agriculture Pest Roundtable (FLAPR) organized by the Rutgers Urban Forestry Program of NJAES. Universities, natural resource protection organizations, and industry groups are also partners of both groups.

Marketing

Laboratory services are advertised at grower meetings or other green industry events. Table-top and banner display units are used to advertise Soil Testing Laboratory and Plant Diagnostic Laboratory services. Staff from both the Soil Testing Laboratory and Plant Diagnostic Laboratory regularly attends and staffs a booth to explain laboratory services and sell soil test kits.

Print ads reflecting Plant Diagnostic and Soil Testing Laboratory services have been developed and deployed into several green industry publications. Lastly, PDL staff are frequent lecturers in regional green industry educational programs. These events have been an excellent option for capturing new clients and educating potential clients in laboratory services and submission protocols.

Income

The PDL is expected to recover all costs and be self-supporting. Laboratory clientele are charged a nominal fee for diagnostic and testing services, site visits, and for educational activities. Grant activity and cost-sharing arrangements also provide some degree of funding.

A sample submission form and the appropriate payment accompanied the majority of samples received by the PDL from residential clientele. The ability to accept payment via credit card has been a very successful tool in limiting the time necessary to collect our fees and has reduced losses due to non-payment. In many cases, commercial growers preferred to be invoiced, which costs laboratory personnel time and effort to collect. Internal transfer of funds was used to pay for the plant samples diagnosed for research programs at Rutgers University.

In FY23, $367,308.28 was generated from all PDL activities and revenue streams, which covered 109% of all costs. A complete breakout of all revenues and expenses is included in Appendix 2.

National Plant Diagnostic Network

In 2003, the PDL was invited to participate in the National Plant Diagnostic Network (NPDN). The NPDN is a coordinated network of plant diagnostic laboratories from land grant universities in the US. The network provides a cohesive distribution system to quickly detect pests and pathogens that have been deliberately or unintentionally introduced into agricultural and natural ecosystems. It is designed to be a key part of our homeland security effort to protect agriculture in the nation. Advantages of joining the system include rapid evaluation and reporting of potential bioterrorist threats and other high consequence diseases or pest problems; rapid response time for diagnosis; formal coordination of diagnostic labs within the NPDN; improved links with Federal and State regulatory agencies; and improved quality and uniformity of information associated with sample submission and reporting. The USDA provides grant monies as incentive to participate. Mr. Buckley is the principal investigator in the Rutgers subcontract.

Northeast Plant Diagnostic Network

The Northeast Plant Diagnostic Network (NEPDN) is the regional part of the National Plant Diagnostic Network that focuses on regional concerns regarding plant diseases and insect pests. The regional center for the NEPDN is Cornell University. The Rutgers PDL has been identified as a cooperating institution and participates as a subcontractor to the regional center at the University of Maine. Grant monies provided by the USDA through the NEPDN were used in FY23 to pay salaries, participate in professional training programs and meetings, and to purchase equipment and supplies to upgrade the laboratory's capability for accurate and timely diagnosis of plant problems. Upgrades to laboratory technologies improve communication with our local stakeholders, cooperators, and experts in the northeast regional and na-

tional networks. The capacity for improved communication facilitates the rapid dissemination of information concerning current plant disease and insect pest activity. The new equipment and upgrades in technology also provide the means to create modern educational resources for use in local and regional training programs. Grant monies received for FY24 will be used to continue to upgrade laboratory capability to handle pathogens of consequence and other biohazards; attend training programs for insect and disease identification; hire labor to enter data into the National Plant Disease Information System.

Northeast IPM Program

The Rutgers Plant Diagnostic Laboratory's partnership with the NPDN has well equipped the laboratory to execute its mission. Trained staff, however, is necessary to ensure that we continue to play our part as a partner in the efforts of local and regional IPM programs, USDA-APHIS-PPQ, and CAPS to protect the agricultural interests in the region. Proper staffing is also critical in providing diagnostic services for the agricultural interests within the state and to maintain the strong historical relationships with Rutgers IPM and New Jersey Department of Agriculture programs. Grant monies received to that end will be used to cover a portion of the costs of one technical employee who is trained to perform basic diagnostic tasks including fungal culturing, insect identifications, ELISA, PCR, and other common tasks associated with insect pest and disease diagnostics. The technician will also train in SOPs for pests and diseases of concern in our region and will participate in ongoing training programs for Rutgers graduate and undergraduate students who are interested in IPM, diagnostics, and plant biosecurity.

Ramapo Tomato Sale

In the spring of 2008, the New Jersey Agriculture Experiment Station revived the hybrid tomato variety 'Ramapo'. The staff of the PDL conducted the retail sale of the seed with Cindy Rovins. With Ms. Rovin's retirement from Rutgers at the end of FY22, the tomato seed sale program was discontinued in FY23 as of January 1, 2023. The variety 'Moreton' was added for the 2009 season, a "Rediscover the Jersey Tomato" t-shirt for 2010, and the variety 'KC-146' was introduced for 2013. The 'Rutgers 250' tomato seed variety was released for the 2016 growing season, coinciding with the 250th anniversary of Rutgers University, and a "Rediscover Jersey Strawberries" t-shirt was added for 2017. The 'Pumpkin' habanero pepper seeds were offered for sale to the public in 2018. A bicolor grape tomato variety, 'Scarlet Sunrise', was added to the seed sales in 2020. Over the program's almost 15 years, the PDL processed 18,631 orders for 52,934 packets of seeds. The t-shirts were extremely popular also with over 1,877 sold.

Client Survey

Beginning in January of 2021 a client satisfaction survey was included with each emailed sample report. Survey data and comments are currently being collected to assist laboratory staff in evaluating the impact of our work. Survey responses collected during FY23 (73 responses) are included in Appendix 4 of this report. We anticipate reporting additional results in this publication for FY24 as the data set increases in size.

Future Directions and Challenges

The top priority for FY24 will be to increase revenue and reduce expenses. To accomplish this, we will continue to promote laboratory services wherever possible. Increasing the awareness of laboratory services should bring increasing numbers of samples, however, our expectations are tempered in this regard due to the nature of the operation. Many factors outside of our control (ex. weather) strongly contribute to the need for laboratory services from season to season.

Despite continuing efforts to promote laboratory services, samples numbers from the turfgrass industry have plateaued or fallen in recent year. For many seasons, the Rutgers PDL was one of the only outlets for turf industry professionals to get quality turfgrass disease diagnosis. In the last decade, however, University laboratories in several states have adopted turfgrass diagnostics, chemical manufacturers and distributors have hired Ph. D. turfgrass pathologists to their sales staffs, and many private turf consultants have entered the market. These developments, as well as several other factors, have significantly diluted the number of turf samples coming into our laboratory from around the country. Any reduction in turf samples has an outsized impact on revenues. In order to combat this trend, we continue to engage with turf industry professional associations in education and awareness programs in the hopes of capturing new clients or re-engaging with old ones.

In the spring of 2019, PDL staff convened a focus group of laboratory stakeholders to discuss the laboratory fee schedule. The group consisted of golf course superintendents, lawn and landscape professionals, academic advisors, and chemical industry representatives. The group agreed that prices were too low. Our fee schedule was adjusted accordingly and the new fees were implemented

immediately to zero complaints. This was the first fee increase since 2006. We expect to reconvene the group in the winter of 2023 to discuss price increases for the 2024 growing season.

In 2022, the NPDN established a Core standard to require all NPDN member laboratories to commit to excellence in plant diagnostics by achieving core accreditation. The purpose of the NPDN Core standard is to provide an overarching framework that helps laboratories to maintain a high level of professionalism and quality of diagnostic results. The Rutgers PDL intends to achieve the Core standard and has been attending regular monthly meetings with other NEPDN diagnosticians to that end. We expect that this process will take several years.

In recent years, there has been an exponential increase in the number of plant pathogen diagnostic protocols using nucleic acid tools. These advances in science have led a rapid transition to molecular diagnostics at many Land Grant University diagnostic facilities. The Rutgers PDL recognizes the need to incorporate these tools into our routine laboratory practices. To that end, the NJAES administration has provided funding to purchase new equipment that will help us begin the transition to more modern diagnostic tools. We hope to incorporate the new techniques in the coming season.

Funding has always been the fundamental challenge to the success of the Plant Diagnostic Laboratory. Salaries are the main cost driver for the operation. The need to increase revenues each year to meet increasing salaries is unsustainable. If the New Jersey Agricultural Experiment Station and Rutgers Cooperative Extension deem that a plant diagnostic facility is indispensable to our mission, then the salaries of all full-time employees must be paid and guaranteed by the administration. We are one of the only diagnostic facilities in the country that must cover our own salary expenses to operate. Our cost structure and funding model is foreign to most of our colleagues. As a result, many of our colleagues diagnose samples for free or at modest fees compared to our laboratory for the services they offer. This makes competing for samples in their states impossible and is a financial incentive for New Jersey green industry professionals to send samples to out-of-state facilities, which limits our ability to increase revenues.

Because our ability to control salary costs is so limited, we have had to forgo student employees in the laboratory post-pandemic to counter the salary creep of our full-time employees. Furthermore, over the years, more and more administrative tasks have been passed down to the laboratory from the business office. As a result, a considerable amount of time is spent by Mr. Buckley and Ms. Tirpak doing routine laboratory chores rather than pursuing diagnostics, educational outreach activities, and professional development. Funding our salaries will allow us to re-staff the laboratory with student and administrative help and to upgrade our capabilities as diagnosticians.

Diversity, Equity, and Inclusion

The Rutgers PDL has a long history of hiring underrepresented minority students as laboratory technicians. The experience gained in our laboratory has enabled many of them to gain University credits toward their degrees and has led to graduate school positions. Several of our black, Asian, and female technicians now have excellent, successful jobs in the green industry. Administrative support via salary support will enable us to continue this tradition of training and promoting underrepresented populations into the historically white, male dominated green industry professions.

Appendix 1.

PLANT DIAGNOSTIC LABORATORY - FEE SCHEDULE

All fees are per sample. Please visit **www.njaes.rutgers.edu/services** for sampling instructions.

STANDARD SAMPLE (most samples except fine turf)

In-state	$50
Out-of-state	$100

FINE AND SPORTS TURF

In-state	
Disease/insect diagnosis	$100
Disease/insect diagnosis & nematode assay*	$150
Out-of-state	
Disease/insect diagnosis	$120
Disease/insect diagnosis & nematode assay*	$200

*** Combination price applies only to samples from same location (i.e. the same green, field, etc.)**

NEMATODE ASSAY

In-state (except fine turf)	$50
In-state fine turf	$75
Out-of-state	$100

FUNGUS AND MOLD IDENTIFICATION

In-state microscopic identification	$50
Out-of-state microscopic identification	$100

INSECT IDENTIFICATION

In-state	$50
Out-of-state	$100

PLANT AND WEED IDENTIFICATION

In-state	$50
Out-of-state	$100

SPECIAL TESTS AND SERVICES*

Endophyte screening

Fungicide resistance testing

Pesticide residue and contaminant testing

Site consultation

Speaker request

Virus testing

***Please call ahead to discuss available tests, fees, and specifics.**

OTHER SERVICES NEGOTIABLE. CONTRACTS AND VOLUME DISCOUNTS ARE AVAILABLE.
ALL FEES ARE SUBJECT TO CHANGE WITHOUT NOTICE.

Appendix 2. Plant Diagnostic Laboratory Budget

Table A2.1. Expenses, PDL-FY23.

Salaries and benefits	
(full and part time staff)	$328,616.23
Supplies and services	
Diagnostic and testing supplies	
Printing and marketing	
References	
Equipment maintenance	
Office supplies	
Credit card fees	$12,936.91
Communications	
Telephone/fax	
Postage	$2,961.02
Travel	
Paid talks and professional meetings	$1,244.42
Total operating costs	$345,758.58

Table A2.2. Income, PDL-FY23.

Sample fees	$108,169.53
Lecture fees	
OCPE and other honorarium	$41,511.21
Grants and contracts	
NPDN	$25,000.00
IPM	$32,088.84
Other	
Salaries (NJAES/SEBS)	$160,538.70
Total actual income	$367,308.28

Table A2.3. Estimated expenses, PDL-FY24.

Salary and benefit costs	$310,000.00
Supplies and services	$10,000.00
Communications, marketing and travel	$5,000.00
Total potential cost FY24	$325,000.00

Table A2.4. Estimated income, PDL-FY24.

Plant Health Samples	
2000 @ $55 average fee per sample	$110,000.00
Lecture fees	
OCPE and other honoraria	$25,000.00
Cost recovery	
Grant and contracts	$60,000.00
Salaries (NJAES/SEBS)	$150,000.00
Total potential income FY24	$345,000.00

Appendix 3.
Table A3.1. Complete listing of lectures presented by Richard J. Buckley, PDL Director, FY23.

Date	Title	Audience	Location	Par-ticipants[1]
08/23/22	Diagnostic Tips for the Problem Lawn (0.75hr)	Illinois Landscape Contractors Association: Turf Education Day	Glencoe, IL	I,L,T
08/23/22	Turf Disease: Pick Your Best Defense (0.75hr)	Illinois Landscape Contractors Association: Turf Education Day	Glencoe, IL	I,L,T
08/30/22	Anthracnose: The Scourge of the Modern Putting Green (1hr) ONLINE	Golf Course Superintendents Assoc. of America: Western Washington Chapter	online	I,T
09/13/22	Diseases and Pests of Trees in the Urban Forest (2.5hr)	Joshua Tree Experts Education Day	Easton, PA	A
10/06/22	Basic Plant Pathology and the Art of the Diagnosis (3hr)	Master Gardener Training Program	Mercer County	H
10/10/22	#1. Principles of Pest Management: Introduction to Integrated Pest Management (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
10/10/22	#1. Turf Diseases. Turf Diseases: Principles of Plant Pathology (2hr)	Professional Golf Turf Management School	Middlesex County	T
10/11/22	#1. Diseases and Insect Pests of Ornamentals: Abiotic Stress in Trees (2hr)	Professional Golf Turf Management School	Middlesex County	T
10/11/22	#1: Insects in Fine Turf: Introduction to Entomology; Insect Structure and Function (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
10/12/22	Diagnostic Tips for the Problem Lawn (1hr)	Emergency Pesticide Recertification Short Course	Middlesex County	L,T
10/13/22	Emerging New Pests and Diseases to the Urban Forest (1hr)	NJ Shade Tree Federation: Annual Conference	Cherry Hill, NJ	A
10/17/22	#2. Principles of Pest Management: IPM Basics: Considerations for Setting up a Program (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
10/17/22	#2. Turf Diseases: Introduction to Mycology and Fungal Structures (2hr)	Professional Golf Turf Management School	Middlesex County	T
10/18/22	#2. Diseases and Insect Pests of Ornamentals: Scouting Tips for Landscapes; Pesticide Review (2hr)	Professional Golf Turf Management School	Middlesex County	T
10/18/22	#2. Insects in Fine Turf: Insect Classification; Orders (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
10/20/22	Basic Turf Management (3hr)	Master Gardener Training Program	Mercer County	H
10/21/22	Lawn Pests (3hr)	Emergency Pesticide Recertification Short Course	Middlesex County	L,T
10/24/22	#3. Principles of Pest Management: Principles of Insect Pest and Disease Control (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
10/24/22	#3. Turf Diseases: The Red Thread Syndrome; Snow Molds (2hr)	Professional Golf Turf Management School	Middlesex County	T
10/25/22	#3. Diseases and Insect Pests of Ornamentals: New Plant Pathogens: Bacteria, Phytoplasma, Virus, Parasitic Plants (2hr)	Professional Golf Turf Management School	Middlesex County	T

Appendix 3. (Continued)
Table A3.1. (Continued)

Date	Title	Audience	Location	Par-ticipants[1]
10/25/22	#3. Insects in Fine Turf: Insect Growth and Development; Insect Behavior (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
10/27/22	Complete Turf Disease (7hr)	Advanced Turf Disease Short Course	Middlesex County	L,T
10/31/22	#4. Principles of Pest Management: Cultural Control (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
10/31/22	#4. Turf Diseases: Diseases caused by Algae and Other Related Organisms; Slime Molds (2hr)	Professional Golf Turf Management School	Middlesex County	T
11/01/22	#4. Diseases and Insect Pests of Ornamentals: Leaf Spots, Anthracnose, and Stem Diseases (2hr)	Professional Golf Turf Management School	Middlesex County	T
11/01/22	#4. Insects in Fine Turf: IPM Basics: A Review of Scouting Techniques and Insecticides (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
11/01/22	The Rings of Death Part 1: Summer Patch and Take-All (1hr)	West Virginia Golf Course Superintendents: Annual Turf Conference	Roanoke, WV	I,T
11/01/22	The Rings of Death Part 2: Fairy Rings (1hr)	West Virginia Golf Course Superintendents: Annual Turf Conference	Roanoke, WV	I,T
11/03/22	2022 Dead Golf Turf Year in Review: The Diagnostician's Point of View (1hr)	Golf Course Superintendents Assoc. of America: Eastern Shore Chapter Annual Conference	Ocean City, MD	I,T
11/07/22	#5. Principles of Pest Management: Fungicide Selection and Use (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
11/07/22	#5. Turf Diseases: Diseases Caused by Species of the Fungus Rhizoctonia; Fairy Ring (2hr)	Professional Golf Turf Management School	Middlesex County	T
11/08/22	#5. Diseases and Insect Pests of Ornamentals: Root Rots and Vascular Wilt Diseases (2hr)	Professional Golf Turf Management School	Middlesex County	T
11/08/22	#5. Insects in Fine Turf: Nematodes (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
11/14/22	#6. Principles of Pest Management: Fungicide Selection and Use (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
11/14/22	#6. Turf Diseases: Root-infecting Patch Diseases (2hr)	Professional Golf Turf Management School	Middlesex County	T
11/15/22	#6. Diseases and Insect Pests of Ornamentals: Rusts, Mildews, and Molds; Mites (2hr)	Professional Golf Turf Management School	Middlesex County	T
11/15/22	#6. Insects in Fine Turf: Coleoptera--Scarabs: The White Grub Complex (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
11/17/22	Basic Plant Pathology and the Art of Diagnosis (3hr)	Master Gardener Training Program	Somerset County	H
11/21/22	#7. Principles of Pest Management: Insecticide Selection and Use (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
11/21/22	#7. Turf Diseases: Anthracnose; “Helminthosporium” Leaf Spots (2hr)	Professional Golf Turf Management School	Middlesex County	T

Appendix 3. (Continued)
Table A3.1. (Continued)

Date	Title	Audience	Location	Par-ticipants[1]
11/22/22	#7. Diseases and Insect Pests of Ornamentals: Suckers: Scale, Bugs, Hoppers, and Plant Lice (2hr)	Professional Golf Turf Management School	Middlesex County	T
11/22/22	#7. Insects in Fine Turf: Coleoptera--Weevils: Annual Bluegrass Weevil; Billbugs (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
11/24/22	New and Emerging Diseases and Insects in NJ/NY Urban Forests (1hr) ONLINE	Nassau County Cooperative Extension	online	I,L
11/28/22	#8. Principles of Pest Management: The Least Toxic Alternative (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
11/28/22	#8. Turf Diseases: Dollar Spot; Gray Leaf Spot (2hr)	Professional Golf Turf Management School	Middlesex County	T
11/29/22	#8. Diseases and Insect Pests of Ornamentals: Borers: Round-headed and Flat-headed Borers; Gall Makers and Miners (2hr)	Professional Golf Turf Management School	Middlesex County	T
11/29/22	#8. Insects in Fine Turf: Lepidoptera: Armyworms, Cutworms, and Sod Webworms (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
11/30/22	31 Years of the Plant Diagnostic Lab at Rutgers: Trends in Turf Disease Diagnosis (1hr) ONLINE	SiteOne University	online	I,L,T
12/01/22	#9. Principles of Pest Management: Commercial Biocontrol and Biocontrol Concepts (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
12/01/22	#9. Turf Diseases: Rust, Smut, Mildews and Other Minor Leaf Blighting Diseases (2hr)	Professional Golf Turf Management School	Middlesex County	T
12/02/22	#9. Diseases and Insect Pests of Ornamentals: Borers: Weevils, Bark Beetles, and Clear-winged Moths (2hr)	Professional Golf Turf Management School	Middlesex County	T
12/02/22	#9. Insects in Fine Turf: Hemiptera: Chinch Bugs; Ground Pearls (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
12/05/22	Our Majestic Oaks and Their Achilles' Heel (1hr)	Penn State Professional Pest Managers School	online	A,L
12/07/22	Is it Drought, Disease, or Insects? (1hr)	New Jersey Green Expo - Turf and Landscape Conference	Atlantic City, NJ	I,L,T
12/07/22	Old and Emerging Oak Diseases (0.5hr)	New Jersey Green Expo - Turf and Landscape Conference	Atlantic City, NJ	I,L,T
12/08/22	Landscape Plants in 2022: Is it Drought, Disease, or Insects? (1.75hr)	New Jersey Green Expo - Turf and Landscape Conference	Atlantic City, NJ	I,L,T
12/08/22	The Rings of Death: Fairy Rings and Summer Patch (2hr)	New Jersey Green Expo - Turf and Landscape Conference	Atlantic City, NJ	I,L,T
12/12/22	#10. Principles of Pest Management: Scouting Your Golf Course (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
12/12/22	#10. Turf Diseases: Abiotic Stress in Turfgrass (2hr)	Professional Golf Turf Management School	Middlesex County	T

Appendix 3. (Continued)
Table A3.1. (Continued)

Date	Title	Audience	Location	Par-ticipants[1]
12/13/22	#10. Insects in Fine Turf: Regional Concerns: Mole Crickets and Crane Flies (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
12/13/22	#10. Diseases and Insect Pests of Ornamentals: Leaf Feeders: Lepids, Sawfly, and Weevils (2hr)	Professional Golf Turf Management School	Middlesex County	T
12/16/22	Pest Bull Session: Tree Diseases Update (2hr)	ISA of PA-DE-NJ	Bryn Mawr, PA	A
12/19/22	Basic Plant Pathology and the Art of Diagnosis (3hr)	Master Gardener Training Program	Morris County	H
01/09/23	#1. Principles of Pest Management: Introduction to Integrated Pest Management (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
01/09/23	#1. Turf Diseases. Turf Diseases: Principles of Plant Pathology (2hr)	Professional Golf Turf Management School	Middlesex County	T
01/11/23	Diagnostic Tips for Problem Turf (1hr)	Maine Golf Course Superintendents Association	Portland, ME	I,T
01/11/23	31 Years of the Plant Diagnostic Lab at Rutgers: Trends in Turf Disease Diagnosis (1hr)	Maine Golf Course Superintendents Association	Portland, ME	I,T
01/13/23	#1. Diseases and Insect Pests of Ornamentals: Abiotic Stress in Trees (2hr)	Professional Golf Turf Management School	Middlesex County	T
01/13/23	#1: Insects in Fine Turf: Introduction to Entomology; Insect Structure and Function (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
01/16/23	#2. Principles of Pest Management: IPM Basics: Considerations for Setting up a Program (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
01/16/23	#2. Turf Diseases: Introduction to Mycology and Fungal Structures (2hr)	Professional Golf Turf Management School	Middlesex County	T
01/17/23	#2. Diseases and Insect Pests of Ornamentals: Scouting Tips for Landscapes; Pesticide Review (2hr)	Professional Golf Turf Management School	Middlesex County	T
01/17/23	#2. Insects in Fine Turf: Insect Classification; Orders (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
01/18/23	31 Years of the Plant Diagnostic Lab at Rutgers: Trends in Turf Disease Diagnosis (1hr)	Hudson Valley Golf Course Superintendents Association	Monticello, NY	I,T
01/19/23	The Art of the Diagnosis	Landscape IPM Short Course	Middlesex County	A,I,L,N,T
01/19/23	The Complete Turf Disease for Golf Courses (2hr) Three Week Course	Professional Golf Turf Management School:	Middlesex County	T
01/20/23	The Complete Turf Disease for Golf Courses (2hr) Three Week Course	Professional Golf Turf Management School:	Middlesex County	T
01/23/23	#3. Principles of Pest Management: Principles of Insect Pest and Disease Control (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
01/23/23	#3. Turf Diseases: The Red Thread Syndrome; Snow Molds (2hr)	Professional Golf Turf Management School	Middlesex County	T

Appendix 3. (Continued)
Table A3.1. (Continued)

Date	Title	Audience	Location	Par-ticipants[1]
01/24/23	#3. Diseases and Insect Pests of Ornamentals: New Plant Pathogens: Bacteria, Phytoplasma, Virus, Parasitic Plants (2hr)	Professional Golf Turf Management School	Middlesex County	T
01/24/23	#3. Insects in Fine Turf: Insect Growth and Development; Insect Behavior (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
01/25/23	The Complete Turf Disease for Golf Courses (1.5hr) Three Week Course	Professional Golf Turf Management School:	Middlesex County	T
01/26/23	Dead Plant Update: 2022 in the Plant Diagnostic Laboratory (1hr)	North Jersey Ornamental Horticulture Conference: Landscape Day	Morris County	L,T
01/30/23	#4. Principles of Pest Management: Cultural Control (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
01/30/23	#4. Turf Diseases: Diseases Caused by Algae and Other Related Organisms; Slime Molds (2hr)	Professional Golf Turf Management School	Middlesex County	T
01/31/23	#4. Diseases and Insect Pests of Ornamentals: Leaf Spots, Anthracnose, and Stem Diseases (2hr)	Professional Golf Turf Management School	Middlesex County	T
01/31/23	#4. Insects in Fine Turf: IPM Basics: A Review of Scouting Techniques and Insecticides (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
02/01/23	Dead Plant Update: 2022 in the Plant Diagnostic Laboratory (1hr)	New Jersey Nursery and Landscape Association: Total Pro Expo and Conference	Edison, NJ	A,I,L,N,T
02/02/23	#5. Diseases and Insect Pests of Ornamentals: Root Rots and Vascular Wilt Diseases (2hr)	Professional Golf Turf Management School	Middlesex County	T
02/02/23	#5. Insects in Fine Turf: Nematodes (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
02/03/23	Insects that Suck: Scale (1hr)	PLANT WNY: Trade Show and Education Conference	Buffalo, NY	A,H, I, L,N,T
02/03/23	Diseases of Conifers (1hr)	PLANT WNY: Trade Show and Education Conference	Buffalo, NY	A,H, I, L,N,T
02/06/23	#5. Principles of Pest Management: Fungicide Selection and Use (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
02/06/23	#5. Turf Diseases: Diseases Caused by Species of the Fungus Rhizoctonia; Fairy Ring (2hr)	Professional Golf Turf Management School	Middlesex County	T
02/07/23	Basic Turf Disease: Pick Your Best Defense (3hr)	Lawn Care Association of Pennsylvania	Breinigsville, PA	L,T
02/08/23	Heat and Drought Stress in Turfgrass (1hr)	Penn State Turf and Ornamentals Conference	Leesport, PA	L.T
02/09/23	Boxwood Pests and Diseases (1.5hr)	Weeds, Diseases, and Insects of Plants (11:776:391:01)	Middlesex County	C
02/13/23	#6. Principles of Pest Management: Fungicide Selection and Use (1.5hr)	Professional Golf Turf Management School	Middlesex County	T

Appendix 3. (Continued)
Table A3.1. (Continued)

Date	Title	Audience	Location	Par-ticipants[1]
02/13/23	#6. Turf Diseases: Root-infecting Patch Diseases (2hr)	Professional Golf Turf Management School	Middlesex County	T
02/14/23	#6. Diseases and Insect Pests of Ornamentals: Rusts, Mildews, and Molds; Mites (2hr)	Professional Golf Turf Management School	Middlesex County	T
02/14/23	#6. Insects in Fine Turf: Coleoptera--Scarabs: The White Grub Complex (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
02/16/23	Basic Turf Disease: Pick Your Best Defense (3hr)	Lawn Doctor National Training	online	L,T
02/20/23	#7. Principles of Pest Management: Insecticide Selection and Use (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
02/20/23	#7. Turf Diseases: Anthracnose; “Helminthosporium” Leaf Spots (2hr)	Professional Golf Turf Management School	Middlesex County	T
02/21/23	#7. Diseases and Insect Pests of Ornamentals: Suckers: Scale, Bugs, Hoppers, and Plant Lice (2hr)	Professional Golf Turf Management School	Middlesex County	T
02/21/23	#7. Insects in Fine Turf: Coleoptera--Weevils: Annual Bluegrass Weevil; Billbugs (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
02/21/23	Dead Plant Update: 2022 in the Plant Diagnostic Laboratory (1hr)	SynaTek Winter Seminar	Earl, PA	L,T
02/22/23	New and Emerging Diseases and Insect Pests A,I,L,N,T	Central Jersey Turf and Ornamentals Institute	Middlesex County	
02/23/23	Heat and Drought Stress in Turfgrass (1hr) ONLINE	New York State Turf Association	online	L.T
02/27/23	#8. Principles of Pest Management: The Least Toxic Alternative (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
02/27/23	#8. Turf Diseases: Dollar Spot; Gray Leaf Spot (2hr)	Professional Golf Turf Management School	Middlesex County	T
02/28/23	#8. Diseases and Insect Pests of Ornamentals: Borers: Round-headed and Flat-headed Borers; Gall Makers and Miners (2hr)	Professional Golf Turf Management School	Middlesex County	T
02/28/23	#8. Insects in Fine Turf: Lepidoptera: Armyworms, Cutworms, and Sod Webworms (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
02/28/23	Dead Plant Update: 2022 in the Plant Diagnostic Laboratory (1hr)	Reed and Perrine Turf and Ornamental Seminar	Middlesex County	L,T
03/01/23	Dead Plant Update: 2022 in the Plant Diagnostic Laboratory (1hr)	New Jersey Landscape Contractors Association: Annual Tradeshow and Conference	Secaucus, NJ	I,L,T
03/02/23	Basic Plant Pathology and the Art of Diagnosis (3hr)	Certified Gardener Training Program	Camden County	H
03/06/23	#9. Principles of Pest Management: Commercial Biocontrol and Biocontrol Concepts (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
03/06/23	#9. Turf Diseases: Rust, Smut, Mildews and Other Minor Leaf Blighting Diseases (2hr)	Professional Golf Turf Management School	Middlesex County	T

Appendix 3. (Continued)
Table A3.1. (Continued)

Date	Title	Audience	Location	Par-ticipants[1]
03/07/23	Weed (Not That Kind) Control in Landscape Turf	SiteOne University	Verona, NY	A,I,L,N,T
03/07/23	Nematodes in Golf Turf	SiteOne University	Verona, NY	A,I,L,N,T
03/08/23	Common Root Diseases in Golf Turf	SiteOne University	Verona, NY	A,I,L,N,T
03/09/23	#9. Diseases and Insect Pests of Ornamentals: Borers: Weevils, Bark Beetles, and Clear-winged Moths (2hr)	Professional Golf Turf Management School	Middlesex County	T
03/09/23	#9. Insects in Fine Turf: Hemiptera: Chinch Bugs; Ground Pearls (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
03/13/23	#10. Principles of Pest Management: Scouting Your Golf Course (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
03/13/23	#10. Turf Diseases: Abiotic Stress in Turfgrass (2hr)	Professional Golf Turf Management School	Middlesex County	T
03/14/23	#10. Insects in Fine Turf: Regional Concerns: Mole Crickets and Crane Flies (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
03/14/23	#10. Diseases and Insect Pests of Ornamentals: Leaf Feeders: Lepids, Sawfly, and Weevils (2hr)	Professional Golf Turf Management School	Middlesex County	T
03/21/23	Basic Plant Pathology and the Art of Diagnosis (3hr)	Master Gardener Training Program	Monmouth County	H
03/22/23	Basic Plant Pathology and the Art of Diagnosis (3hr)	Certified Gardener Training Program	Gloucester County	H
03/23/23	Basic Plant Pathology and the Art of Diagnosis (3hr)	Master Gardener Training Program	Ocean County	H
03/25/23	Key Insect Pests in New Jersey Landscapes (3hr)	Master Gardener Training Program	Ocean County	H
03/31/23	Turf Disease Diagnostic Workshop (6hr)	Davey Tree Company	Kent, OH	T
04/05/23	Diseases of Woody Ornamentals (6hr)	Morris Arboretum School of Arboriculture	Philadelphia, PA	A,L
04/11/23	Key Insect Pests in New Jersey Landscapes (3hr)	Master Gardener Training Program	Monmouth County	H
04/12/23	Basic Turfgrass Disease: Pick Your Best Defense (2hr)	Pest Management of Landscape Turf Short Course	Middlesex County	L,T
04/22/23	Basic Tree Disease Identification and Control (3hr)	Licensed Tree Expert Prep Course	Middlesex County	A,L
05/01/23	Invaders in NJ: The Spotted Lanternfly and Joro Spider (0.75hr)	Somerset County Library System Webinar Series	online	H

[1] Audience Addressed: A=Arborists; C=College (Academic); Co=Construction; E=Engineers; F=Farmers; G=Greenhouse; H=Residential Clientele; Hf=Health Officers; I=Industry; L=Landscapers; N=Nursery Growers; S=State Officials; T=Turfgrass Managers; X=Christmas Tree Growers

Appendix 3.
Table A3.2. Complete listing of lectures presented by Sabrina Tirpak, PDL Principal Laboratory Technician, FY23.

Date	Title	Audience	Location	Par-ticipants[1]
10/04/22	Insights into a Career in Plant Diagnostics (2hr)	County College of Morris	Randolph, NJ	C
10/06/22	Introduction to Entomology (3hr)	Master Gardener Training	Somerset County	H
10/12/22	Key Insect Pests of Ornamental Plants (1hr)	Emergency Pesticide Recertification Short Course	Middlesex County	L,T
10/13/22	Introduction to Entomology (3hr)	Master Gardener Training	Mercer County	H
10/18/22	#1. Turf Disease Laboratory - Basic Mycology (3hr)	Professional Golf Turf Management School	Middlesex County	T
10/19/22	#1. Turf Insect Laboratory - Structure and Function and Insect Orders (3hr)	Professional Golf Turf Management School	Middlesex County	T
10/25/22	#2. Turf Disease Laboratory - Introduction to Microscopy (3hr)	Professional Golf Turf Management School	Middlesex County	T
11/01/22	#3. Turf Disease Laboratory - Recognizing Signs Produced by Turf Pathogens, Part 1 (3hr)	Professional Golf Turf Management School	Middlesex County	T
11/02/22	#2. Turf Insect Laboratory - Metamorphosis and Behavior (3hr)	Professional Golf Turf Management School	Middlesex County	T
11/07/22	Introduction to Entomology (3hr)	Master Gardener Training	Morris County	H
11/09/22	#3. Turf Insect Laboratory - Nematodes (3hr)	Professional Golf Turf Management School	Middlesex County	T
11/15/22	#4. Turf Disease Laboratory - Recognizing Signs Produced by Turf Pathogens, Part 2 (3hr)	Professional Golf Turf Management School	Middlesex County	T
11/16/22	#4. Turf Insect Laboratory - White Grubs (3hr)	Professional Golf Turf Management School	Middlesex County	T
11/17/22	Household Insect Pests (3hr)	Master Gardener Training	Mercer County	H
11/28/22	Household Insect Pests (3hr)	Master Gardener Training	Morris County	H
11/29/22	Introduction to Entomology (3hr)	Master Gardener Training	Hunterdon County	H
11/30/22	#5. Turf Insect Laboratory - Using an Insect ID Key (3hr)	Professional Golf Turf Management School	Middlesex County	T
12/02/22	#5. Turf Disease Laboratory - Recognizing Signs Produced by Turf Pathogens, Part 3 (3hr)	Professional Golf Turf Management School	Middlesex County	T
12/06/22	Lessons from the Rutgers PDL: Who Turned Off the Water? (0.5hr)	New Jersey Green Expo - Turf and Landscape Conference	Atlantic City, NJ	I,L,T
12/06/22	Rhododendron: Royalty… or Roadkill? Insects (0.5hr)	New Jersey Green Expo - Turf and Landscape Conference	Atlantic City, NJ	I,L,T
12/06/22	Rhododendron: Royalty… or Roadkill? Diseases (0.5hr)	New Jersey Green Expo - Turf and Landscape Conference	Atlantic City, NJ	I,L,T
12/13/22	#6. Turf Disease Laboratory - Lab Final: Diagnose the Problem (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
12/14/22	#6. Turf Insect Laboratory - Lab Final: Identifying Common Insects in Turf (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
01/10/23	Leaf Feeding Insects on Turfgrass (1hr)	SiteOne University	Atlantic City, NJ	I,L,T

Appendix 3. (Continued)
Table A3.2. (Continued)

Date	Title	Audience	Location	Par-ticipants[1]
01/11/23	New and Emerging Threats to New Jersey Urban Forests (1hr)	North Jersey Ornamental Horticulture Conference: Tree Day	Randolph, NJ	A,I,L
01/17/23	#1. Turf Disease Laboratory - Basic Mycology (3hr)	Professional Golf Turf Management School	Middlesex County	T
01/18/23	#1. Turf Insect Laboratory - Structure and Function and Insect Orders (3hr)	Professional Golf Turf Management School	Middlesex County	T
01/24/23	#2. Turf Disease Laboratory - Introduction to Microscopy (3hr)	Professional Golf Turf Management School	Middlesex County	T
02/01/23	#2. Turf Insect Laboratory - Metamorphosis and Behavior (3hr)	Professional Golf Turf Management School	Middlesex County	T
02/14/23	#3. Turf Disease Laboratory - Recognizing Signs Produced by Turf Pathogens, Part 1 (3hr)	Professional Golf Turf Management School	Middlesex County	T
02/15/23	#3. Turf Insect Laboratory - Nematodes (3hr)	Professional Golf Turf Management School	Middlesex County	T
02/16/23	Introduction to Entomology (3hr)	Master Gardener Training	Ocean County	H
02/22/23	#4. Turf Insect Laboratory - White Grubs (3hr)	Professional Golf Turf Management School	Middlesex County	T
02/28/23	Spotted Lanternfly and Friends (1hr)	Brooklyn Landscape Gardeners Association	Brooklyn, NY	L,T
02/28/23	#4. Turf Disease Laboratory - Recognizing Signs Produced by Turf Pathogens, Part 2 (3hr)	Professional Golf Turf Management School	Middlesex County	T
03/03/23	Our Majestic Oaks and Their Achilles' Heel (1hr)	Garden State Tree Conference	Atlantic City, NJ	A,I,L
03/08/23	#5. Turf Insect Laboratory - Using an Insect ID Key (3hr)	Professional Golf Turf Management School	Middlesex County	T
03/09/23	Introduction to Entomology (3hr)	Master Gardener Training	Monmouth County	H
03/10/23	#5. Turf Disease Laboratory - Recognizing Signs Produced by Turf Pathogens, Part 3 (3hr)	Professional Golf Turf Management School	Middlesex County	T
03/14/23	#6. Turf Disease Laboratory - Lab Final: Diagnose the Problem (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
03/15/23	#6. Turf Insect Laboratory - Lab Final: Identifying Common Insects in Turf (1.5hr)	Professional Golf Turf Management School	Middlesex County	T
03/30/23	Household Insect Pests (3hr)	Master Gardener Training	Ocean County	H
04/04/23	Household Insect Pests (3hr)	Master Gardener Training	Monmouth County	H
04/12/23	Turfgrass Pests: Leaf Feeding Insects and Grubs (1.75hr)	Pest Management of Landscape Turf Short Course	Middlesex County	L,T
05/01/23	Invaders in NJ: The Spotted Lanternfly and Joro Spider (0.25hr)	Somerset County Library System Webinar Series	online	H

[1] Audience Addressed: A=Arborists; C=College (Academic); Co=Construction; E=Engineers; F=Farmers; G=Greenhouse; H=Residential Clientele; Hf=Health Officers; I=Industry; L=Landscapers; N=Nursery Growers; S=State Officials; T=Turfgrass Managers; X=Christmas Tree Growers

Appendix 4. (Continued)

Yellow Leaf Spot or Septoria Leaf Spot

One of the most frequently observed leaf spot diseases of hemp in New Jersey is Yellow leaf spot or Septoria leaf spot caused by the fungus *Septoria* spp. The disease begins as small, irregular, brown to gray spots that rapidly expand in diameter. As spots enlarge, brown areas become more irregular. Spots with chlorotic (yellow) halos are typically observed. Round, dark brown to black pustules, called pycnidia, are scattered within the spots. Pycnidia produce spores, called conidia, which serve as the primary means for dispersion. Symptoms appear in late August within the lower leaves of the inner canopy where leaf wetness and humidity are higher. The severity of leaf spot disease development depends on the duration of leaf wetness caused by rain/dew as well as specific cultivar susceptibility to the disease. In states or regions with wet humid summers, such foliar diseases will be a persistent problem. *Septoria cannabis* was identified as the species causing Septoria leaf spot in Kentucky. Since alternative hosts have not been identified for *Septoria cannabis*, it is likely that weeds may play the role of "green bridge" to facilitate the survival of the pathogen. It likely also overwinters on infested debris and in the soil. A list of hemp cultivars susceptible to leaf spot diseases from Tennessee Extension is included in the references. Resistance of cultivars should always be considered. Cultural practices for disease management include crop rotation and increasing plant spacing within and between rows to improve air flow to allow for rapid leaf drying. Ensuring that plant debris is buried by deep-tilling infested fields or removed from the site after harvest, will also help mitigate the spread of the disease.

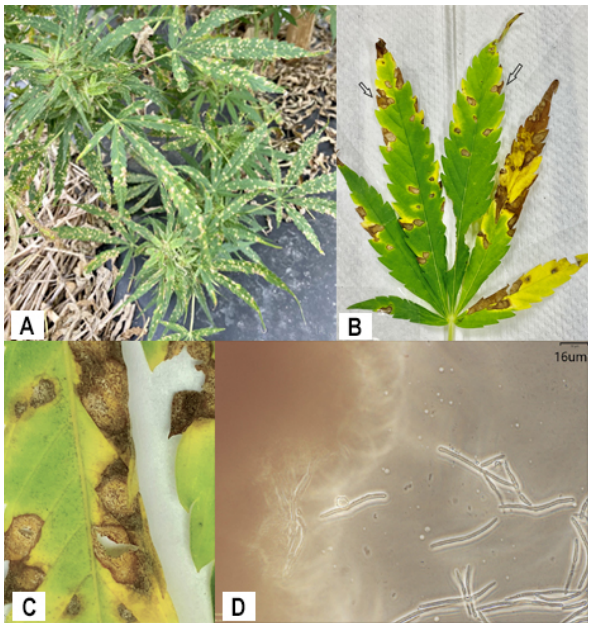


Figure 1. Yellow leaf spot symptoms and signs. A) ellow leaf spot caused by *Septoria* spp. on field-grown hemp B) Arrows indicate brown irregular spots with yellow halos C) Leaf spots with dark colored pycnidia D) Septoria spores being released from the pycnidia as viewed under a compound microscope. Photos: Nimmi Rajmohan.

Appendix 4. (Continued)

Hemp Leaf Spot or Bipolaris Leaf Spot

Hemp leaf spot emerged in 2014 with the reintroduction of hemp production in the United States and has become widespread. Severe disease and extreme yield losses were reported in Kentucky. This disease starts as tiny, dark, necrotic spots on infected leaves. The spots typically have a tan center and dark brown margins. Multiple lesions may merge (coalesce) to cause leaf blight, which may cause the leaf to turn yellow and defoliate prematurely. Dark conidiophores (stalks that produce dark cigar-shaped conidia) are visible in the centers of spots on both upper and lower leaf surfaces. Symptoms begin to appear in August.Warm, wet weather favors disease onset and development. *Bipolaris* spp. has also been found to infect grass and weed hosts, such as *Acalypha ostryifolia* (hophornbeam copperleaf), *Microstegium vimineum* (Japanese stiltgrass), and *Eleusine indica* (Indian goosegrass) in Kentucky. *Drechslera gigantea,* belonging to the genus *Bipolaris*, has been identified as the pathogen causing Hemp leaf spot in Kentucky. Cultural practices for mitigating Hemp leaf spot include crop rotation, weed control, and increasing plant spacing within and between rows to improve air flow to allow for rapid leaf drying. Deep-tilling infested fields after harvest to ensure that plant debris stays buried will also help reduce the spread of the disease.

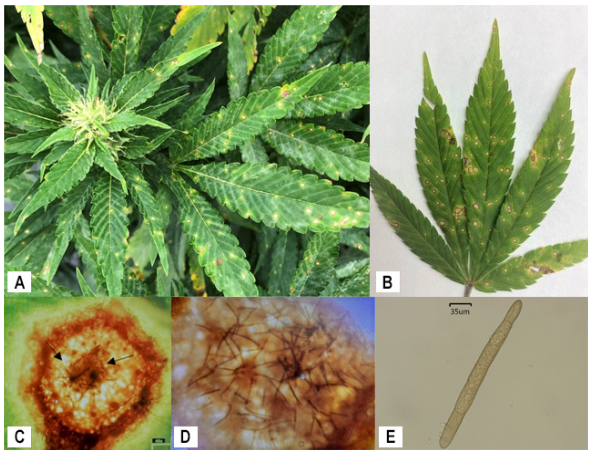


Figure 2. Hemp leaf spot. A) Hemp leaf spot caused by *Bipolaris* spp. on field-grown hemp. Photo: Raul Cabrera
B) Indi dual leaf showing light brown/tan lesions with tan borders. C) Magnified view of a leaf spot with dark conidiophores visible in the center of the leaf spot, indicated by arrows, viewed under a compound microscope. D) Magnified view of *Bipolaris* spp. conidiophores and conidia E) Conidium of *Bipolaris* spp. viewed under a compound microscope. Photos: Nimmi Rajmohan.

Cercospora Leaf Spot

Cercospora leaf spot is caused by the fungus *Cercospora*s spp. This fungus causes circular to elliptical spots, with gray centers and dark brown-black margins. Symptoms generally start on older leaves and eventually spread throughout the canopy. Lesions turn light tan, or even white, with yellow halos. Severely infected leaves usually develop chlorosis (yellowing), which leads to premature defoliation. *Cercospora* produces pseudostromata (tiny black dots) that form in leaf substomatal cavities within the grayish-tan lesions. The pseudostromata produce conidiophores (conidia bearing structures) that are borne in clusters in the center of the spot. Pseudostromata are visible with a hand lens and are a good diagnostic feature. Conidia easily move through wind and in free moisture. The primary source of inoculum for this disease is residue from a previously infected crop. *Cercospora* cf. *flagellaris* was identified as the pathogen causing Cercospora leaf spot in Florida. The pathogen has a wide host range with reports on plant species from 24 different families, including soyabean and melon. Cultural practices for mitigating Cercopsora leaf spot include crop rotation, weed control, and increasing plant spacing within and between rows to improve air flow to allow for rapid leaf drying. Any plant debris should be buried or removed from the site after harvest to help mitigate the spread of the disease.

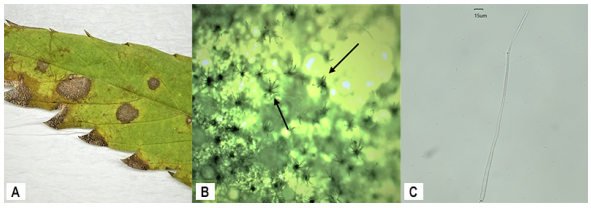


Figure 3. Cercospora leaf spot symptoms. A) Dark lesions on an individual leaf. B) Arrows indicate conidiophore bearing conidia on *Cercospora* spp. infected leaf as viewed under a dissecting scope. C) Conidium of *Cercospora* spp. viewed under a compound microscope. Photos: Nimmi Rajmohan.

Brown Leaf Spot

Brown leaf spot is caused by Phoma spp. Infections result in light brown leaf spots with concentric rings. These infections are most common during wet, cool conditions, and can survive in soil and old plant debris. These fungi can also form pycnidia that produce conidia (spores). Conidia are moved to uninfected plants from overwintering sites by splashing water, equipment, and human beings during wet weather. Pycnidia are easily seen within the leaf spots in concentric rings. Brown leaf spot rarely kills the plant but can reduce the yields. Cultural practices for mitigating Brown leaf spot include crop rotation,

weed control, and increasing plant spacing within and between rows to improve air flow to allow for rapid leaf drying. Ensuring that plant debris is buried or removed after harvest will help to mitigate the spread of the disease.

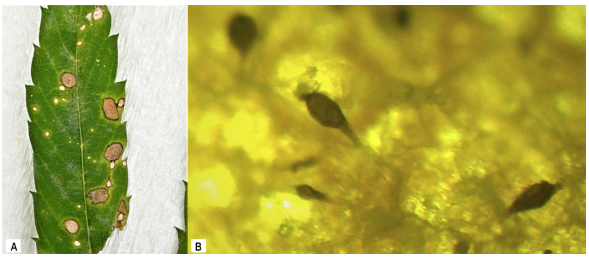


Figure 4. Brown leaf spot symptoms. A) Brown leaf spot symptoms on Hemp leaf. B) Fruiting structures which carry conidia as viewed under a compound microscope. Photos: Nimmi Rajmohan.

Powdery Mildew

Powdery Mildew is a common foliar disease of hemp. It is different from the other leaf spot diseases and appears as white patches on the leaf surface. During the growing seasons of 2020 and 2021, powdery mildew symptoms were observed during the summer months (Jun. to Aug.) in greenhouse hemp research and fall months (Aug. to Oct.) in field production plots on Rutgers NJAES farms in southern and northern New Jersey. Symptoms were observed on leaves and stems of hemp cultivars ‘CB Genius’, ‘Cherry Wine’, and ‘Bay Mist’. Symptoms initially appeared as white patches of mycelia and conidia on the upper surface of leaves that gradually spread to entire leaves and stems. Leaf discoloration and premature leaf drop were observed. More severe symptoms and damage were observed in the greenhouse than outdoor cultivation. Powdery mildew pathogens are generally host specific. *Golovinomyces* sp. (synonym *Erysiphe* sp.) is the most common of the powdery mildew pathogens that infect hemp.

Appendix 4. (Continued)

Figure 5. Powdery Mildew symptoms. A) Heavy Powdery mildew infection on a susceptible Hemp plant. Photo: Michelle Infante-Casella.B) White patches of mycelia and spores visble on a Hemp leaf. C) Spores of *Golovinomyces ambrosiae* as viewed under a compound microscope. Photos: Nimmi Rajmohan.

Non-Leaf Spot Diseases

Botrytis or Gray Mold

Botrytis or Gray Mold is caused by the fungus *Botrytis cinerea.* Gray mold is favored by high humidity, poor airflow, and moderate temperatures. It is an opportunistic pathogen that easily invades weak, damaged, or senescing tissue. This fungus is very common in the Pacific Northwest. It was observed in greenhouse and field-grown hemp in New Jersey during the 2020 and 2021 growing seasons. Infection is most common in flower buds but can be observed on all plant parts. Gray mold can cause brown, water-soaked lesions on different parts of the plant, including stems, leaves, and flowers. Leaf and flower lesions eventually become necrotic and produce a mass of gray, grape-like conidia. *Botrytis* generally enters through a wound or opening in plant tissue. Black sclerotia may develop in diseased tissues, which allows the fungus to overwinter in dead plants and plant debris. *Botrytis cinerea* may also cause damping-off in small seedlings or cuttings in the greenhouse when conditions are cool and wet. Plants may girdle at the soil line and roots become necrotic and water-soaked.

Figure 6. Botrytis gray mold symptoms. Gray fuzzy Botrytis spores on Hemp. Photo: Stephen Komar.

Fusarium Bud Blight and Flower Blight

Fusarium bud blight and flower blight symptoms include yellowing and necrosis of flower parts. This was mainly observed in the field during the 2020 and 2021 growing seasons. The fungus produces abundant white mycelial growth on the flowers. Several *Fusarium* species have been implicated in flower blight on hemp, including *F. equiseti, F. proliferatum and F. graminearum. Fusarium graminearum* was identified by DNA sequencing as the pathogen causing flower blight in New Jersey. The pathogen overwinters on infested crop residues and other host plants. On infested residue, the fungus produces asexual spores called macroconidia, which are dispersed to plants and other plant debris by rain-splash or wind. *F. graminearum* is known to cause head blight on wheat and ear rot on corn. *F. graminearum* produces mycotoxins like deoxynivalenol (DON) and zearalenone, which exhibit acute toxic effects in humans. It is therefore important to test for mycotoxin levels in hemp grown for human consumption.

Figure 7. Fusarium flower blight symptoms A) Yellowing necrotic flower parts and leaves on field Hemp. Photo: William Bamka. B) Infected flower and bud of hemp, arrows indicate white mycelial growth. Photo: Nimmi Rajmohan.

Appendix 4. (Continued)

Disease Management

This document is aimed at presenting information about emerging New Jersey Hemp diseases and their management. Updated information will be provided as new diseases are identified in the state. The U.S. Environmental Protection Agency has expanded the number of pesticides approved for hemp cultivation since its initial guidance was released in December 2019. The expanded list now includes just one conventional pesticide and 58 biopesticides. The link to this list is included in the Additional Resources section of this document. There are currently only a few of these non-conventional fungicides approved for use on hemp in New Jersey, all of which are biopesticides. Furthermore, additional research is needed as efficacy data for these materials in New Jersey cropping systems is not available. While pesticides are an important tool for disease management, they are just one of many tools available. An integrated approach to disease management in commercial hemp production is key, with modification of cultural practices and cultivar selection being the primary methods to mitigate disease incidence.

Season-long best management practices for:

1. **Pre-plant for greenhouse or field production**

    a. Purchase only disease-free plant material or clean seed from a reputable source.

    b. Only use new pots and potting media. If recycling pots, hey must be cleaned and sterilized.

    c. Quarantine newly arrived plant material for 2-3 weeks in a separate space.

    d. Cleaning and sanitizing surfaces in greenhouse as well as field equipment in preparation for seeding/transplants or field preparation.

    e. Never reuse planting medium for transplant production or for crops started from seed.

2. **During the production season (field)**

    a. Maximize air flow in the plant canopy with proper row spacing and row orientation.

    b. void overhead irrigation or excessive watering.

    c. ime irrigation events for morning to allow for the rapid drying of leaves.

    d. Monitor s l moisture levels. Avoid overwatering.

    e. Carefully prevent excessive, rapid plant growth (monitor n rogen fertility to prevent excessive growth, especially N).

    f. void physical injury to the plant.

    g. Scout, monit , and control insect pests.

Appendix 4. (Continued)

h. Control weeds, especially those that may serve as alternate hosts for pests and diseases.

i. Properly treat infe ed or infected plants and those nearby.

j. Maintain weed-free fields by growing on plas c mulch or black landscape fabric.

k. Remove and destroy infested plant material by bur ng (requires a burning permit) or burying.

l. Sanitize equipment and to s between use.

3. **During the production season (greenhouse)**

a. Maximize air flow in the plant canopy with proper row spacing and row orientation.

b. void overhead irrigation; use drip irrigation to keep leaves dry.

c. void overwatering the soil to help prevent root rot development.

d. void physical injuries to plants.

e. Scout and monitor for and control i ect pests and diseases.

f. Regular maintenance of crop debri

4. **Post-harvest (field)**

a. Plow-down infested plant material (if bur ng, obtain burning permit).

b. Rotate away from hemp fields for 3 to 4 years with legume

c. Control weeds, especially those that serve as alternate hosts for insect pests or diseases.

d. Sanitize equipment and too between use.

Sanitation

Due to the limited availability of registered fungicides for preventative or curative control of hemp plant diseases, preventative measures must be an important component of any disease management system. Sanitation, both in-field and in the greenhouse, can be an effective method to reduce pathogen inoculum and disease spread. An effective sanitation program will include regular scouting and monitoring of the growing area throughout the year.

Field Sanitation Practices

a. Properly wash farm implements before mo ng to a new field.

b. Limit mo ng through fields when plants or soil are wet.

Appendix 4. (Continued)

c. Remove diseased plants from field and fectively destroy plant material.

d. Properly clean tools and hands with approved solu ons to reduce pathogen spread.

Greenhouse Sanitation Practices

a. Maintain clean floors free of soil or ant debris. When possible, use concrete, gravel, or covered soil to reduce disease transmission.

b. Maintain fective weed control measure inside the greenhouse.

c. Clean and sanitize all work surfaces, benches, and tools to minimize inoculum spread.

d. Remove diseased plant materia

e. Maintain proper biosecurity protoco before entering the greenhouse, including plant screenings, clothing and boot washing, and proper hand washing.

Additional Resources

- Integrated Pest Management of Hemp in Virginia. Virginia Cooperative Extension. ENTO-349NP.
- An Overview of Systems-based Pest Management for Nursery Production. University of Tennessee Extension publication PB 1825. An Overview of Systems-based Pest Management for Nursery Production.
- Pesticide Products Registered for Use on Hemp (EPA)

References

- Environmental Protection Agency (EPA). 2021. Pesticide Products Registered for Use on Hemp. United States Environmental Protection Agency, Washington, DC.
- Hemp variety trials in Teneseesee 2020 (PDF). Plant Pathology Extension Publications. University of Tennessee Institute of Agriculture.
- Marin, M.V., Coburn. Desaeger, J. and Peres, N.A. 2020. First Report of Cercospora leaf spot Caused by *Cercospora* cf. *flagellaris* on Industrial Hemp in Florida. Plant Disease, 104:5, 1536
- McPartland, J.M. 1994. Cannabis pathogens X: Phoma, Ascochyta and Didymella species. Mycologia, 86(6): 870-878
- New Jersey Department of Agriculture (NJDA). 2022. New Jersey Hemp Program. Plant Industry Division of the NJ Department of Agriculture, Trenton, NJ.
- Rahnama, M., Szarka, D., Li, H., Dixon, E., Castlebury,L. and Gauthier.N. 2021. Reemergence of Septoria Leaf Spot caused by *Septoria cannabis* on Hemp in Kentucky

Appendix 4. (Continued)

Plant Disease*, 105:9, 2286-2289*

- Rajmohan, N., Price, D.C., Buckley, R.J., Komar, S.J., Bamka, W.J., Petit, E.A., Cabrera, R.I., Gianfagna, T.G., Simon, J.E. and Wyenandt, C.A. 2022. First report of powdery mildew caused by *Golovinomyces ambrosiae* on Industrial Hemp in New Jersey. Plant Disease, 106:9, 2534

- Szarka, D., Amsden, B., Beale, J., Dixon, E., Shardl, C.L. and Gauthier, N. 2020. First report of hemp leaf spot caused by a *Bipolaris* species on hemp (*Cannabis sativa*) in Kentucky. Plant Health Progress, 21: 82-84

- Yulfo-Soto, G.E., Smith, H., Szarka, D., Dixon, E., Vaillancourt, L.J. and Gauthier, N. 2022. First Report of *Fusarium graminearum* Causing Flower Blight on Hemp (*Cannabis sativa*) in Kentucky. Plant Disease, 106:1,334

March 2023

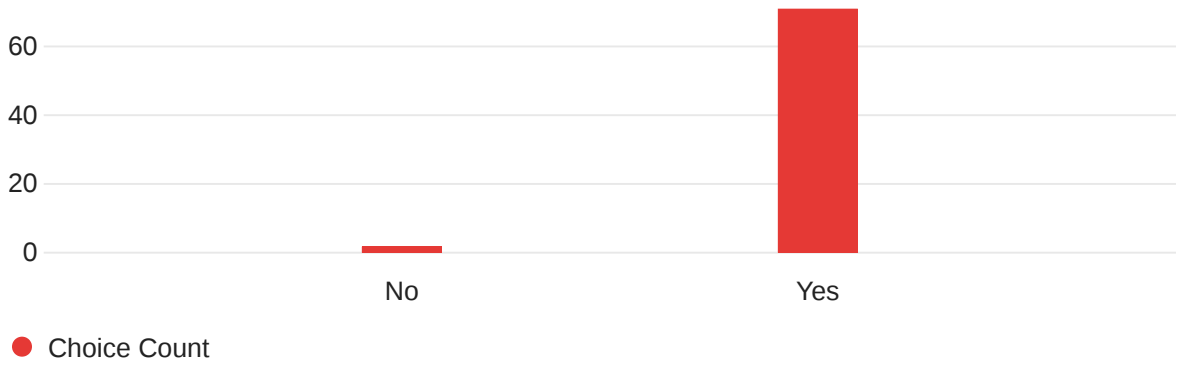
For more information: njaes.rutgers.edu.

Cooperating Agencies: Rutgers, The State University of New Jersey, U.S. Department of Agriculture, and Boards of County Commissioners. Rutgers Cooperative Extension, a unit of the Rutgers New Jersey Agricultural Experiment Station, is an equal opportunity program provider and employer.

Appendix 5. Plant Diagnostic Laboratory Client Survey, FY23.

Q1 - Did you receive the diagnostic report(s) in a timely manner?

73 Responses



Q2 - Please describe the issue with the timeliness of your diagnostic report(s).

1 Responses

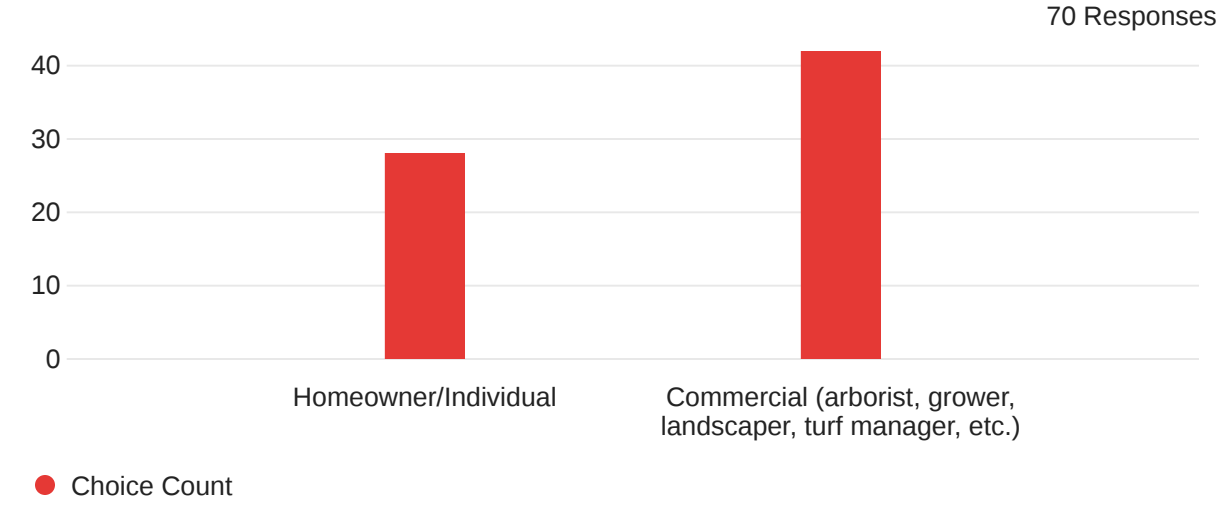
Please describe the issue with the timeliness of your diagnostic report(s).

Sent sample overnight on 12/19/2022. Didn't get report until 1/5/2023.

Appendix 5. (Continued)

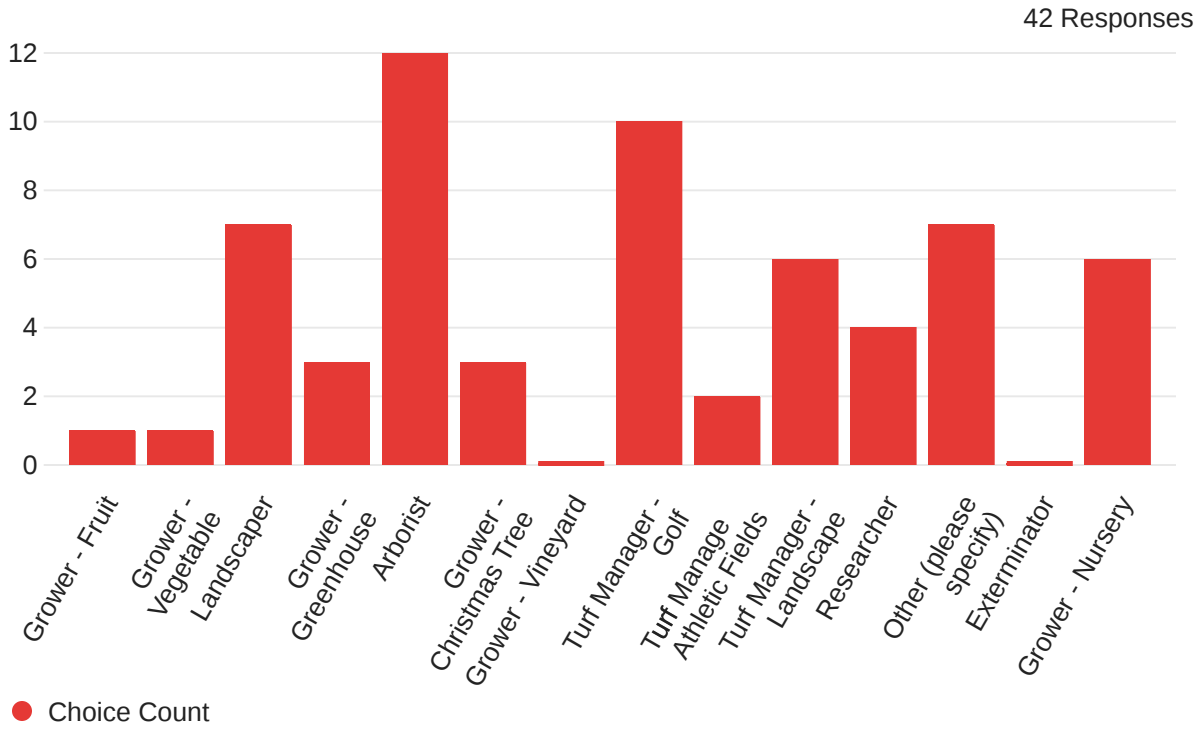
Q3 - Did the information provided help you to solve your problem?

Q4 - As a client of the Rutgers Plant Diagnostic Laboratory, how is your role best described?



Appendix 5. (Continued)

Q4.1 - Please check all that apply to describe yourself: - Selected Choice

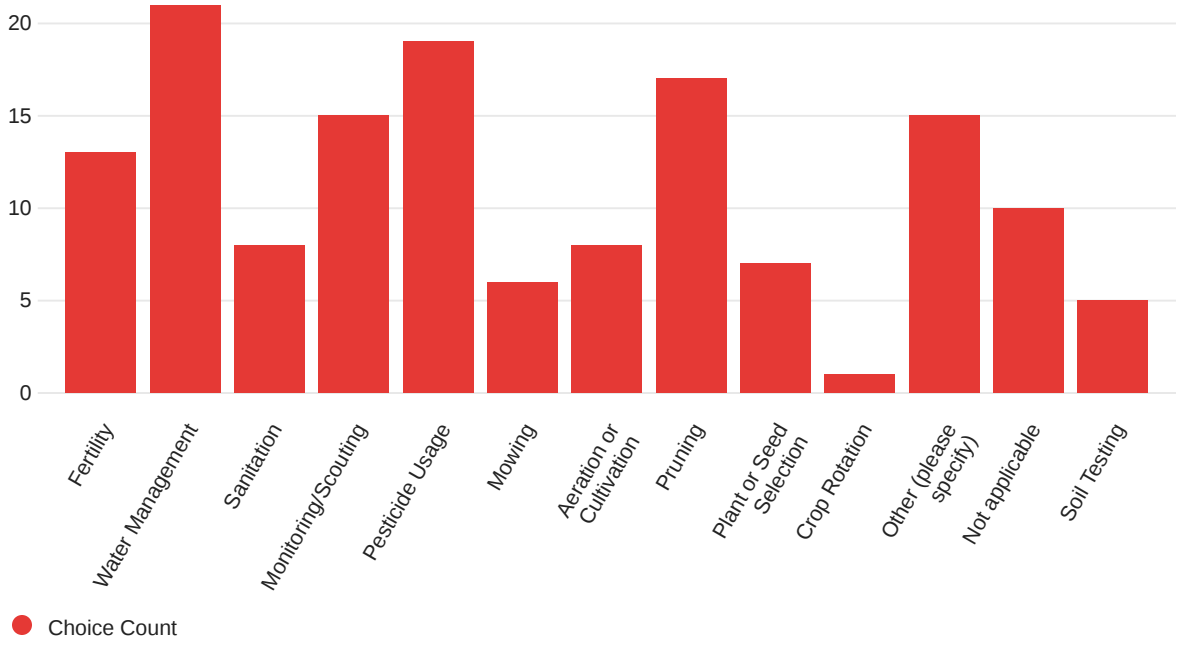


Q5 - Did the information provided help you to use Integrated Pest Management (IPM) strategies (cultural practices and use of least toxic pesticides as a last resort) to manage your pest or disease problem(s)?

Appendix 5. (Continued)

Q6 - Did you implement or alter any management practice(s) based on recommendations in the diagnostic report(s)? Please select all that apply: - Selected Choice

68 Responses



Q6_11_TEXT - Other (please specify) - Text

14 Responses

Other (please specify) - Text
Will be doing it now.
Leaf debris clean up
Just got the report . Likely will use recomended pesticides
not yet!
I intend to, but haven't followed through yet.
too early in season
Infested nursery stock-order cancelled
i may try phosphite fertilizers to treat my beech leaf disease.
Nutrient management
Core aeration
fungicide
Adjust mulch type

Appendix 5. (Continued)

removed and disposed of planting

Will consider changes to forest management plan based on results

Q7C - If you implemented any of the practice(s) recommended, please select all of...

20 Responses

Field	1-10%	11-25%	26-50%	51-75%	76-100%
A reduction in potential plant loss	0	1	2	4	3
Increased yield	0	0	2	0	0
Reduced the amount of unnecessary inputs (pesticides, fertilizer, etc.)	1	0	3	2	6
Limited the spread of disease or insect pest	0	1	2	2	7
Reduced the impact on aesthetics	0	0	2	1	7
Increased profit	2	1	0	1	2
Increased quality of crop/plant	0	1	1	4	6

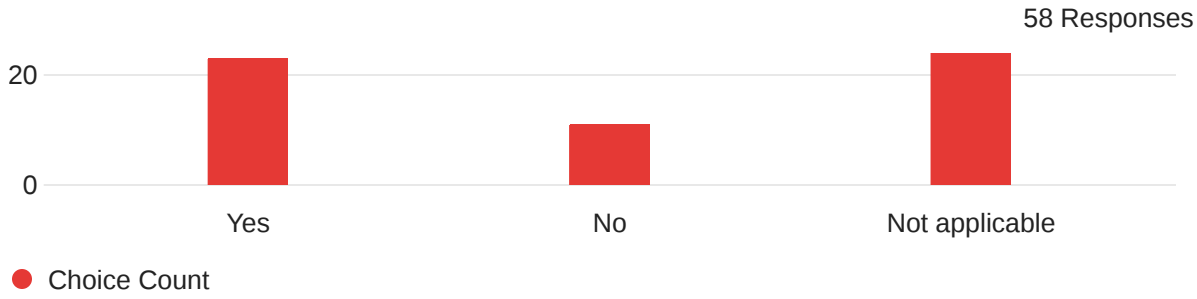
Q7H - If you implemented any of the practice(s) recommended, please select all of...

8 Responses

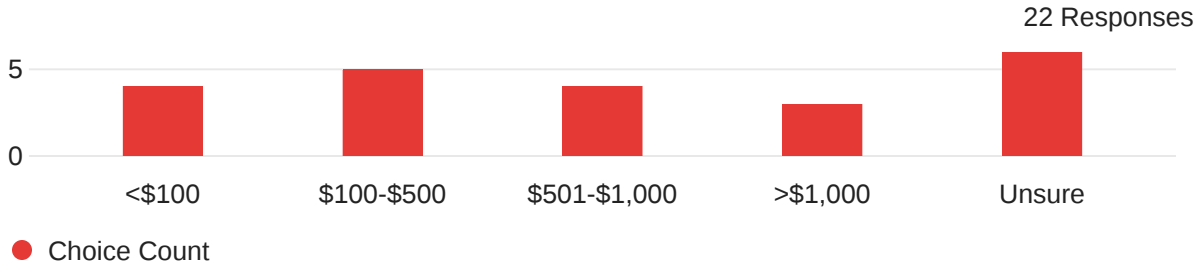
Field	1-10%	11-25%	26-50%	51-75%	76-100%
A reduction in plant death	0	0	1	0	3
Reduced the amount of unnecessary inputs (pesticides, fertilizer, etc.)	1	0	2	0	1
Limited the spread of disease or insect pest	0	0	2	0	2
Reduced the impact on aesthetics	0	1	1	0	1
Increased quality of crop/plant	0	0	1	1	1
Increased yield	0	0	0	0	0

Appendix 5. (Continued)

Q8 - Were you able to reduce the use of pesticides as a result of the information provided in the diagnostic report(s)?



Q8.1 - What would be an estimate of the cost savings from reducing the use of pesticides as a result of the information provided?



Q9 - Does the Rutgers Plant Diagnostic Laboratory provide a beneficial service for you?

Appendix 5. (Continued)

Q10 - If you would like to share any additional comments about the service you received from the Rutgers Plant Diagnostic Laboratory, please enter them below.

31 Responses

If you would like to share any additional comments about the service you received from the Rutgers Plant Diagnostic Laboratory, please enter them below.

I can provide more feedback when I implement the results just received. However, I must say my experience was very pleasant. Staff was professional and very helpful. Thank you for this great service.

What a great service! So prompt and thorough.

This report will likely save my hydrangea. I will have the soil tested and prune the plant , as recommended.

A very quick turn-around and very courteous staff. A local tree company was going to charge us $350 to test ONE tree, and we were able to do 2 trees for $100. Plus, I have confidence that your organization knows what they're doing. Thank you.

Very impressed with the quick turn around and makes my customers very pleased that my personal diagnosis was correct. Except for BLS and or Oak Wilt which I explained to customer that it needed to be sent to lab. Thanks for being there when needed always a pleasure.

Thanks for your timely report. I will have to pour over it more. One issue not addressed is am I able to eat the herbs after treating with any of the recommended pesticides.
Identifying the least toxic solutions would be helpful.

I find the staff very knowledgeable and helpful. I see Richard Buckley as a very brilliant scientist in his field of pathology. The lab staff give their unbiased factual opinions that help back my diagnosis. You have an excellent staff and should be commended for the services that you provide. Thank you Todd

Thank you.
Please with the outcome.

Appreciate your service. Very informative. Great resource. Thanks

Many thanks for fast results greatly appreciated.

Extremely quick results. I haven't taken action yet but will follow the recommendations.
Thanks.

Appendix 5. (Continued)

This service detected phytophthora infested plant material prior to purchase and planting. This prevented a potentially devastating impact on my farm.

The service was timely, professional, and very helpful. Thank you so much!

I cannot open the receipt link.. i will need it resent.

Thank You for your service

Mickey Riggin - Arborist
NJLTE # 366

I just got the results so it is too early to answer the questions related to outcome

Excellent service, staff was very helpful and the results came in faster than we expected. We will use this service again. Thank you for going above and beyond

You guys provide a valuable service. Keep up the good work!

Extremely pleased with service.

The recommendations have yet to be implemented by owner/LCO. With any luck marked improvement will be noticeable this fall.

Thank you!

they do a great job. its really appreciated

I would like to see more of what was tested and what was ruled out based on established criteria.

I dropped off lawn samples in person. When I dropped off the samples I had a discussion with Sabrina that was informative. The service was extremely fast, reasonably priced and the report was comprehensive. I will recommend the Rutgers Plant Diagnostic Laboratory to anyone having a similar problem.

I have not implemented the strategies yet because I just read the sample results

Professional, quick turnaround with easy to understand solutions.

Always receive accurate scientific information from the lab in a timely manner.

We appreciate having you as an unbiased resource for our plant diagnostic needs.

They make my life easier because the customer believes me when I show them the report. Then I can do my job It takes out “Well the other guy said”. The other guy was wrong and here’s why

This was the first time I used the lab's services and I am very pleased with the service and information I received as I found it very helpful.

Thank you!

RUTGERS
New Jersey Agricultural
Experiment Station
PLANT DIAGNOSTIC LABORATORY

Plant Diagnostic Laboratory
New Jersey Agricultural Experiment Station
Rutgers, The State University of New Jersey
Ralph Geiger Turfgrass Education Center
20 Indyk-Engel Way
New Brunswick, NJ 08901

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