IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Department of Plant Pathology
351 Bessey Hall
Ames, Iowa 50011-1020
515 294-1741
FAX 515 294-9420
plantpath@iastate.edu

January 12, 2003

Dr. Kenneth Kruempel, Chair
Faculty Senate Curriculum Committee
1124 Coover

Dr. Kruempel,

The Regents Post-Audit Review for the interdepartmental undergraduate major in Plant Health and Protection is attached. We ask that the program be continued. If you need any additional information about the program please contact me. Thanks for your consideration of our request.

Sincerely,

Edward Braun

Edward Braun
Professor

Regents Post-Audit Review Questions

Program Title: PLANT HEALTH AND PROTECTION

Administrative Unit: DEPT. OF PLANT PATHOLOGY

College: AGRICULTURE

Introduction

Plant Health and Protection is an interdepartmental program involving the Departments of Plant Pathology, Entomology, Forestry, Agronomy, and Horticulture. Plant Pathology serves as the lead department and Plant Pathology faculty advise students in the program. Plant Health and Protection is a broad-based curriculum in biological and agricultural science. In addition to the College of Agriculture core curriculum requirements, students take coursework in the basic biological and physical sciences, plant fertility management, entomology, weed science, plant pathology, and plant production systems (agronomy, horticulture, or forestry). Our students find the diversity of the curriculum appealing. The broad, interdisciplinary education that our students receive prepares them well for a variety of careers in the agricultural and horticultural industries. The curriculum also provides an excellent foundation for graduate study.

The Plant Health and Protection program is preparing students to deal with some of the most exciting and challenging problems facing agriculture and society today. In the years ahead, agriculture will continue to be challenged to provide adequate food and fiber for the world's growing population while, at the same time, protecting our environment. We believe that graduates of the Plant Health and Protection program have a broad perspective and experience that will enable them to contribute productively to the development of more sustainable agricultural and horticultural systems. For instance, they are well prepared to take part in research and education efforts that will result in plant production systems that depend less heavily on inputs of chemical pesticides and fertilizers. In recent years, basic research in genetics and biotechnology has provided us with new ways to approach plant protection. Plant health professionals have been key players in the development of products like Bt-corn, Roundup-ready soybeans and transgenic virus-resistant plants. We now face the challenge of learning how to use these products in safe and effective ways. We must also respond to the concerns of those who feel that these new products of genetic engineering present risks to our health and environment. We believe that the Plant Health and Protection curriculum provides a solid foundation in the biological sciences that prepares our students to contribute to the development and assessment of these new technologies.

Throughout the country, programs of this type (plant protection, plant pathology, integrated pest management, etc.) are small and ours is no exception. We currently

fluctuate between 15 and 20 majors and our goal has been to reach a sustained enrollment of 20-25. One advantage of a small program is that we have been able to get almost all of our students actively involved in our research and/or extension programs. A few examples of publications resulting from these student experiences are included in appendix F. We have been very pleased with the quality of the students that we have had in the program.

For many years a Pest Management secondary major has been offered in the College of Agriculture at Iowa State. This program is focused on protection of crops, livestock, and households from pests. It has also been a very small program and it currently has very few majors. The Plant Health and Protection program differs from the Pest Management program in that our focus is on plant health in a broad sense comprising crop genetics, cropping systems, and environmental stress, as well as protection from pests such as insects, weeds, and the microorganisms that cause plant diseases.

In light of the current budget concerns in the state, we feel it is necessary to address the issue of potential savings that might be realized by elimination of the Plant Health and Protection program. As can be seen in the specific information provided below, staffing and expenditures associated with this program are minimal. The only courses that would be eliminated would be Pl HP 110 (orientation) and 498 (Plant Health Management). All the other courses have strong enrollments and primarily serve students majoring in Horticulture, Agronomy, Forestry, and other undergraduate programs in the College of Agriculture. Because of the small number of majors, our FTE commitments in advising and student services are minimal. The only monetary savings would be the few hundred dollars we spend on direct mail recruiting.

1. Program Availability

a. Is this program now available in other Regent universities or in other colleges and universities in Iowa?

No.

b. If so, has the availability of other similar programs changed in the last five years? Do existing programs in Iowa have the capacity to meet student demand and the demand for graduates?

Not applicable.

c. What are the similarities and differences among programs in this general area at Iowa institutions? What distinguishes this program from similar programs at other Iowa institutions?

Not applicable.

d. What interactions are there between this program and similar programs at other Iowa institutions?

Not applicable.

2. Enrollment (data shown only for most recent years, earliest years 92-97 not shown)

a. Provide the actual fall semester enrollment in the program for the last four years and the current year, and estimate enrollment for the next three years.

		Year 1 98-99	Year 2 99-00	Year 3 00-01	Year 4 01-02	Current Year 02-03	Year 6 03-04	Year 7 04-05	Year 8 05-06
1	Total majors in program (fall semester enrollment)	8	15	19	15	15	15	17	20
2	Non-major enrollment in program courses (fall and spring semesters).*	49	55	76	72	68	68	68	68

* Enrollments shown include only Pl HP 206 (Spring), 391 (Fall, limit 24 students), and 498 (Spring). These are the only courses that are not cross-listed with one or more other departments and majors. Enrollments in the cross-listed Pl HP courses (Pl P 407, 416; Agron 317, 354; Ent 376; Hort 320) are very strong.

Estimate the number of Iowa residents and the number of international students who have enrolled in the program (by percentage of total number of declared majors).

Iowa residents 86.7% International 6.7%

b. If the actual enrollment figures for the last four years differ markedly from those projected in the original program proposal, indicate the factors which may have led to the disparity.

Our goal has been to reach a sustained enrollment of 20-25 Plant Health and Protection majors. We are approaching this goal.

c. Dropouts

1) How many "dropouts" can be identified for this program over the last five years?

Year 1 98-99	Year 2 99-00	Year 3 00-01	Year 4 01-02	Current Year 02-03
0	1	2	1	0

2) What reasons were given by "dropouts" for leaving the program?

Two students transferred to majors outside the sciences. The other two dropped Plant Health & Protection as a double major in order to finish their other programs in a more timely fashion.

3. Graduation and Placement Information

a. Indicate the number of graduates of the program each of the previous four years and estimate the number that will complete the program this year and each of the next three years.

Year (98-99)- 0	Current Year- 3
Year 2 (99-00)- 2	Year 6 (03-04) - 2
Year 3 (00-01)- 5	Year 7 (04-05)- 2
Year 4 (01-02)- 8	Year 8 (05-06)- 3

b. To what extent have graduates been successful with respect to certification and/or licensure (if applicable)?

Not Applicable.

c. Estimate placement of program graduates for each of the past five years (by percentage of total graduates for each year).

	Year 1 98-99	Year 2 99-00	Year 3 00-01	Year 4 01-02	Current Year 02-03
Further study in graduate or professional school			80%	25%	67%
Employed in field or related field		50%		50%	
Employed in non-related field			20%		
Unemployed					
Unknown		50%		25%	33%

d. To what extent have graduates been successful in obtaining the preferred first job?

Most students have been successful in obtaining a desired first job or acceptance into graduate school.

e. Indicate the employment (placement) experiences of the graduates of the program.

Graduate program in Plant Pathology, ISU- 3

Graduate program in Plant Pathology, University of Georgia

Graduate program in Plant Pathology, North Carolina State University

Graduate program in Plant Science, South Dakota State University

Graduate program in Sustainable Agriculture, ISU

Research technician- Pioneer Hi-Bred

Research technician- USDA-ARS, Urbana IL

Research technician- Plant Pathology, ISU/Agronomy distance M.S. program

Landscape professional, Vail, CO; Retail florist, Ames, IA

Agronomist- Oakville Feed & Grain, Oakville, IA

Church-affiliated social services agency

Currently seeking employment in field- 1

Unknown- 3

4. Accreditation Status

Is an accreditation process available in this field of study? If so, what is the accreditation status of the program?

Not applicable.

5. Staffing

Outline the previous and current FTE staffing of the program and estimate future staffing needs for the next three years.

	Year 1	Year 2	Year 3	Year 4	Current Year	Year 6	Year 7	Year 8
Faculty*	.25	.25	.25	.25	.25	.25	.25	.25
Graduate Assistants	0	0	0	0	0	0	0	0
Other Staff	0	0	0	0	0	0	0	0

* No new faculty were hired to staff this program. We estimate that approximately .25 FTE are involved in advising Pl HP majors and in teaching courses that are offered exclusively for Pl HP majors (Pl HP 110, 498).

6. Expenditures

Outline the **increases** in expenditures that resulted from the adoption of this program, as well as estimate the increases which will occur over the next two years. [Increased expenditures should be included only if the costs were incurred in order to support this program specifically. For example, if no new faculty positions were assigned to this program there has been a $0 increase in faculty cost.]

	Year 1	Year 2	Year 3	Year 4	Current Year	Year 6	Year 7
Faculty	0	0	0	0	0	0	0
Graduate Assistants	0	0	0	0	0	0	0
Other Staff	0	0	0	0	0	0	0
General Expense (Excluding computer use)	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0
Library Resources	0	0	0	0	0	0	0
Space Needs (amt. & cost of new space and/or remodeled space)	0	0	0	0	0	0	0
Computer Use	0	0	0	0	0	0	0
Other Resources (please explain)*	$300	0	0	0	0	0	0
TOTAL	$300	0	0	0	0	0	0

***** Expenditure for brochure and direct mail recruiting efforts.

7. Projected versus Actual

If the actual staffing or expenditure figures for the last four years differ markedly from those projected in the original proposal, explain the disparity.

Our original proposal indicated that minimal new resources would be needed for the Plant Health and Protection program. Expenditures and staffing have been consistent with those projections.

8. Supporting Materials

Appendix A: Final version of Plant Health and Protection Major proposal submitted to the Board of Regents.

Appendix B: Request for delay in the post-audit review of the Plant Health and Protection Program.

Appendix C: Letters from students in the Plant Health and Protection Program.

Appendix D: Letters from employers and potential employers.

Appendix E: Letters from other departments involved in the program.

Appendix F: Examples of student publications.

Appendix A:

Final version of Plant Health and Protection Major proposal submitted to the Board of Regents.

REPORT OF THE
AD HOC COMMITTEE ON
PLANT PATHOLOGY/PLANT HEALTH CURRICULA
1992

INTRODUCTION

In mid-November, 1991, Dr. Green, Dean of Resident Instruction, established an ad hoc committee to "study and make recommendations" regarding the proposal to discontinue the plant pathology undergraduate major and other proposals to offer an undergraduate major in “Plant Health and Protection.”

The committee members are Drs. Hart (Entomology), Knapp (Agronomy), Martinson (Plant Pathology), McNabb (Plant Pathology), and Nonnecke (Horticulture). The committee has considered input from several sources including a survey conducted by the American Phytopathological Society, and responses to its inquiries from several universities who have undergone or are undergoing similar considerations.

This report consists of a recommendation and proposal to establish a major and a minor in Plant Health and Protection. A concomitant recommendation from the Plant Pathology Department to discontinue the Plant Pathology undergraduate major, and supporting documentation will accompany this document to the College of Agriculture.

The proposed curriculum represents an educational experience that will prepare undergraduate students with the training required to pursue employment, upon graduation, as professionals in agriculture. At the same time, the curriculum, founded in the sciences, provides suitable preparation for graduate studies. Nonetheless, the committee envisions a continued evolution of this curriculum, particularly in the areas of environmental awareness as it relates to agricultural and social issues.

PROPOSAL TO ESTABLISH A NEW PROGRAM IN PLANT HEALTH AND PROTECTION

A. Background Information

1. Name: Interdepartmental major in Plant Health and Protection.

2. Name of degree: Bachelor of Science, Plant Health and Protection.

3. Name of department(s) involved:

Agronomy
Entomology
Forestry
Horticulture
Plant Pathology*

*Plant Pathology to be lead department

4. Need for proposed program:

Current issues in agricultural practice and research increasingly require a multidisciplinary approach to resolve. Agriculture professionals must be able to develop maximum economic return analyses for agricultural production. Additionally, public concerns regarding environmental protection and sustainable agriculture demand more complex solutions, solutions which are derived from a knowledge of the interactions between plants and plant production practices and diseases and pests. These solutions should be as environmentally benign as possible. Thus, an interdepartmental approach incorporating these aspects of crop production is warranted for the training of agriculture professionals.

5. Objectives of the proposed program:

The objective of the Plant Health and Protection program is to provide students with an educational experience that will enable them to solve agricultural problems via a holistic approach. Such an approach requires the integration of scientific principles from several disciplines and consideration of environmental impacts. Plant Health and Protection courses will integrate fundamental principles learned in agronomy, entomology, forestry, horticulture, and plant pathology; provide clinical and internship experiences, and discipline integrated problem solving.

6. General description of program:

See Attached Curriculum Proposal

7. Comparison of proposed program with:

(a) standards, if any, established by accrediting associations;
Not Applicable

(b) similar programs at other universities
See Attached Letters and Surveys

8. Program requirements, including:

(a) prerequisites for prospective students;

Standard admission standards for the College of Agriculture

(b) language requirements; None

(c) courses and seminars presently available for credit toward the program;

See Attached Curriculum Proposal

(d) proposed new courses or modification of existing courses;

New Courses:

Plant Health and Protection Biology	- PH P 206-- 3 cr.
Plant Nutrition	- Hort 420 - 3 Cr.
Plant Health and Protection Clinic	- PH P 391 - 2 cr.
Plant Health and Protection Internship	- PH P 392 - R
Plant Health and Protection Management	- PH P 498 - 3 cr.

While these are new courses developed for the new curriculum, it is expected that there will be no new teaching loads placed on the faculty for any of these courses except PH P 498. PH P 206 would replace PL P 207, and 391 and 392 would replace existing departmental courses in Plant Pathology. The Horticulture Department plans to develop a plant nutrition course even if a new curriculum were not developed. We expect that PH P 498 would be a team-taught course combining expertise from Agronomy, Entomology, Forestry, Horticulture, and Plant Pathology. Therefore, this course should not require a large and consistent new involvement of any one faculty member.

(e) thesis and non-thesis options in master's programs; Not Applicable.

(f) implications for related areas within the university;

It is believed that there will be few negative impacts on other programs. In fact it is hoped that this curriculum will stimulate interest and subsequent participation on the part of "nontraditional" students. It is probable that if this major is accepted, the Integrated Pest Management Curriculum may be phased out.

9. General description of the resources available and future resource needs, in terms of:

(a) faculty members, including vitae and publications relating to the program;

See Appropriate Section

(b) effects of the new courses on the work load of the present staff;

As indicated, while there are new courses to be offered, and revisions of other courses, there should only be substantial increases in teaching time associated with the new course, PH P 498. Even here, it is expected that this increased teaching load will be distributed among the five participating departments and may not therefore represent a limiting burden.

(c) research facilities; Not Applicable

(d) library facilities (journals, documents, etc) in the proposed area

The Park's Library and departmental reading rooms contain most of the required reference information.

(e) supplies, field work, student recruitment, etc.

Participating departments will support these needs and activities.

B. Board of Regents Questionnaire: See Attachment.

PLANT HEALTH AND PROTECTION CURRICULUM
(Proposal)

12.5 cr	**Interpersonal and Public Communication Skills**	
	Engl 104, 105; 302 or 314; Sp C 312 or 102; Lib 160; + Communication-intensive, major course	
43-44 cr	**Mathematical, Physical and Life Sciences**	
	Math 140 or 150 or 160; Stat 104; Chem 163, 163L, 231, 232; Phys 106 or 111; Biol 110, 312; Bot 207, 310; B & B 301; Gen 330; Micro 300; + Demonstrate computer proficiency	
16 cr	**Personal Development, Human Relations, and Global Awareness**	
	Econ 201; 3 cr in humanities; from approved lists: 3 cr in ethics, 3 cr in critical thinking, 3 cr in international / multicultural awareness; + Environ mental -intensive, major course; + Problem solving -intensive, major course	
32-33 cr	**Plant Health and Protection**	
	PH P 110, 206, 391, 392, 498; Agron 114 or Hort 221; Agron 154, 206, 317, 354, 354L; Ent 376; Hort 420; PI P 407	
22.5-24.5 cr	**Free Electives**	
128 cr	**Total Credits**	

PLANT HEALTH and PROTECTION CURRICULUM
ADMINISTRATION

Administrative Unit:

Department of Plant Pathology

Administrative Personnel:

The program will be administered by a curriculum committee comprised of at least one representative from each of the participating departments. Additional committee members will be selected to ensure that all pertinent subject-matter specialties are represented. For the initial term of appointment, committee members will be appointed for 1, 2, or 3 years; after the initial term of appointment, all appointments will be for 3 years. Initial appointments by the projected participating departments will I be:

Agronomy --	3 years
Entomology	2 years
Forestry--	I year
Horticulture	2 years
Plant Pathology --	3 years

The Chair of the Department of Plant Pathology will appoint an additional faculty member from the Plant Pathology Department to serve as Chair of the Plant Health and Protection Curriculum Committee. The Chair of the Plant Health and Protection Curriculum Committee will also serve as the committee representative to the College of Agriculture Curriculum Committee. The representative of the Department of Plant Pathology will serve as committee representative to the College of Agriculture Academic Affairs Committee.

It will be the obligation of the committee to establish and implement matters pertaining to curriculum, advising, public relations, recruitment, or such other issues as necessary or appropriate.

PROPOSAL FOR THE ESTABLISHMENT OF A MINOR IN PLANT HEALTH AND PROTECTION

Because the justification and parameters for the creation of a minor are the same as for the major, a separate criterion sheet has not been included. The proposal for the minor is consistent with the interdisciplinary nature of the proposed major in Plant Health and Protection.

PLANT HEALTH AND PROTECTION MINOR (Proposal)

Interpersonal and Public Communication Skills
AS FOR THE FIRST OR PRIMARY MAJOR in the COLLEGE OF AGRICULTURE

Mathematical, Physical and Life Sciences
AS FOR THE FIRST OR PRIMARY MAJOR in the COLLEGE OF AGRICULTURE

Personal Development, Human Relations, and Global Awareness
AS FOR THE FIRST OR PRIMARY MAJOR in the COLLEGE OF AGRICULTURE

17-18 cr Plant Health and Protection Minor

a. two of the following:

Ent 376; PI P 407 or 416; Agron 317

b. each of the following:

PH P 206, 391; Agron 354 or 357; Hort 420 or For. 301

REGENTS PROGRAM REVIEW QUESTIONS

Bachelor of Science Degree, Major in Plant Health and Protection

1. Need.

A. How will this proposed program further the educational and curriculum needs of the students in this discipline?

Current issues in agricultural practice and research increasingly require a multidisciplinary approach to resolve. Agriculture professionals must be able to develop maximum economic return analyses for agricultural production. Additionally, public concerns regarding environmental protection and sustainable agriculture demand more complex solutions, solutions which are derived from a knowledge of the interactions between plants and plant production practices and diseases and pests. These solutions should be as environmentally benign as possible. Thus, an interdepartmental approach incorporating these aspects of crop production is warranted for the training of agriculture professionals.

B. How does it further the educational and curriculum needs of other units in the college or university?

This program will interface with five participating departments, namely; Agronomy, Entomology, Forestry, Horticulture, and Plant Pathology. Each of these departments will provide expertise for the development of the curriculum and students may participate as majors or minors.

2. Inter-institutional Issues.

A. What programs in this field of study are available in other colleges and universities in Iowa?

To our knowledge, no other programs in this field of study are available in Iowa.

B. With what representatives of these programs have you consulted in developing this proposal? Provide a summary of the reactions of each institution consulted.

Not Applicable.

C. In what ways is this proposed program similar to those mentioned in A? In what ways is it different or does it have a different emphasis?

Not Applicable.

D. How does the proposed program supplement the current programs available?

Not Applicable.

E. Has the possibility of some kind of inter-institutional program or other cooperative effort been explored? What are the results of this study?

Not Applicable.

ADDITIONAL RESOURCE NEEDS

1. Please estimate the probable marginal increases in expenditures that may be necessary as a result of the adoption of this program for the next three years.

It is not believed that this new program will result in any increased costs over the next three years. It may require some reallocation of staff resources among programs within that period.

2. Describe the nature and the justification for the additional resource needs.

3. How is it anticipated that the additional resource needs will be provided? (For programs planning to use external grants, what would be the effect of the grant termination?)

SURVEY OF PLANT PATHOLOGY PROGRAMS
1990

by Dr. C. R. Curtis, Chair,
Department of Plant Pathology
The Ohio State University

A. Universities having majors or curricula in Plant Pathology

University of Florida with 2 options:

Agriculture Technology and Biotechnology (1-10 students the last 5 yr.)

University of Georgia
*Iowa State University
University of Massachusetts with 4 options:

Standard, Landscape Plants, Biotechnol., and Integr. Pest Mgmt. (15 students at present)

Mississippi State University
Cornell University, New York
North Dakota State University
*The Ohio State University;

(but only as a focus on Plant Pathology in the Honors Program for high ability students)

Clemson University, South Carolina
Washington State University
*University of Wisconsin

B. Universities having only minors in Plant Pathology

University of Missouri
*The Ohio State University

C. Universities having **alternative programs** including;

Integrated Pest Management (IPM), Crop Protection with a Plant Pathology Option, Major in Plant Science with a specialization in Plant Pathology, Major in Pest Management, Curriculum in Agricultural Technology and Biotechnology, Major in Plant Protection, Environmental Management Systems Curriculum, Biotechnology or IPM option, Options in Crops/SoiLs/Horticulture/EnvironmentaI Horticulture, Plant Protection option offered under B.S. in Agronomy, Program in Plant Protection, Bioenvironmental Sciences Curriculum, and Major in Plant Health and Protection.

*University of California at Davis
University of Delaware
University of Idaho
University of Illinois
*Purdue University, Indiana
Kansas State University
University of Maine
University of Minnesota
Mississippi State University
Montana State University
University of Nebraska
Cornell University, New York
*The Ohio State University
Pennsylvania State University
University of Puerto Rico
*Texas A. & M University
Utah State University
Washington State University
University of Wyoming

* refers to peer 11 institutions.

Appendix B:

Request for delay in the post-audit review of the Plant Health and Protection Program.

Request for Delay in Post-Audit Review for the
Plant Health & Protection Program
(Revised 4/5/98)

The interdepartmental undergraduate major in Plant Health & Protection was established in the fall of 1992. The program is jointly administered by the departments of Plant Pathology, Entomology, Agronomy, Horticulture, and Forestry with Plant Pathology acting as the lead department.

The Plant Health & Protection curriculum is designed to educate agricultural professionals capable of dealing with some of the most complex problems facing agriculture and society today. The public has placed great emphasis on environmental protection and sustainability, while at the same time expecting a high-quality, low-cost supply of food and fiber. These seemingly contradictory goals are placing new demands on our abilities to alleviate plant stress and manage plant pests. We believe that graduates of the Plant Health & Protection program will have the broad training and interdisciplinary perspective which will enable them to make valuable contributions to agriculture now and in the future.

The greatest challenge to the success of the Plant Health & Protection program is lack of visibility. In spite of the fact that effective pest management is essential for efficient agricultural production and landscape maintenance, the public has no real awareness of plant health professionals or what they do. (We have even been surprised to learn that many biologists have little awareness of the field.) Admittedly, we were slow to realize the seriousness of this lack of visibility and to develop a strategy to deal with the problem.

As the Plant Health & Protection program was implemented, and the problems associated with lack of visibility became clear, it also became clear to us that only the Plant Pathology Department had a real stake in the success of the program. The major and minor in Plant Health & Protection received virtually no promotion from the other participating departments. It finally became obvious to us that ISU departments are not likely to support an interdepartmental program at the expense of their own majors.

Over the last two years we have developed a multi-faceted recruiting strategy which has been initiated and is beginning to show results. Our major emphasis is on targeted mailings. We are contacting students who have an interest in studying a plant science discipline at Iowa State. The Admissions Office provides us with lists of students who have submitted their ACT scores to ISU and have indicated a career interest in agronomy, horticulture, or botany. We also have access to names of students who have requested information from ISU concerning undergraduate programs in Plant Health & Protection, Agronomy, or Horticulture. All of these students receive a mailing which includes a brochure and general information about Plant Health & Protection (what it is, why it's important, etc.). Later they receive a follow-up mailing discussing availability of scholarships, student employment, and internships. (We have established a scholarship fund which allows us to award 3-5 scholarships to incoming students each year.)

Students contacting us or applying for scholarships receive phone calls. Basically, we try to have some sort of contact with the prospects several times during the recruiting period. In addition to contacting prospects by mail and telephone, campus visits are strongly encouraged. We have also developed a poster display and we have begun participating in science fairs by acting as judges and making special departmental awards to students doing projects related to plant health. We have developed an informative Web page about the Plant Health & Protection program and we intend to add additional informational features to it periodically. Finally, we feel that transfer students from community colleges consitute an important source of potential students. We have sent information out to biology and agriculture programs at several of the community colleges and we are working on articulation plans with agriculture and biology programs at NIACC and Kirkwood CC. We have also restructured two of our Plant Health and Protection courses and have seen significantly increased enrollments. Our hope is that these courses may expose a broad cross section of students to our program and perhaps encourage some of those students to major in Plant Health and Protection.

We are very excited because we think the recruiting process is beginning to show results. Three freshmen entered the program last fall, all of whom were first contacted by our targeted mailings. We have received inquiries from several other students who have received our mailings. Although we have few students in the program (five majors currently enrolled, four majors so far admitted for next fall, two graduated last spring) we feel that our structured recruiting program can and will be successful.

At this time we are asking for a delay in the post-audit review process. Because we misjudged the help we would get in promoting the program, we don't feel there has been a sufficient test of its potential. We are requesting that the post-audit review be delayed until Fall of 2000. By then we will have had two more fall recruiting seasons with our recruiting program in full swing. By that date we will have a much better idea of what the potential of the program can be. Thanks for your consideration of this request. Please don't hesitate to contact us if you need any additional information.

Appendix C:

Letters from students in the Plant Health and Protection Program.

To Whom It May Concern,

I am writing to express my appreciation of the Plant Health and Protection Curriculum. I graduated in 1997, one of the first graduates in PH&P, and am now happily employed as a graduate student in Plant Pathology at ISU.

A wide variety of courses comprise the PH&P curriculum such as Meteorology, Horticulture, Agronomy, Soil Science, Entomology... Such diversity prepares the student for further specialization in many different areas while at the same time, prepares the student for the integration of all areas concerning plant health. This is a tremendous asset for anyone working in Plant Health Management.

In my case, the PH&P curriculum accomplished 2 things:

1) It provided exposure to a wide variety of topics and disciplines that culminated in a fascination and love for my current area of interest as a graduate student, plant-microbe interactions.
2) It prepared me for entry into graduate school with a solid scientific background.

I can still recall the first moment I began to be aware of the intricacy and beauty of the microbial interactions taking place all around us. It was during PI HP 206, Plant Health Biology. Dr. Martinson was explaining interactions among microbes in the Rhizosphere. I thought, "Wow, this is really exciting!" I began to pursue this topic in other courses such as Soil Microbiology. By the time I graduated, I was sure that I wanted to make a career of plant-microbe interactions and am currently finishing a master's thesis on the Influence of the Maize Plant Cuticle on Bacterial Colonization of the Leaf.

The PH&P curriculum also provided for me an easy entry and transition into graduate school. The biology, chemistry and genetics courses I took as an undergraduate student gave me a solid basis for undertaking graduate level courses.

Overall, the combination of strong science and diversity of courses makes the PH&P curriculum one that prepares students for a variety of future directions and an overall understanding of how interrelated are all areas of the plant sciences.

I highly recommend this program for any student who is interested in plant sciences at ISU.

Sincerely,

Lise Marcell

4343-1 Avent Ferry Road
Raleigh, NC 27606

January 1, 2001

College of Agriculture Curriculum Committee
Iowa State University
Ames, IA 50010

To Whom It May Concern:

I am writing to share my positive experiences while attending Iowa State University and attaining my degree in Plant Health and Protection. The curriculum of this program gave me the opportunity to gain a breadth and depth of knowledge in the area of plant health and plant protection. Plant health students also participate in a practical work experience, and through this I was able to apply what I learned in the classroom to real-life work experiences. For my practical experience, I worked as the plant pathology intern for the USDA Plant Introduction Station, where I gained valuable field, lab and greenhouse skills.

After graduation, my Plant Health and Protection degree helped me to obtain an offer from a large seed company in a plant health related research position. However, I have chosen to further my education, and my degree from ISU helped me to be competitive in the application process for graduate school, and I was awarded a fellowship to pursue my Ph.D. in plant pathology at North Carolina State University. I feel very fortunate to have chosen ISU's Plant Health and Protection as my major. It has allowed doors to open for me that I believe would not have been possible with another major.

Sincerely,

Leilani Robertson

Undergraduate Experience in the Department of Plant Pathology

I entered college with an uncertain idea as to what my future would have in store for me. I had an interest in plants, and I knew that Iowa State was the in-state university to choose, but I wasn't sure into what department I belonged. If I remember correctly, the head of the Plant Pathology department, Dr. Ed Braun, contacted me to consider the undergraduate major of Plant Health and Protection. Because the name of the major was something I had never seen before, I was hesitant to choose this major. However, after obtaining information about how the major involved the broad concept of plants, I decided to step into the undergraduate major of Plant Health and Protection.

After four years at Iowa State, I earned a double major in Plant Health and Protection and Horticulture. There were three main reasons why I remained in Plant Health and Protection. I enjoyed the wide diversity in classes dealing, both directly and indirectly, with plants, and the flexibility in taking the classes I desired to take. I was more interested in horticultural plants so I could take classes in that area while still learning about plant pathology, entomology, and agronomy. I also enjoyed the personal relationships students in this major could have with not only their adviser, but with other professors as well. I would feel comfortable discussing questions about classes or careers with any or all of these professors. Thirdly, I enjoyed the opportunity to undertake an independent project during my last three semesters. I chose a project dealing with the potential use of biological control agents against anthracnose fruit rot on strawberries. This project gave me the opportunity to learn, in a more personal setting, the challenge and success of research. With this project, I had the opportunity to present a poster at the APS meeting in Salt Lake City, and I am now in the final process of submitting a paper to

the journal Advances in Strawberry Research. This project helped me relate what I was learning in certain classes with the research process. My enjoyment of and interest in research led me to enter graduate school where I am currently pursuing a M.S. degree in Plant Pathology at Iowa State.

I believe the Plant Health and Protection major will have a positive future if it proceeds in a similar working fashion as it does now. However, there are a few suggestions I would make for improvement. I think the name of the major can be a drawback for incoming students. Like judging a book from its cover, many students, I believe, will glance at the name Plant Health and Protection and consider it too broad of a subject and will not know the specific courses it will include and the importance of a broad knowledge in these subjects. Another suggestion would be to have a Plant Health and Protection club. This idea has been considered but never implemented. A club would allow students to get to know one another better and would allow them to learn subject material in a more casual setting than the classroom. A third suggestion would be to do a better job of discussing what options students have after graduation. This subject, through my experience, was only dealt with during the first and last semesters. Options after graduation could be something dealt with through a club setting.

Overall, I believe that completing a four-year major dealing with the broad subject of plant health and protection will be very useful for future graduate and occupational settings.

Dan Thorpe
02/06/02

Appendix D:

Letters from employers and potential employers.

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

College of Agriculture
Department of Microbiology
207 Science I
515 294-1630
FAX 515 294-6019

Interoffice Communication

OCT 05 2000

DATE: October 2, 2000

TO: Ed Braun, DEO of Plant Pathology

FROM: Gwyn A. Beattie, Dept of Microbiology GAB

RE: Plant Health and Protection Program

After receiving her bachelor's degree in the PHPP program in 1997, Lise Marcell came to my laboratory to work on her master's degree in Plant Pathology, and she has just recently completed this degree. Lise was clearly very well prepared for her graduate coursework, as evidenced by the fact that she consistently earned high grades in her courses, in fact mostly A's, without spending an exceptional amount of time on them. Lise began the PHPP program after a career in music, having had little exposure to the life sciences, and the exposure she had had was from many years in the past. This fact, coupled with her ease and successful performance in her graduate courses, is a strong testament of the quality education that she must have received in the PHPP program.

In the first months after Lise began working with me, I was truly impressed with Lise's broad understanding of plant-microbe interactions and her insight into the relevant and important questions in the field. Although this may be in part attributable to her maturity during her years in the PHPP program relative to other more traditional students, credit must be given to the program for providing this type of comprehensive knowledge of plant health. The program provided her the very foundation she needed to make an intelligent decision as to her future in the field. I recall well her efforts in deciding on the appropriate laboratory in which to pursue a master's degree: her questions during our meeting were strongly focused on which subdiscipline within the field of plant health she should invest her time and career in. Again, she exhibited a really good understanding of both the "big picture" of the field of plant health, and specific details, such as the nuances of microbial colonization processes on roots versus on leaves.

I must also comment on Lise's laboratory skills and approach to science at the time she arrived in my laboratory. To say the least, more than any other student that I have had, she hit the ground running. She had an excellent feeling for experimental design and how to actually apply the scientific method in a bench setting. She started and finished a major set of experiments for her degree in the first 3 months she was in my laboratory. Again, I am sure that some of this talent was inherent to Lise, but it clearly had been fostered and trained during her undergraduate years. Her knowledge of laboratory skills were quite sufficient to launch her into learning the specific skills she needed for her project, which included techniques in chemistry, microbiology, and plant physiology. Based on my experience with Lise, my impression is that the PHPP program provided a strong education and highly appropriate training for its majors.

>From root Thu Oct 5 10:38:12 2000
Mime-Version: 1.0
X-Sender: ghartman@staff.uiuc.edu
Date: Thu, 5 Oct 2000 10:39:24 -0500
To: Ed Braun <ebraun@iastate.edu>
From: Glen Hartman <ghartman@uiuc.edu>
Subject: Re: Letter Request

Dear Ed,

>I would be glad to contribute to your survey.

Chandra has been very well trained in applied plant pathology. I am very satisfied with her work to isolate fungal pathogens, to purify cultures, and to make preliminary identifications. She has a broad knowledge base that includes areas of entomology, soils and general agriculture. I think she also learned a lot in her undergraduate on the job training. I think this is an invaluable experience for undergraduates to work in a research laboratory on specific projects. It gives them training that can enhance their classroom experience. In Chandra's case, she has been very well prepared for research work and I think her undergraduate training has been very good based on her job performance so far.

Let me know if you need more information.

Glen

GLen L. Hartman
70 NSRC, 1101 W. Peabody Dr.
UIUC, Urbana, IL 61801

Phone: 217-244-3258
Fax: 217-244- 7703
Email: ghartman@uiuc.edu

Campus mail only: 70 NSRC MC 637

>From root Mon Oct 30 13:23:06 2000
Reply-To: "ABC Ag Inc The Clarks" <ccabc@pionet.net>
From: "ABC Ag Inc The Clarks" <ccabc@pionet.net>
To: <ebraun@iastate.edu>
Subject: Perspective and a campus visit
Date: Mon, 30 Oct 2000 13:25:31 -0600
MIME-Version: 1.0
X-Priority: 3
X-MSMail-Priority: Normal
X-MimeOLE: Produced By Microsoft MimeOLE V5.50.4133.2400

Hello Ed: Please forgive me for the tardy reply. Two days after you contacted me my oldest brother passed away so things have been unsettled here. I do appreciate your request for my perspective and a visit with your group. I'll try to do my best for you and yes, I'd like to come to campus when the schedules work out. Let me know when you're group wants me to come. **Perspective on Value of ISU Plant Health & Protection Program** The crop production industry in Iowa and the Midwest needs young, educated minds to keep pace with the changing world in which we work and live. In my experience as an ISU ag graduate and independent crop consultant, college students best prepare for their ag careers with a combination of excellent classes on-campus and hands-on training off-campus. The Plant Health & Protection Program at Iowa State University offers interested students the opportunity to participate in both settings. Iowa State has always provided pertinent coursework and now with this curriculum, offers students a six-month internship to apply their classroom education. The program's diverse coursework challenges students to understand the "systems approach" which will help them relate to the crop production industry when they begin their careers. This format should be valuable to both students and future employers. I personally think the Plant Health & Protection Program is right on target and well positioned to meet the needs of today and tomorrow. I wish the program and its students many successes. Chris Clark, BS '89 ABC Ag, Inc. Ida Grove, Iowa 712-364-2424 See you Ed, Chris

Appendix E:

Letters from other departments involved in the program.

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

College of Agriculture
Academic Programs
134 Curtiss Hall
Ames, Iowa 50011-1050
515 294-6614
FAX 515 294-5334

August 23, 2002

Ken Kruempel, Chair
Faculty Senate Curriculum Committee
1121 Coover Hall

Dear Professor Kruempel:

I am writing this letter in support of the Plant Health and Protection major as part of the information currently being gathered for the program's five year Regents' review. The College of Agriculture Administration is very supportive of this program because it exemplifies a cutting edge, interdisciplinary program that is unique in the state of Iowa and well-suited to the needs of the continually evolving agricultural industry in the state and region.

Members of the Coordinating Committee for the Plant Health and Protection major have worked tirelessly to publicize the program and make prospective students aware of the opportunities available to them upon graduation. Their awareness building plan has focused internally on students already enrolled at Iowa State and externally on both community college graduates and graduating high school seniors. It is clear from the numbers that the recruitment strategy is working. Even though there was significant attrition last year from graduation, there are still 13 majors, with four new freshmen entering the program this fall. In the past couple of years, 9 students have graduated from Plant Health and Protection and are either gainfully employed or successfully pursuing graduate studies. These numbers represent a healthy trajectory and I fully expect that the program will continue in its steady pattern of growth in the future. I want to emphasize that the College of Agriculture Administration anticipates that the number of students enrolled in this program will be modest when compared to other majors in our college, but we fully expect the program to eventually reach its goal of 25 students.

I am hopeful that the Board of Regents will grant the Plant Health and Protection major full program status. I consider the program to be an integral part of our comprehensive curriculum package in the College of Agriculture as it prepares students to work in an exciting and challenging career area, as well as in a critically important segment of Iowa's economy. Please contact me if I can provide additional information.

Sincerely,

Eric O. Hoiberg

Eric O. Hoiberg
Associate Dean
Academic Programs

:ms

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Department of Plant Pathology
351 Bessey Hall
Ames, Iowa 50011-1020
515 294-1741
FAX 515 294-9420
plantpath@iastate.edu

August 20, 2002

Dr. Edward Braun
Department of Plant Pathology
Iowa State University
Ames, IA 50011

Dear Ed,

This memo is in support of your Post-Audit Review document for the Plant Health and Protection undergraduate major in our department.

Until recently, I knew very little about the Plant Health and Protection undergraduate major. I was not involved in its creation, operation, or evaluation. The focus of my teaching was exclusively on graduate students. In fact, as a relatively uninformed outsider, I was skeptical that an undergraduate major in such a seemingly specialized area was the best thing for students. However, since becoming chair of Plant Pathology in April of this year, I have learned about the undergraduate teaching program and have had a chance to meet some of the students and recent graduates of Plant Health and Protection. What I have learned has changed my mind completely.

What I see now is that the Plant Health and Protection major serves students exceptionally well. First of all, it provides a home for students who know they are interested in the practical aspects of plants, but don't yet know what interests them the most. Plant Health and Protection, far from being specialized, is a discipline that spans many other disciplines. As such, students receive a broad, yet solid, education that gives them a chance to sample many different fields to determine where their interests and talents lie. The curriculum prepares them for jobs in science and agriculture, and for graduate school in agriculture, microbiology, plant pathology, entomology and the fundamental plant sciences.

Another real strength of the program is the way it provides so many of its students with hands-on research and extension experiences. Because the program is small and the faculty is dedicated to helping students develop, a high percentage of the students are able to work, for pay, with various research and extension faculty while still in school. These research and extension experiences have resulted in a number of student-authored publications, some of which are excellent. I suspect it is these hands-on experiences that account for the high number of students that become excited by science and decide to go to graduate school. As I look over the graduate students now in Plant Pathology that originally graduated in Plant Health and Protection, I am very impressed by their quality.

They are intelligent, mature, and dedicated and some of the best students in the department.

Although I could see some persons being concerned that the small size of the major might make it cost-ineffective, you have provided evidence that this is not true. Most of the classes need to be taught anyway to serve other majors, no additional faculty members were hired to serve this major, and the costs for advertising and administration have been nominal.

I agree with your assessment that Plant Health and Protection struggles to attract students because of the "invisibility" of the discipline. I didn't learn about Plant Pathology, a similar discipline, until I finished my Master's degree in Plant Physiology and thirsted to do research with more obvious utility. If I had known as an undergraduate what I now know about the Plant Health and Protection major (if one had existed at my undergraduate institution), I would have jumped at the chance to enroll. Your award-winning recruitment brochure and your efforts to obtain scholarships funds for this major will no doubt help to reduce the "invisibility" problem.

In short, I believe the value of the Plant Health and Protection undergraduate major far exceeds its costs. I hope, for the sake of future students who love science, agriculture and plants, that it continues.

Sincerely,

Charlotte R. Bronson

Charlotte R. Bronson
Professor and Chair, Department of Plant Pathology
Interim Director, Center for Plant Responses to Environmental Stresses

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Interoffice Communication

Department of Entomology
10 Insectary
Ames, Iowa 50011
Phone: (515) 294-7400
FAX: (515) 294-8027

Date: August 27, 2002

To: Dr. Charlotte Bronson, Chair
Department of Plant Pathology
351 Bessey Hall

From: Joel Coats, Chair
Department of Entomology
116 Insectary

RE: **Support for Plant Health & Protection Major**

I am pleased to provide you with the strong support of the Department of Entomology for the interdepartmental major in Plant Health and Protection. Our department has had an interest in this program for many years, but especially recently, since the decision to terminate the interdepartmental IPM secondary major. The Plant Health and Protection degree program provides excellent multidisciplinary training for students who desire employment in this broad field or who want to initiate graduate studies in any of the plant-protection fields. There is a rapidly growing "green industry" that is focused on the plant needs of many stakeholders, especially across the general public; it includes plant protection and plant health needs in turf, ornamentals, fruits, vegetables, shade trees, wood lots, nurseries, greenhouses, house plants, etc. The College of Agriculture is making a strong effort to address the needs of these new groups of stakeholders that are primarily in metropolitan areas and require the expertise of the graduates from this major, for their personal residence, nutrition, and aesthetics, as well as in municipal and recreational settings. The immediate job market for undergraduates is very good, and those who use the major as a platform to launch them onward toward graduate work also find themselves very well served by Iowa State's program. Much like the similar-sized undergraduate major in Entomology, the Plant Health and Protection major provides its students with a

wide range of outstanding opportunities to conduct research or participate in extension activities while still in school. Students in this major are highly sought-after in the participating departments for lab and field part-time work, because their expertise, as it develops, is extremely valuable to our research efforts. The program, has, over the years, especially under the guidance of Ed Braun, developed into an important option for students in the College of Agriculture. As we focus on development of a new commitment to serve the new stakeholders, this major will grow; its graduates will serve them well, and the major will benefit from garnering more students from that population. We are impressed with the faculty and staff, as well as the quality of students that graduate from the program.

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Department of Agronomy
Crop, Soil, and Environmental Sciences
Dr. Steven L. Fales
2101 Agronomy Hall
Ames, Iowa 50011-1010
Phone: 515 294-7636
Fax: 515-294-3163
E-mail: slf@iastate.edu

February 5, 2002

Dr. Ed Braun, Head
Department of Plant Pathology
Iowa State University
Ames, IA 50011

Dear Dr. Braun:

As you requested, am writing to offer the support of the Agronomy Department for interdepartmental undergraduate major in Plant Health and Protection. We believe that Plant Health & Protection is a very good program and that it complements our baccalaureate degree program well. Many of our students take one or two of the Pl HP classes, especially Pl HP 391 (Practical Plant Health), and Pl HP 407 (Principles of Plant Pathology). Our students find these courses valuable – they are well taught, interesting and pertinent. In addition, we generally have agronomy majors who are double-majoring in Pl HP. People with this background are highly sought after by industry because of their broad understanding of plant growth and well-being, and we encourage students to take this path if they wish.

While the major may seem small by comparison to other large programs (such as Agronomy), I believe that losing it would be a significant detriment to the College and University. It certainly would be a loss for Agronomy. I hope that the decision makers will recognize this, and also recognize that although certain disciplines do not necessarily attract hoards of students, they are still extremely valuable to science and society, and should not be lightly discarded or subsumed by others.

I wish you and the Program success for the future.

Regards,

Steven L. Fales
Professor and Head

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

College of Agriculture
Department of Forestry
253 Bessey Hall
Ames, Iowa 50011-1021
Phone 515 294-1458
FAX 515 294-2995

February 4, 2002

Dr. Edward Braun
Department of Plant Pathology
217 Bessey Hall
Iowa State University
Ames, IA 50011

Dear Ed:

Thank you for the opportunity to support the continuation of the interdepartmental undergraduate major in Plant Health and Protection. We fully support the continuation of this program since it provides an essential requirement in our curriculum, PLP 416-Forest Pest Management. Without the continued presence of the Plant Health and Protection program it is doubtful that the continued offering of PLP 416 could be justified. Since this is a required course for our program accreditation, loss of the Plant Health and Protection interdepartmental major could lead to the loss of SAF accreditation of our whole degree program. Information provided in this course is a key component in the training of professional foresters and its loss would have negative impacts on the quality of the program we would be able to offer. Because of its importance, the loss of this course would force the department to use its very limited resources to hire an individual capable of teaching in this area.

Thank you again for the opportunity to provide input to your review process.

Sincerely,

J. m. Kelly

J. Michael Kelly
Chair and Professor

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

College of Agriculture
Department of Horticulture
Horticulture Building
Ames, Iowa 50011-1100
515 294-2751
FAX 515 294-0730

February 6, 2002

Dr. Edward Braun
Department of Plant Pathology
217 Bessey Hall
Iowa State University
Ames, IA 50011

Dear Dr. Braun:

The College of Agriculture is an extremely diverse college with a broad array of Departments and program offerings. Some of its programs are large, while others have comparatively fewer students. Although relatively small, the interdepartmental Plant Health and Protection Program is an asset to the COA and is extremely valuable to those undergraduate students who wish to work as research technicians after graduation or go on to graduate school. Programs like PLHP are unique and are an integral part of what makes the ISU College of Agriculture one of the best in the country.

The Plant Health and Protection Program attracts high-quality students to the COA. It was my pleasure to co-advise one such student. He was extremely dedicated to this program and thankful for the on-campus training and off-campus internship opportunities afforded him. We are a better college because of this program and the 20-25 gifted and talented students you mentor.

Finally, the broad and rich curriculum associated with PLHP has benefited students in the Department of Horticulture, and therefore I urge the Department of Plant Pathology to grow this effective program and continue serving this important academic niche.

Let me know how I can assist you in this worthwhile endeavor.

Sincerely,

Jeff Iles
Chair, Department of Horticulture

Appendix F:

Examples of student publications.

Jour. Iowa Acad. Sci. 109(1,2):30–34, 2002

Fungi and Diseases Associated with Cultivated Switchgrass in Iowa

C. E. GRAVERT and G. P. MUNKVOLD

Department of Plant Pathology, Iowa State University, Ames, Iowa 50011

Switchgrass (*Panicum virgatum* L.) is a native perennial prairie grass that is now cultivated as a forage crop and a biomass crop for renewable energy. Biomass yields of switchgrass in southern Iowa have recently dropped significantly in some fields and the reduction has been attributed to disease. A disease survey was conducted in 1999 to assess the prevalence of major diseases in Chariton Valley switchgrass production. There were disease symptoms present on switchgrass plants in each field and thirteen fungal species were identified from leaf, stem, and root samples. Two pathogenic fungi, *Tilletia maclaganii* and *Colletotrichum graminicola,* were present in 88% and 100% of fields, respectively. Severity (% diseased leaf area) of *C. graminicola* was low in each field. However, *Tilletia maclaganii* was at high incidence (>70%) in some fields and apparently is causing significant reductions in biomass and seed production. Nine of the other fungi identified in the survey have not been reported previously from switchgrass in Iowa.

INDEX DESCRIPTORS: biomass, fungi, *Panicum virgatum,* switchgrass, *Tilletia maclaganii.*

Switchgrass (*Panicum virgatum* L.) is a native perennial prairie grass in which cultivars have been developed for use as forage (Hughes et al. 1984) and biomass crops. In southern Iowa, a consortium of private groups and government agencies has established an infrastructure for using switchgrass as a cash crop for renewable energy, by combining biomass from switchgrass with coal for combustion. This project also was designed to provide erosion control for the Lake Rathbun watershed and provide wildlife refuge land (Chariton Valley Resource Conservation and Development 2000).

The four-county area, known as the Chariton Valley, is composed of Lucas, Monroe, Wayne, and Appanoose Counties in south-central Iowa. Landowners have committed 1,600 hectares in the area to the production of switchgrass for biomass (M. Braster, pers. comm.). Biomass harvested from switchgrass fields in the Chariton Valley is co-fired with coal at the Alliant Energy Ottumwa Generating Station in Chillicothe, Iowa.

In 1998 the Chariton Valley project coordinators became aware that biomass and seed yields were beginning to decline. Expected biomass yields are approximately 9.0 Mg/ha, but in some fields there had been a decline of approximately 5.0 Mg/ha in the past two years (M. Braster, pers. comm.). Diseases were suspected of contributing to the declining yields, but it was unclear which diseases might be involved or to what extent they were affecting biomass production.

At least 42 fungal species have been reported to occur on switchgrass in the U.S., but only 10 have been reported previously in Iowa (Table 1). Pathogenicity of many of these fungi is unknown. Because switchgrass has not been an economically important plant in the state, there has not been extensive research on its diseases, and there is a strong likelihood that many of the other 32 fungi occur in Iowa but have not been reported.

Our objectives were to: investigate fields with declining yields for possible disease-related causes, and to assess the occurrence of diseases of switchgrass in biomass production areas.

METHODS

Preliminary sampling was conducted on 27 May and 24 June 1999, in fields previously identified as low-yielding, and at a cultivar trial at the Iowa State University McNay Research Farm near Chariton, IA, in Lucas Co. Stem, leaf, and root samples with disease symptoms were collected from cooperator fields near the towns of Derby, Lucas (Lucas Co.), Iconium (Appanoose Co.), and Millerton (Wayne Co.). Samples were collected from several cultivars. During the preliminary sampling, a seed smut was observed in several fields.

A more intensive survey, focused primarily on the smut disease, was conducted in late August. We used a weighted random sampling procedure to select 20 switchgrass fields from approximately 60 switchgrass fields involved in biomass production. Neither yield nor suspected disease status were considered in the field selection. The sampling procedure was designed so that the probability of each field being chosen was proportional to its area. This resulted in samples being taken from 16 fields representing approximately 50% of the total area of the 60 fields. Four of the 20 selected fields were not suitable for sampling due to low switchgrass densities. In addition to the randomly selected fields, one additional field (field 2) was sampled in Appanoose Co. This field was chosen because of its high incidence of smut. All 17 fields had been planted to the predominant cultivar, Cave-in-Rock. In each field, five samples were taken from arbitrary locations. Each sample consisted of one square meter in which all vegetation was clipped approximately 15 cm above the soil and brought to the laboratory. Samples were stored at 4°C until they were assessed for disease. The total number of tillers and the number of tillers with smut were counted. The incidence of smut (% of tillers with smut) was calculated for each sample. The mean incidence of smut for the sampled area was calculated as a weighted average of the 16 randomly selected fields. Linear correlation analysis (SigmaStat, Jandel Scientific, San Diego, CA) was conducted to assess the relationship between tiller density (tillers/m^2) and smut incidence. Other disease symptoms were recorded and sub-samples were retained for disease identification.

In order to identify diseases and fungi other than smut, leaf and stem samples from the surveyed fields were placed into moist chambers (sterile petri dish with moistened filter paper) and allowed to develop for four to seven days. Fungi developing on symptomatic tissue were microscopically examined and identified. Fungi that

Table 1. Fungi and Oomycetes reported to infect switchgrass in Iowa and other areas of the United States.

Class or Phylum	Species	Reference	Iowa Reports
Oomycetes	*Pythium arrhenomanes* Drechs.	Farr et al. 1995	
	Pythium debaryanum R. Hesse	Farr et al. 1995	
	Pythium graminicola Subramanian	Farr et al. 1995	
	Sclerophthora macrospora (Sacc.) Thirumalachar, C.G. Shaw & Narasimhan	Farr et al. 1995	
Ascomycota	*Balansia epichloe* (Weese) Diehl	Farr et al. 1995	
	Balansia henningsiana (A. Möller) Diehl	Farr et al. 1995	
	Claviceps Tul.sp.	Farr et al. 1995	
	Elsinoë panici L.H. Tiffany & Mathre	Tiffany and Mathre 1961	Tiffany and Mathre 1961
	Exarmidium fusariisporum (Ellis & Everh.) Theiss. & Syd.	Farr et al. 1995	
	Graphyllium hysterioides (Ellis & Everh.) Barr	Farr et al. 1995	
	Leptosphaeria orthogramma (Berk. & M.A. Curtis) Sacc.	Tiffany and Knaphus 1985	Tiffany and Knaphus 1985
	Metasphaeria subseriata Ellis & Everh.	Farr et al. 1995	
	Phyllachora graminis (Pers.:Fr.) Nitschke	Gabel and Tiffany 1999	Gabel and Tiffany 1999
Basidiomycota	*Puccinia emaculata* Schwein.	Farr et al. 1995	Gilman and Archer 1929
	Puccinia graminis Pers.:Pers.	Farr et al. 1995	
	Puccinia virgata Ellis & Everh.	Cummins 1971	
	Uromyces graminiciola Burrill	Farr et al. 1995	Gilman and Archer 1929
	Sporisorium cenchri (Lagerh.) K. Vánky	Farr et al. 1995	
	Tilletia barclayana (Bref.) Sacc. & Syd.	Fischer 1953	Farr et al. 1995
	Tilletia maclaganii (Berk.) G.P. Clinton	Fischer 1953	Gilman and Archer 1929
	Ustilago heterogena Henn.	Fischer 1953	Farr et al. 1995
	Ustilago trebouxii Syd. & P. Syd.	Fischer 1953	
	Thanatephorus cucumeris (A.B. Frank) Donk	Farr et al. 1995	
	Rhizoctonia solani Kühn	Farr et al. 1995	
Hyphomycetes	*Alternaria* Nees sp.	Farr et al. 1995	
	Beniowskia sphaeroidea (Kalchbr. & Cooke) E. Mason	Farr et al. 1995	
	Bipolaris sorokiniana (Sacc.) Shoemaker	Farr et al. 1995	
	Cerebella andropogonis Ces.	Farr et al. 1995	
	Curvularia geniculata (Tracy & Earle) Beodijn	Farr et al. 1995	
	Fusarium acuminatum Ellis & Everh.	Farr et al. 1995	
	Fusarium equiseti (Corda) Sacc.	Farr et al. 1995	
	Micordochium bolleyi (R. Sprague) DeHoog & Hermanides-Nijhof	Farr et al. 1995	
	Phaeoramularia fusimaculans (Atk.) X. Liu & Guo	Farr et al. 1995	
Coelomycetes	*Ascochyta missouriensis* R. Sprague & A.G. Johnson	Farr et al. 1995	
	Ascochyta Lib. sp.	Farr et al. 1995	Tiffany et al. 1990
	Colletotrichum graminicola (Ces.) G.W. Wils.	Farr et al. 1995	
	Hendersonia panicicola Petr.	Farr et al. 1995	
	Phoma sorghina (Sacc.) Boerema, Dorenbosch, & Van Kesteren	Farr et al. 1995	
	Phoma terrestis E.M. Hans.	Farr et al. 1995	
	Phyllosticta panici E. Young	Sprague 1950	
	Pseudoseptoria donacis (Pass.) Sutton	Farr et al. 1995	
	Septoria sigmoidea Ellis & Everh.	Farr et al. 1995	Farr et al. 1995
	Wojnowicia hirta Sacc.	Farr et al. 1995	

could not be identified from moist chambers were aseptically transferred to potato dextrose agar (PDA, Difco Brand, Becton Dickinson and Co., Sparks, MD) amended with 50 mg/L chlortetracycline hydrochloride, 120 mg/L neomycin sulfate, and 200 mg/L streptomycin sulfate, or carnation leaf agar (CLA) (Nelson et al. 1983). Root samples from the field were cut into three to four 1-cm sections, including necrotic areas, surface disinfested in 10% bleach for one minute, rinsed with sterile water, and placed onto PDA. The samples were incubated for 7 days in the dark. Fungal colonies then were examined microscopically for identification according to morphological characters. Colonies that could not be identified from the PDA cultures were transferred to CLA, incubated for 7 additional days,

and then examined microscopically. Presence of each fungus recovered from leaves, stems, or roots was recorded for each sample and prevalence (% of fields from which the fungus was recorded) was calculated for the more common fungi.

Seeds of the cultivar Cave-in-Rock, contributed by a commercial seed producer in Lucas County, were cultured for seedborne diseases. Approximately 75 seeds were surface sterilized for 3 min in 0.5% NaOCl, rinsed with sterile distilled water, and placed in moist chambers for 24 h to initiate germination. The moist chambers were then placed in a freezer (−20°C) for 48 h; seeds were removed and cultured on PDA for 7 days. Fungal colonies growing on PDA were transferred to CLA for identification. Additional seeds of cultivars Forestburg and Sunburst, contributed by Dr. Charles Brummer (Iowa State University Dept. of Agronomy), were planted in greenhouse soil mix. After 3 weeks, seedlings were removed and rinsed with tap water to remove soil. Seedlings were dissected into root, stem, and leaf pieces, which were surface sterilized in 0.5% NaOCl for 3 min and rinsed with sterile distilled water. Plant tissue pieces were cultured on PDA for 7 days. Fungal colonies growing on PDA were transferred to CLA for identification.

RESULTS

Thirteen fungal species were identified during the preliminary sampling or survey sampling. Additional fungi were collected but not identified due to a lack of sufficient taxonomically meaningful morphological characters.

Alternaria alternata (Fr.) Keissler (Ellis 1971) was found on fresh leaves from the field, seeds, and from the base of seedling leaves in the greenhouse. Clavate or pyriform, olive-pigmented conidia formed in chains from conidiophores on leaf tissue and in culture. Conidia had transverse and longitudinal septa, short beaks, and a verrucose surface. This fungus can be parasitic or saprophytic on plant material (Agrios 1997) and it is unclear from our examination whether the fungus was present as a leaf pathogen or saprophyte.

Bipolaris sorokiniana (Sacc.) Shoemaker was found on lesions on leaves collected in the field, on the bases of seedling leaves from the greenhouse, and also was isolated from seed. Isolates from each source were morphologically identical. The leaf lesions were elliptical, approximately 1 to 3 mm long, and had yellowish halos. The halo was surrounded by tissue that had a reddish-purple tint. Conidia formed sympodially on dark-pigmented, erect conidiophores arising from the lesions or in culture. Conidia were brown, 3 to 10 pseudoseptate, elliptical, and slightly curved, as described by Ellis (1971), as *Drechslera sorokiniana. Bipolaris sorokiniana* (Sacc.) Shoemaker (*Helminthosporium sativum*) has been reported to cause a seedling blight (Farr et al. 1995) and leaf disease (Zeiders 1984) on switchgrass.

Colletotrichum graminicola (Ces.) G.W. Wils. (Sprague 1950) was found on lesions on leaves from the field. Lesions were 3 to 5 mm long, elliptical, and tan with a brown border and a yellow halo. Within the lesions were numerous acervuli with dark setae. Abundant conidia formed in mucilage in the acervuli; conidia were single-celled, falcate, hyaline, and slightly pink in mass. This fungus has been reported from switchgrass in Iowa (Tiffany et al. 1990).

Elsinoë panici L.H. Tiffany & Mathre (Tiffany and Mathre 1961) was found on leaves in the field, causing elongated white to cream-colored lesions, 10 to 20 mm long, or with a black fungal stroma on the leaf surface. Conidia were hyaline, single-celled and ovoid. Globose, eight-spored asci were present in some samples, with ascospores that were three- to four-celled, ellipsoid, and hyaline.

Species of *Fusarium* Link were isolated from fresh leaf tissue, root tissue, and seeds. *F. acuminatum* Ellis & Everh. was isolated from leaf tissue and *F. oxysporum* Schlechtend.:Fr. and *F. solani* (Mart.) Sacc. were isolated from root tissue and seeds. The necrotic lesions on the roots were brown to dark brown in color and covered 1 to 3 mm of tissue. *Fusarium* isolates were identified to species by morphological characters on CLA as described by Nelson et al. (1983).

Isolates of *Penicillium* Link:Fr. were isolated from root tissue and seed. Root lesions covered 2 to 5 mm on the roots and were brown to dark brown. In culture on CLA, the fungus produced long branched conidiophores tipped with clusters of phialides. Conidia were small, globose, hyaline (but blue-green in mass), and produced in chains, as described by Barnett and Hunter (1998).

A species of *Phyllosticta* Pers. was found on leaf lesions from the field. Lesions were elliptical, 3 to 5 mm long, and yellow to tan with dark spots (pycnidia) in the middle of the necrotic tissue. Pycnidia were globose with a short beak. Conidiophores were indistinguishable. Conidia were small, single-celled, ovoid, and hyaline, as described by Barnett and Hunter (1998). *Phyllosticta panici* E. Young has been reported previously from switchgrass (Sprague 1950).

Pseudoseptoria donacis (Pass.) Sutton was found on leaf lesions from the field. Lesions were elliptical, 2 to 5 mm long, and tan with black spots (pycnidia) in the middle of the lesion. Pycnidia were globose and about 100 μm in diameter. Conidia were falcate, nonseptate, and hyaline, as described for *Pseudoseptoria donacis* (Sprague and Johnson 1950) (as *Selenophoma donacis*). This fungus has been reported previously on switchgrass (Farr et al. 1995).

Puccinia emaculata Schwein. was found on fresh leaves and year-old dead stems. Pustules were 1 to 2 mm long, black, linear, and contained between veins on the stems. Urediniospores and teliospores were found on leaf samples, but stem pustules contained only teliospores. Urediniospores were almost globose and approximately 24 μm long; teliospores were two-celled, ellipsoidal, and 32–40 μm × 15–20 μm, consistent with *P. emaculata* as described by Cummins (1971). *Puccinia emaculata* Schwein., *P. virgata* Ellis & Everh., and *P. graminis* Pers:Pers. have been reported previously on switchgrass (Gilman and Archer 1929, Cummins 1971, Tiffany and Knaphus 1985, Farr et al. 1995).

Tilletia maclaganii (Berk.) G.P. Clinton was found on inflorescences in the field. This smut disease was characterized by a purpling of the panicles, early heading, stunted plants, and seeds replaced by orange-brown teliospore masses. Sori remained covered by the glumes even after the plants matured, with small inconspicuous spore masses exuding from the tips of the florets. Teliospores were reddish-orange when immature, then becoming dark brown as they matured. They were globose to slightly irregular, approximately 18–25 μm in diameter, finely verrucose, and with a thick exospore. True sterile cells also were present, as described by Fischer (1953).

A species of *Trichoderma* Pers:Fr. was isolated from root lesions that were 2 to 5 mm long and brown to black in color. In culture on CLA, the fungus produced hyaline, branched conidiophores with hyaline to pale green single-celled, ovoid conidia in terminal clusters, as described by Barnett and Hunter (1998). Conidia were bright green in mass.

Among the fungi we identified, *T. maclaganii* and *C. graminicola* were the most commonly encountered (Tables 2 and 3). Although *C. graminicola* was found on several cultivars, *T. maclaganii* was found only on Cave-in-Rock, which is the most commonly planted cultivar. Other cultivars were observed primarily at the cultivar trial at the ISU McNay Research Farm, and the smut disease did not occur there.

Smut caused by *T. maclaganii* was widespread in the Chariton Valley switchgrass plantings. It was found in each of the four counties, in 15 of the 17 fields surveyed (Table 3) at an incidence of 0.2 to 70.5% of tillers. Mean incidence was 10.1%. Field 2 was not included in this calculation since it was not one of the randomly selected fields. Based on the occurrence of the disease in individual subsamples, we estimate that 50–82% of the sampled land area was infested with smut in 1999. A more precise estimate is not possible

Table 2. Fungi isolated from switchgrass in the Chariton Valley in 1999; cultivars, infected tissue, and prevalence in biomass production fields.

Fungi	Cultivars	Plant Tissue	Prevalence (%)[a]
Alternaria alternata	Blackwell	Leaf	
	Cave-in-Rock		82
	Sunburst		
Bipolaris sorokiniana	Blackwell	Leaf, seed	
	Cave-in-Rock		24
	Sunburst		
Colletotrichum graminicola	Blackwell	Leaf	
	Carthage/Shawnee		
	Cave-in-Rock		100
	Forestburg		
	IALM		
	NU94-2CH		
	Sunburst		
Elsinoë panici	Cave-in-Rock	Leaf	29
Fusarium acuminatum	Cave-in-Rock	Leaf, root, seed	NR
F. oxysporum	Cave-in-Rock	Root	NR
F. solani	Cave-in-Rock	Root	NR
Penicillium sp.	Cave-in-Rock	Root	NR
Phyllosticta sp.	Cave-in-Rock	Leaf	47
Pseudoseptoria donacis	Blackwell	Leaf	NR
Puccinia emaculata	Cave-in-Rock	Leaf, stem	47
Tilletia maclaganii	Cave-in-Rock	Head	88
Trichoderma	Blackwell	Root	NR

[a]Percentage of fields (out of 17) in which the fungus was found or isolated. NR = not recorded

Table 3. Incidence of seed smut caused by *Tilletia maclaganii* in cultivated switchgrass stands sampled in the Chariton Valley in southern Iowa.

Field	County	Hectares	Tillers /m^2	Incidence (%)[a]
1	Appanoose	41.3	81	46.5
2	Appanoose	53.4	252	70.5
3	Lucas	5.7	128	9.4
4	Lucas	13.0	61	0.0
4-1	Lucas	13.8	86	1.2
5	Lucas	2.8	97	1.4
7	Lucas	57.5	95	3.2
8	Lucas	16.2	122	15.0
9	Lucas	48.2	121	6.6
12	Lucas	80.9	127	11.8
13	Monroe	6.9	152	1.7
14	Wayne	8.1	176	0.8
15	Wayne	40.9	96	0.2
16	Wayne	68.9	112	0.0
18	Wayne	30.8	171	21.4
19	Wayne	6.5	147	13.2
20	Wayne	12.1	126	8.8
Total		507		
Weighted mean[b]			114	10.1

[a]% of tillers
[b]Does not include field 2

without a more intensive sampling procedure. There was a positive linear correlation (correlation coefficient, $R = 0.57$, $P = 0.017$) between the number of tillers/m^2 and smut incidence, but only when Field 2 was included in the analysis. A preliminary report on the occurrence of *T. maclaganii* was published (Gravert et al. 2000).

DISCUSSION

Of the 13 fungi identified (Table 2), only four (*C. graminicola, E. panici, Puccinia emaculata,* and *T. maclaganii*) have been reported previously from Iowa switchgrass. Five of the fungi identified have been reported previously from switchgrass in areas other than Iowa. This represents the first reports for *Alternaria alternata, Bipolaris sorokiniana, Fusarium acuminatum, Phyllosticta* sp., and *Pseudoseptoria donacis* from switchgrass in Iowa. Four species reported here (*Fusarium oxysporum, Fusarium solani, Trichoderma* sp., and *Penicillium* sp.) have not been reported previously from switchgrass. However, it is not clear whether any of these four fungi are pathogenic to this host.

Rusts are recognized as a potential threat to cultivated switchgrass and some cultivars have been selected for resistance to rust (Hughes et al. 1984). At least three *Puccinia* species and one species of *Uromyces* have been reported on switchgrass, but only *P. emaculata* was found in our survey. Mycologists surveying native prairie grasses in Iowa in the 1920s and 1980s also did not report other *Puccinia* species on switchgrass (Tiffany and Knaphus 1985, Tiffany et al. 1990). In 1999, rust was not present at a high incidence. In 2000, a systematic survey was not conducted, but rust was observed in several fields in the area and appeared to be more prevalent than in 1999.

The results indicate that there is a wide distribution of two pathogenic fungi on switchgrass cultivated in southern Iowa: *Tilletia maclaganii* and *Colletotrichum graminicola.* Both are well-known pathogens; *Tilletia maclaganii* is the causal agent of seed smut and *Colle-*

totrichum graminicola causes anthracnose. Both fungi were found in the majority of samples, but only *T. maclaganii* appeared to have a significant impact on plant growth. Plants infected by *T. maclaganii* were 30 to 50 cm tall, whereas healthy plants grew to a height of 2 m or more. Conversely, *C. graminicola* lesions affected only a small amount of leaf area on infected plants and were not associated with stunting of the plants.

Tilletia maclaganii greatly reduces biomass yields because infected plants flower prematurely, when the plant is less than 1 m in height. The disease cycle for this pathogen is unknown. The source of inoculum for cultivated switchgrass fields is a high priority for current research. No other hosts are reported for this fungus (Farr et al. 1995). Some species of *Tilletia* are primarily seedborne while others overwinter as teliospores in the soil and infect plants through the roots. Covered smuts of wheat, *Tilletia caries* and *T. foetida,* have been found to survive up to three years in the soil in the teliospore stage (Agrios 1997). Additional research is needed on overwintering and seed-related aspects of *T. maclaganii* in Iowa.

Tilletia maclaganii occurs on native switchgrass in Iowa, but is not common (L. H. Tiffany, personal communication). Previous surveys of fungi found on switchgrass have been conducted primarily in prairie remnants (Tiffany and Knaphus 1985, Tiffany et al. 1990, Gabel and Tiffany 1999). The limited genetic diversity and higher density of switchgrass in cultivated fields may lead to predominance of specific fungi that are not common in prairies. A positive relationship between tiller density and smut incidence could indicate a greater tendency for disease spread when switchgrass density is high, but the evidence for this relationship is not clear-cut.

The high prevalence and incidence of the disease in cultivated switchgrass may be a result of the widespread planting of a single cultivar, Cave-in-Rock, which is obviously highly susceptible to the pathogen. Effective control practices are difficult to determine, but alternative cultivars must be investigated, and planting a greater diversity of cultivars would reduce the risk of widespread disease losses.

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Sustainable Urban Landscapes

CROWN ROT

A Serious Disease of Hosta and Other Ornamentals

Hostas are the top-selling herbaceous perennials nationwide thanks to their attractive foliage, endless diversity of shape and size, tolerance of shady areas, and minimal maintenance needs.

Few pests plague hostas in Iowa. Since the mid-1990s, however, a disease called crown rot has damaged many hosta plantings. This fungal disease, caused by *Sclerotium rolfsii*, can severely damage established hostas within a week, and is difficult to eradicate. Formerly restricted to warm, humid states in the southern United States, crown rot has now appeared in many Midwest gardens.

This bulletin explains how *S. rolfsii* has managed to spread into the Midwest, how it causes crown rot in hostas, and ways to manage the disease.

IOWA STATE UNIVERSITY
University Extension

SUL 8 February 2000

Symptoms

Symptoms begin to appear on hosta after prolonged hot, humid weather. The lower leaves begin to turn yellow, then brown, and wilt from the margins back toward the base (Figures 1, 2, and 3). The upper leaves may soon collapse, too. The wilted leaves can be easily pulled from the crown, because they have been attacked at the base of the petiole. The bases of these damaged petioles show a brown discoloration and mushy texture (Figure 4). Plants with less succulent stems, such as peony, are girdled at the base of stems, causing discolored and wilted leaves, but the stems may not collapse (Figure 5). Fluffy white threads (mycelium) of the crown rot fungus typically are present on the rotted tissue and surrounding soil (Figure 6). A closer look shows small spheres, about the size of mustard seeds, sprinkled on the soil (Figure 7). These tiny spheres, called sclerotia, allow the fungus to survive cold winters and other unfavorable conditions. As sclerotia mature, their color changes from white to a light tan or reddish brown.

FIGURE 1
A hosta bed showing the leaf yellowing typical of crown rot.

FIGURE 4
Brown, softened tissue at the base of hosta petioles. Tiny, orange spheres on the soil surface below the petioles (see arrow) are sclerotia of the fungus Sclerotium rolfsii. *Note penny for scale.*

FIGURE 2
Close-up of a hosta with marginal yellowing and browning caused by crown rot.

FIGURE 3
Collapse and death of lower leaves of hosta, caused by crown rot attack at the bases of the leaf petioles.

FIGURE 5
A wilted, collapsed peony (center) whose fronds were attacked at the base by Sclerotium rolfsii. *The source of the fungus was a nearby, infected hosta.*

FIGURE 6
White mycelium (fungal strands) of Sclerotium rolfsii *on the base of a hosta petiole severed by the fungus.*

FIGURE 7
Sclerotia of Sclerotium rolfsii. *Sclerotia are approximately 1 mm in diameter (about the size of mustard seeds) and vary in color from white to brick red.*

How *S. Rolfsii* Causes Crown Rot

The crown rot life cycle begins with the germination of sclerotia (Figure 8). Mycelium fans out in all directions from the sclerotia, slowly growing across the surface of the soil in warm, moist weather. When a host plant is nearby, the fungus exudes droplets containing oxalic acid and tissue-destroying enzymes. Oxalic acid poisons plants, causing their cell walls to break down.

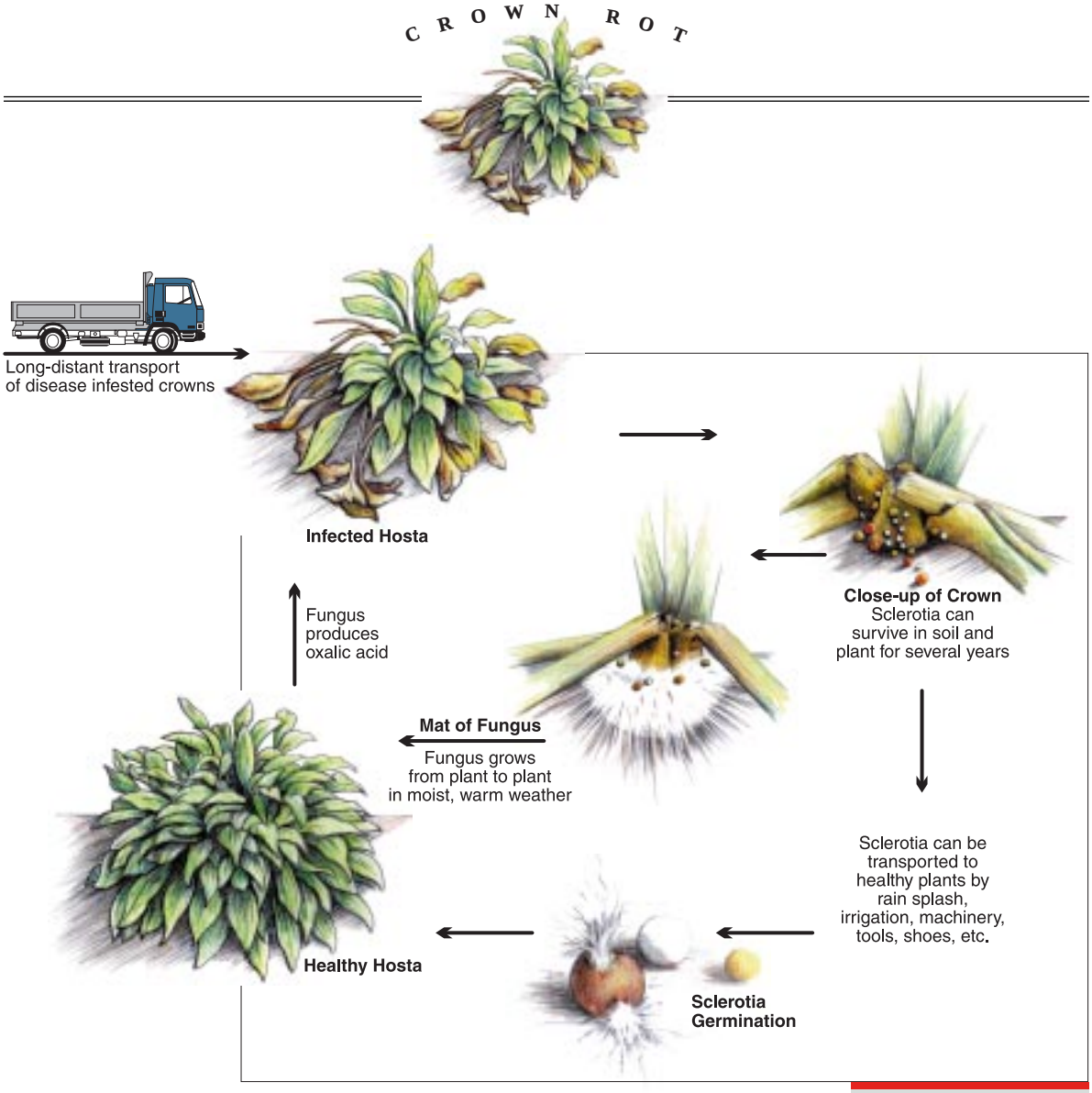

FIGURE 8
Disease cycle of crown rot on hosta.

When *S. rolfsii*'s mycelium comes into contact with hosta, the oxalic acid kills the petioles at the base. With their support gone, the leaves begin to collapse. The stem bases, and the soil for several inches around the crown, can be covered with fluffy white mycelium. Mature mycelium begins to produce sclerotia. There is no required dormancy period, so newly formed sclerotia can produce new mycelium at once or remain dormant in the soil for years.

Sclerotia are hard-shelled survival structures. It was once thought that the cold winters of the Upper Midwest would kill *S. rolfsii*, but gardeners have seen crown rot spread through their plantings year after year. It now appears that *S. rolfsii* sclerotia can survive temperatures well below freezing, either in plant debris or at the soil surface.

On the positive side, *S. rolfsii* seldom produces microscopic spores like most other fungi. Without spores, it cannot spread by moving on air currents, but only as sclerotia in soil or plants, or by mycelium that grows slowly across the ground from plant to plant.

TABLE 1
Genera of herbaceous perennials known to be hosts for *Sclerotium rolfsii*. The plants on this list grow well in part sun to full shade in the Upper Midwest.

Ajuga–bugleweed
Anemone–windflower
Aquilegia–columbine
Arrhenatherum–oat grass
Asplenium–dragontail fern
Caladium–fancy-leaved caladium
Campanula–bellflower
Chrysogonum–goldenstar
Convallaria–lily-of-the-valley
Dicentra–bleeding heart
Digitalis–foxglove
Dryopteris–wood fern
Hemerocallis–daylily
Hosta–plantain lily, hosta
Lysimachia–loosestrife
Phlox–phlox
Ranunculus–buttercup
Vinca–periwinkle
Viola–violet, pansy

For a more complete listing of host genera, consult the following reference: Farr, D.F., Bills, G.F., Chamuris, G.P., and Rossman, A.Y. 1989. *Fungi on Plants and Plant Products in the United States.* American Phytopathological Society, St Paul, MN.

Spread of Disease

What are the circumstances behind crown rot's introduction into northern landscapes? The answer is unknown, but one possibility is that *S. rolfsii* has been spread on contaminated nursery plants (Figure 8). Others point to the nonstop exchange of hostas among gardeners throughout the United States. Once crown rot has entered a planting it is easily spread by sclerotia clinging to soil on shoes, tools, and plant material.

S. rolfsii can affect more than 200 different plant genera, including ornamentals, fruits, and vegetables. Table 1 lists genera of ornamental plants susceptible to crown rot and, like hosta, adapted to partial to full shade environments. Many susceptible ornamentals, such as daylily (*Hemerocallis*), impatiens, ajuga, peony, and vinca, are often planted in the same beds as hosta, so the disease can move from hosta to neighboring plants.

Management

Effective management of crown rot requires combining several strategies. The most effective management practices are a combination of cultural tactics such as careful inspection before planting, sanitation to control spread, and choosing plants believed to be less susceptible (see Table 2). These methods will not cure infected hostas but can slow or stop the spread of disease.

Cultural Management of Crown Rot in the Landscape
Avoidance is one of the best crown rot management tactics. Simply put, no fungus means no disease. But how do you keep *S. rolfsii* away from your hostas?

TABLE 2
Genera of herbaceous perennials *not* known to be hosts for *Sclerotium rolfsii*. The plants on this list grow well in part sun to full shade in the Upper Midwest.

Acanthus–bear's breech
Aconitum–monkshood
Actaea–baneberry
Adiantum–maidenhair fern
Alchemilla–lady's mantle
Anaphilis–pearly everlasting
Aruncus–goatsbeard
Astilbe–false spirea
Cimicifuga–bugbane
Corydalis–corydalis
Disporum–fairy-bells
Epimedium–barrenwort
Erythronium–trout lily
Filipendula–meadowsweet
Gaura–gaura
Gentiana–gentian
Geranium–cranesbill
Hakonechloa–hakone grass
Hedera–ivy
Helleborus–hellebore
Heuchera–coral bells
Houttuynia–chameleon plant
Lamiastrum–yellow archangel
Lamium–dead nettle
Mertensia–bluebells
Myosotis–forget-me-not
Osmunda–royal fern
Pachysandra–spurge
Papaver–poppy
Polemonium–Jacob's ladder
Polygonatum–Solomon's seal
Polystichum–shield fern
Primula–primrose
Pulmonaria–lungwort
Pulsatilla–pasque flower
Sanguinaria–bloodroot
Stachys–lamb's ear
Thalictrum–meadow rue
Tiarella–foamflower
Tradescantia–spiderwort
Trillium–wake-robin
Trollius–globeflower

One key to avoiding crown rot is careful inspection. Before purchasing or transplanting, examine plants for yellow, wilted lower leaves, sclerotia on the soil surface, softening and browning at the bases of petioles, and white mycelium around damaged tissue. Checking for these symptoms will reduce the risk of *S. rolfsii* entering the garden.

If the problem is already present in landscape plantings, the contaminated area containing the infected hostas and soil should be quarantined, and care should be used to avoid spreading any soil or plant material outside of this zone. You can excavate soil in the contaminated area to a depth of at least 8 inches, discard the soil, and replace it with uncontaminated soil. But the time, labor, and expense of this tactic is discouraging, especially when the contaminated area is more than a few square feet in size. Do not transplant from the contaminated area, because sclerotia clinging to the roots and crown can start a new infection cycle in another part of the garden. All tools and implements should be washed thoroughly, and the wash water should go back into the contaminated bed. Some recommendations call for dipping tools in a 10 percent bleach solution for a few minutes to kill *S. rolfsii*, but bleach is corrosive to tools and messy to work with. More important than bleaching is to scrub tools clean of all adhering soil. If you decide to use a bleach dip, clean your tools thoroughly beforehand.

Many growers mulch their hosta beds to help provide the consistently moist soil conditions that hostas prefer. Since the mycelium of *S. rolfsii* can grow rampantly through moist mulch in warm weather, it may be helpful to maintain a mulch-free zone several inches wide around hosta crowns if crown rot has appeared in the planting. Some hosta growers also recommend planting crowns as high as possible, with soil barely covering the roots, to reduce the odds that the vulnerable leaf petioles will come into contact with *S. rolfsii* from the soil.

Switching to plants that are not susceptible to *S. rolfsii* is another option. The problem is that so many types of plants are affected by crown rot that you need to choose carefully. Some ornamental plants not known to succumb to *S. rolfsii*, but adapted to partial-shade to full-shade environments in the Upper Midwest, are listed in Table 2. Many of the plants in Table 2, although not confirmed to be hosts of *S. rolfsii*, have not been tested for susceptibility to the fungus. Therefore, it is advisable to try them out on a limited basis before committing large numbers of plants to replace crown rot-killed hostas.

Many people have observed that some types of hostas seem to fare better than others against crown rot. However, crown rot resistance ratings are currently unavailable for hosta species and cultivars.

S. Rolfsii *Problems in Propagation and Production*

A key to avoiding crown rot during plant propagation and production is careful inspection. Regularly examine plants for telltale leaf yellowing and collapse, sclerotia, softening and browning at the bases of petioles, and white mycelium around damaged tissue. Experienced hosta growers know that leaves can turn yellow for other reasons, such as heat stress or a fungal disease called *Rhizoctonia* root rot, but only *S. rolfsii* crown rot will show the other symptoms as well. The Plant Disease Clinic at Iowa State University can help you confirm a diagnosis. You can mail a sample to the Clinic through your County Extension Office, or send it directly to the Clinic at 351 Bessey Hall, Iowa State University, Ames, IA 50011. Once you are convinced that the problem is crown rot, discard the symptomatic plants as well as the planting media and the pot.

Pre-plant fumigation of production fields with methyl bromide and chloropicrin can minimize problems with *S. rolfsii*. Fumigation is expensive, however, and methyl bromide use will be prohibited in the United States after the year 2005 due to recent Federal regulations. In general, home gardeners should avoid using fumigants, because these materials are dangerous to humans.

Fungicides are sometimes used to suppress *S. rolfsii* in hosta as well as other ornamental and food crops. A relatively new fungicide, flutolanil (sold as Contrast®), is labeled for use against this fungus on ornamental plants. Fungicides containing pentachloronitrobenzene (also known as quintozene or PCNB) typically are applied preventively to soil or media, either as a drench or as a granule. Trade names of PCNB products labeled for control of crown rot on hosta include Terraclor®, Defend®, Pennstar®, Revere®, and PCNB®. Note that the labels of these products do not specifically mention hosta, but they are legal to use on hosta because hosta is included within the broad designation "ornamentals" on the labels. Since phytotoxic reactions to PCNB can occur, it is advisable to treat a small bed area or a small number of pots first, then check the hosta's reaction, before attempting larger-scale treatments. To our knowledge, flutolanil and PCNB products labeled for use on ornamentals are available only through commercial pesticide dealers rather than at garden centers or other retail outlets. Sanitizing agents such as chlorine bleach have been used against crown rot, but these products are not legally labeled for this use.

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Prepared by Brooke Edmunds, research assistant, and Mark Gleason, Extension plant pathologist and professor, Department of Plant Pathology; and Ursula Schuch, assistant professor, Department of Horticulture, Iowa State University.

Edited by Elaine Edwards, Extension Communication Systems.

Designed by Mary Sailer, Spring Valley Studio.

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Yard and Garden Column for the Week Beginning April 26,2002

Insects: The Water Garden's Unexpected Guests

By Ryan Holl Plant Health and Protection Student Iowa State University and Donald Lewis Extension Entomologist Iowa State University

Water gardens are increasing in popularity. Whether it’s a whiskey barrel or a large, custom-built pond, a water feature delights the senses in ways grasses and shrubs cannot.

Water gardens can add many positive elements to the surroundings. Aquatic plants add texture and interest to the yard, while colorful fish can be the source of hours of quiet entertainment. Fountains and waterfalls allow owners to relax to the soothing sound of trickling water.

The more natural a pond is, the more native wildlife it will attract. Larger ponds can attract water-loving birds, amphibians, and small mammals. However, there are other things that ornamental ponds supply to their owners, totally free of charge, that are too often overlooked. Insects!

Insect Life

A body of water provides a brand new ecosystem that will attract many insects you might not normally see in your yard.

Dragonflies and damselflies, long slender insects with four large wings, are probably the most obvious insects to appear, and certainly some of the most pleasing. Their speed and agility as fliers can make them entertaining to watch as they dart around the water to capture their airborne insect prey, such as mosquitoes. These insects mate in the air, and it is not unusual to see two connected in flight. The female can later be seen flying down to the water to deposit her eggs at the water's surface.

Naiads, the immature form of dragonflies or damselflies, live in the water and feed on insects and other small animals. Their indescribable looks resemble something out of a horror movie and can be quite startling when come upon unexpectedly. Naiad skins can be found attached to plants above the waterline, where the immature insects crawl before molting and emerging as winged adults.

Water striders are a unique aquatic insect. They make use of surface tension to "walk" on water with two very long pairs of legs. Striders can be found "skating" on nearly every body of water in Iowa. They feed on small animals (mostly insects) that fall onto the water's surface or float up from below.

Whirligig beetles also scamper about on the water and eat insects at the water's surface. Groups of the small, glossy black beetles swarm restlessly until frightened, when they scatter. Their larvae (the immature form of the insect) feed on aquatic insects and mites.

The giant water bug, at up to two inches long and one inch wide, is one of the largest insects in Iowa. It has flattened rear legs for swimming and powerful front legs for grasping its prey. The giant water bug usually targets insects, tadpoles, fish and amphibians as food. However, it has been known to clasp onto the toes of passing humans, earning it the nickname "toe-biter. "

These are just a few of the interesting animals that may inhabit a water garden. Others offer equally entertaining appearances and behaviors. Unfortunately, very few great things come without costs. There are a few negative impacts that insects can make on your water garden.

Naiads, several of the aquatic beetles and the giant water bug can feed on aquatic animals such as very small fish. This is of little concern to most pond owners however, since these animals rarely, if ever, attack fish as large as "feeder" goldfish frequently used to stock ornamental ponds. However, if the water garden is large enough for fish to reproduce, naiads will certainly pose a threat to very young offspring.

What about mosquitoes?

The mosquito is the biggest concern when dealing with bodies of water in the yard. Mosquitoes lay their eggs in stagnant water, where the larvae, or "wrigglers," develop. Wrigglers feed on organic matter in the water until they are ready to pupate and change into the flying, blood-sucking nuisance that everyone knows as the mosquito.

Fortunately, there are measures you can take to reduce mosquito populations in your water garden. Keep the water in motion with a fountain or filtration system to keep mosquitoes from reproducing -they prefer to lay their eggs in stagnant water. Pond design and layout, including steep banks with little vegetation along the water's edge, can also deter mosquitoes from reproducing in the water.

The mosquito also faces many natural perils in the water garden environment. Amphibians, insects and fish consume mosquito larvae as they float near the surface. Adult mosquitoes face further torment when adult dragonflies and birds attack them from the air. All of these factors work together to reduce mosquito problems.

A water feature offers many different and interesting benefits to you and your yard. The next time you find yourself enjoying one, try to appreciate the little details that nature throws your way. Pleasure often comes from unexpected places!