PLANT PATHOLOGY EDUCATION AND TRAINING IN THE UK:

An Audit

British Society for Plant Pathology http://www.bspp.org.uk

Executive Summary

Industry, policy makers and scientists all recognise that plant pathology is essential in addressing the issue of food security and in mitigating the effects of climate change. The UK must retain the ability to teach and train plant pathologists able to tackle these important new challenges. This audit, carried out on behalf of the British Society for Plant Pathology, surveyed the current levels of plant pathology teaching and training in the UK.

Overall, there is less plant pathology teaching in UK Higher Education Institutes (HEI) than there used to be. Less than half of the 103 HEI offering biology, agriculture, horticulture or forestry courses at BSc level provide plant pathology teaching, and this can be as little as 1-2 lectures. Only half of these HEI offer practical classes in plant pathology.

The modular nature of HEI courses means that students can, and do, opt out of plant-based modules. Students should have the opportunity to encounter plant pathology and other plant sciences in the first year, making them more likely to choose more advanced plant pathology modules in subsequent years.

A wide range of teaching and training links exist between HEI and both UK research institutes and industry. These bring practical plant pathology knowledge directly into the lecture theatre. Employers in this survey and elsewhere have highlighted the need for graduates to see beyond the gene and understand plant pathology at the whole organism level.

The age profile of HEI plant pathologists is of major concern and the strategic provision of plant pathology teaching needs to be addressed. Across HEI in general, academics are retiring and not being replaced. Plant pathology is no longer taught at 5 HEI due to staff retirement, and staffing levels have been reduced at a further 6 HEI. This implies that plant pathology is not considered a priority area across a range of HEI and it is not known how many will retain the capacity to teach plant pathology in 5-10 years time.

New departmental appointments and RAE/REF assessments are driven in part by the Impact Factor (IF) of scientific publications. The highly specialised nature of much plant pathology research means that many publications are of low IF. So in terms of this particular measure of esteem, plant pathologists may struggle to compete against scientists from other disciplines.

There are many ways in which outreach and public engagement work can promote plant pathology to a wider audience. The British Society for Plant Pathology has appointed an Outreach Officer.

Today's students are tomorrow's teachers. A reduction in HEI teaching of plant pathology and other highly specialised subjects crucial to UK well being and the economy, will result in fewer teachers able to teach these subjects in future. A vicious circle is developing which must be challenged. A clear and constructive case must be made to policy makers of the importance of plant pathology and the need to teach and train the next generation of plant pathologists.

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Data presented

All responses from academics and scientists have been taken in good faith.

The plant pathology teaching and training data presented in this audit are not exhaustive and the author apologises if data has been overlooked or if the information provided has been misinterpreted.

Abbreviations used

BBSRC
Biotechnology and Biological Sciences Research Council

CABI
Centre for Agricultural Bioscience International

CGIAR
Consultative Group on International Agricultural Research

HEFCE
Higher Education Funding Council for England

IP
Intellectual property

RAE
Research Assessment Exercise

REF
Research Excellence Framework

STEM
Science Technology Engineering and Maths

UCAS
Universities and Colleges Admissions System

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Abstract

The British Society for Plant Pathology (BSPP) board, concerned about the future of UK plant pathology, commissioned this audit of plant pathology teaching and training.

A survey of undergraduate plant pathology teaching was undertaken. Quantitative and qualitative data were collected including links with UK research institutes and industry. Teaching resources and undergraduate training programs such as summer placements were identified, in addition to undergraduate and postgraduate training opportunities.

Finally, ways to raise the profile of plant pathology were addressed such as outreach work, public engagement and lobbying.

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1. Introduction

AGE PROFILE IS OF CONCERN

1.1 A true story...

'Plants are boring' said my biology teacher every year as I ploughed through my biology courses. 'Plants are boring'. Off I went to university to study biology safe in my knowledge about plants. But then something extraordinary happened. Halfway through the first year, an old professor of botany came to give his lecture clutching that week's copy of a top scientific journal. On the front cover was a picture of a transgenic tobacco leaf. The professor was thrilled and he told us why. The technology depicted on the journal cover opened up a whole new world of scientific possibilities. The future is here and the future is plants! He strode up and down the lecture theatre brandishing the journal above his head. The whole episode lasted about 20 minutes and by the end of it he was speculating about the distant prospect of photosynthetic cows. The student next to me, who had written nothing in his notepad, slowly took out his pen and wrote in capital letters in the middle of the page "PLANTS ARE INCREDIBLE". That was it, job done. That one lecture changed my life.

1.2 The impact of plant disease

Food production has tripled in the last 40 years, but of a global population of around 7 billion, approximately 1 billion go hungry, with an average of 30% of all available food being wasted 'from field to fork'[1].

Crop losses through plant disease are an important component of this. Losses occur both pre- and post-harvest and can vary across crops. However, losses are not widely acknowledged and there are no recognised units of measurement or defined ways of measuring losses[1]. The term 'plant health' itself is not clearly defined[2]. This lack of accurate data on crop losses contributes to the low priority given to plant health and research[1].

The western world is somewhat insulated from the vagaries of plant disease. Crop failure and poor harvests do not impinge on our supermarket culture. We may complain when prices rise, but the shelves are still full. By contrast in developing countries, plant disease can result in loss of income, malnutrition or starvation. These countries may lack the financial resources or infrastructure to counter the effects of crop losses.

A 1% reduction in crop losses would improve the lives of millions of people. Importantly this does not require more land, water or chemicals. It can be achieved by using best practise to identify and tackle plant health problems caused by plant pests and diseases[3].

A recent paper on plant health concluded that although human society makes a clear link between medicine and health, it does not make the same link between plants and food[1]. Society needs to invest in plant health in the same way it invests in human or animal health. Plant pathology has an essential role in addressing current yield losses and in managing emerging diseases such as wheat stem rust Ug99[1].

1.3 Food security and climate change

Plant pathology also has a major role to play in addressing the issue of food security and in mitigating the effects of climate change.

We are reliant on a narrow range of crops for the bulk of our calories. The global rise of food prices over the last decade has forced the issue of food security to the top of the international agenda, with rice, wheat and barley all doubling in price[4].

Climate change will dramatically affect the outbreak and spread of plant pathogens worldwide. A major policy document commissioned by CGIAR identified practical solutions to 'achieve food security in the context of climate change'[5]. It made 7 key recommendations, the first 3 of which were

- 'Integrate food security and sustainable agriculture into global and national policies
- Significantly raise the level of global investment in sustainable agriculture and food systems in the next decade
- Sustainably intensify agricultural production while reducing greenhouse gas emissions and other negative environmental impacts of agriculture'[5]

Plant pathology is directly involved in all of these. Indeed, in a news interview on Radio 4 on May 27th, 2012 (the day of a public demonstration at Rothamsted Research against a GM wheat field trial), the UK chief scientific officer, Sir John Beddington, stated that one of the major challenges of climate change is that we do not know what new plant diseases it will bring.

Concerns about food security are also being highlighted at the national level. The UK government launched the Global Food

Security Programme in late 2009. It brings together government departments and research councils such as the BBSRC and has 4 key research themes

- Economic resilience
- Resource efficiency
- Sustainable production
- Sustainable, healthy, safe diets

Again, plant pathology is directly involved here.

Other areas such as forestry and biofuel production also need to be considered. The impact of diseases such as Dutch Elm Disease, Sudden Oak Death and Red Band Needle Blight are writ large across our landscapes. Plant pathology is traditionally seen as concentrating on high value food crops, but it also has an important role in tackling tree and forest pathogens. Climate change may have a profound effect on tree health worldwide. Recent developments such as biofuel and biomass production may also impact on pathogen prevalence and spread.

1.4 Vulnerability of plant pathology

It is clear that plant pathology is important, however the subject is vulnerable. Plant pathology has been identified as a 'strategically important but vulnerable area of UK bioscience' in a public consultation exercise run by the BBSRC in conjunction with the Biosciences Federation[6].

Under-investment and closures

There has been chronic under-investment in agriculture over the last 30-40 years[1]. The UK has seen a reduction in plant science research institutes[7,8] and several UK organisations have reduced their cohort of plant pathologists over the last 15 years[9]. Moreover, the anti-GM stance of European regulators has been a factor in the closure of major UK agrichemical company R&D facilities[7,10].

Taken together these measures represent an overall loss of plant pathology research and expertise. This reduces our ability to teach and train the next generation of plant pathologists.

Age profile

The age profile of UK plant pathologists has been highlighted as a concern[6]. Many have retired whilst others are nearing retirement[8].

'In soil science we only have four specialists under the age of 40, while the 41-60 age group shows 30 specialists, and similarly for water use, there is only one specialist below the age of 40, whereas there are nine aged 41-60. This profile is depressingly similar in all of the major disciplines. The great worry is that in 10 years' time, those specialists at the higher end of the age profile will have retired and take with them many years of accumulated knowledge, while there are insufficient new entrants.' [8]

1.5 Vulnerability of plant pathology teaching

The capacity to teach plant pathology is also at risk.

Academics question the UK's ability to teach and train the additional plant scientists that the challenges of food security and climate change may require[7].

In 2009 the Royal Society produced a strategy document entitled 'Reaping the Benefits' which made a series of recommendations on how best to enable UK science to tackle the challenges of global crop production[11]. In addition to requesting more research funding and a cross-disciplinary approach to research funding, it also stated:

'Universities should work with funding bodies to reverse the decline in subjects relevant to a sustainable intensification of food crop production, such as agronomy, plant physiology, pathology and general botany, soil science, environmental microbiology, weed science and entomology.' [11]

In addition, the lack of practical plant pathology teaching has been highlighted. In a recent skills audit[9], BSPP members said that there is a lack of practical plant pathology teaching at HEI resulting in graduates with little or no field experience or diagnostic skills. This point was reiterated by a wide range of UK employers:

'All respondents identified that there is now a market failure to produce plant pathologists with diagnostic abilities, knowledge of the industries and the capacity to appreciate whole organism biology.' [9]

1.6 Profile of plant pathology

There is a lack of good information on the career options open to plant scientists[6]. For many people it is just not clear what a plant scientist does.

Plant pathology in particular suffers here because the phrase itself seems to be disappearing. It is hidden behind food security and sustainable agriculture. For example, reading the main pages of the recently revamped Rothamsted Research website it is hard to find any mention of plant pathology. The role of the plant pathologist is not an obvious one.

Moreover the agriculture/horticulture sector is viewed as a lowly place to embark upon a career[12]. There is currently a shortage of skilled technical horticulturalists and yet horticulture is not presented as a career option in schools[12]. In a similar vein, the Farming Minister Jim Paice recently launched a campaign to attract more young people with a science or research background into agriculture[13].

1.7 Plants are not popular

In the 1990s two botanists coined the term 'plant blindness' to describe society's inability to register the importance of plants[14]. They defined it in part as the:

- 'Inability to see or notice the plants in one's environment
- Inability to recognize the importance of plants in the biosphere and in human affairs
- Misguided...ranking of plants as inferior to animals and therefore unworthy of consideration'[14]

Plant science is undervalued in both education and research[6,7,15]. By post-16 level, it is one of the least popular branches of biology in school with both pupils and teachers alike[7]. Plant courses are not popular at university, indeed plant content is often 'disguised' within other courses[7].

So although we live in a world where plant pathology is essential, all is not well. The closure of research institutes and industrial R&D departments means there are fewer plant pathologists out there. This is compounded by an ageing population profile amongst plant pathologists. Plant science in not a popular subject in school or university, indeed society as a whole undervalues plants.

1.8 Audit overview

The aim of this audit was to clarify the current situation in the UK in terms of plant pathology teaching and training. There were several aspects to this

- A survey of undergraduate teaching
- Teaching resources and training programmes such as summer schools and placements
- Teaching and training opportunities in research institutes and industry
- Using outreach, public engagement and lobbying to raise the profile of plant pathology

2. Survey Methodology

2.1 Methodology

Higher education institutes (HEI) likely to teach plant pathology were identified. The UCAS database was searched for BSc level courses in biology, agriculture, horticulture and forestry. Searches were performed in February 2012 and some courses may have been added or withdrawn since this date. Having identified HEI, a variety of website search techniques, phone interviews and email were used to capture data on plant pathology teaching. Both quantitative and qualitative data were collected.

2.2 Identifying HEI that may teach plant pathology

Whilst it is acknowledged that plant pathology may be taught in a range of foundation courses, for the purpose of this survey only BSc level courses were investigated. To cast the net as wide as possible, searches were made using both the UCAS course finder system and the Joint Academic Coding of Subjects (JACS) course codes. These searches identified 103 HEI that offer BSc courses in biology, agriculture, horticulture or forestry. These are listed in Appendix I.

2.3 Searching HEI for plant pathology teaching

Identifying contacts

Extensive website searches were made of all 103 HEIs to identify

- Undergraduate courses with plant pathology content
- Departments or research groups likely to perform plant pathology
- A head of teaching or relevant academic

In 6 cases it was clear from website searches that all the biology was human or biomedical. These HEI were eliminated from any further searches.

For the remaining 97 HEI, phone and email were used to ask relevant academics questions about undergraduate plant pathology teaching. Phone was the preferred means of contact. Moreover, a phone call confirmed that the correct person was being questioned. There are 5 HEI for which there is no data. These are Duchy College, Teesside University, University of Gloucestershire, University of the Highlands and Islands, and the University of Westminster. This survey therefore presents data for 98/103 HEI.

Plant pathology may be covered generally in the first year, however the questions in this survey were focussed more on second and third year (and fourth year in Scotland) modules with specific plant pathology content.

Quantitative questions asked

- Do any of your modules have plant pathology content?
- Module title?
- Optional or compulsory?
- Number of students?
- Number of lectures?
- Are there lab practicals?

Qualitative questions asked

- Links with other institutions/industry, for example visiting lecturers?
- Placements/work experience opportunities?

Other issues

In addition, many academics were happy to talk more generally about the issues around plant pathology teaching. These topics came from the academics themselves, they were not prompted.

Academics were contacted without prior warning. Some were unable to answer all the questions as they did not have access to precise data on lecture/practical numbers, or the course was being reworked and numbers were not available, or the course format precluded this (for example block sessions with combined lecture/lab/tutorial, or student-led modules without fixed lecture slots). Several academics were unable to provide data on links with other institutions or student placements.

All the responses have been taken in good faith.

3. Quantitative data on plant pathology teaching

The quantitative data on plant pathology teaching are shown in Appendices II and III.

For privacy, the name of the contact/s used at each HEI is not given. Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

It is acknowledged that aspects of plant pathology may be covered in more general courses particularly in the first year. The data in Appendices II and III concentrate mainly on second and third year (and fourth year in Scotland) modules with specific plant pathology content.

The data show that 47 HEI have specific plant pathology teaching in some form.

Twenty-six HEI have more than one teaching module with plant pathology content.

It must be made clear that these data may not represent all plant pathology teaching. HEI may offer additional teaching that was not identified during this survey.

3.1 Quantifying teaching at HEI

A lecture represents a basic unit of teaching and a means to measure teaching levels, although lectures are not always equal. One academic considered his 2 lectures to be *'really sort of skimming over the topic'* whilst another, an experienced plant pathologist, said she packed lots of plant pathology into her two lectures. Are these two equivalent? Perhaps not. However, it is clear that a module with, say 12 plant pathology lectures, will provide students with a much broader understanding of the subject than one with 2 lectures.

With this caveat in mind, teaching at the 47 HEI can be split into 4 arbitrary groups based on the number of plant pathology lectures in any single module. These are all second, third (or fourth) year modules.

HEI with 1-2 lectures
Biology courses
Oxford Brookes University, Royal Holloway University of London, Sheffield Hallam University, University of Derby, University of Essex, University of York
Forestry courses
University of Cumbria

HEI with 3-6 lectures
Biology courses
Durham University, Lancaster University, Liverpool Hope University, University of Exeter, University of Glasgow, University of Hertfordshire, University of Leeds, University of Liverpool, University of Manchester, University of Salford, University of West of England
Agriculture and Horticulture courses
Harper Adams University, Queen's University, Scottish Agriculture College, Writtle College

HEI with 7-12 lectures
Biology courses
Oxford University, Plymouth University, University of Birmingham, University of Sheffield, University of St Andrews
Agriculture and Horticulture courses
Bishop Burton College, Myerscough College, Newcastle University, University of Worcester

HEI with over 12 lectures
Biology courses
Aberystwyth University, Canterbury Christ Church University, Imperial College London, Newcastle University, University of Aberdeen, University of Bath, University of Bristol, University of Cambridge, University of East Anglia, University of Edinburgh, University of Nottingham, University of Reading, University of Worcester
Forestry
Bangor University, University of Aberdeen

Newcastle University, University of Aberdeen and University of Worcester are listed twice, for biology and agriculture/horticulture/forestry teaching.

Four additional HEI have plant pathology teaching but were unable to give current lecture numbers: Askham Bryan College, Easton College, University of Dundee and the Royal Agricultural College.

There are a lot of data to consider here, but 2 HEI in particular stand out.

University of Exeter

There are a large number of plant pathologists working at the University of Exeter. There are currently 3 plant pathology lectures in the final year. However one of their academics said that Exeter is starting a new first year course and that there will then be new modules with more plant-microbe interaction

content in the second and third year for this student cohort.

University of Warwick

There are several plant pathologists working at the University of Warwick. However, no second or third year plant pathology teaching was identified in this survey. There are no plant-based modules in the final year.

Additional points

The teaching data described above are also presented in Appendix III.

- As an additional reference point, HEI that contribute students to the **Gatsby Plant Science Summer School** (see section 5.4) are highlighted in bold. A full list of HEI that contribute students to the summer school is presented in Appendix IV.
- There is a strong correlation between HEI that contribute students to the Gatsby Plant Science Summer School and plant pathology teaching. Twenty-two of the 25 Gatsby HEI offer plant pathology teaching. Those that do not are Leicester University, University of Southampton and University of Warwick.
- Data on **staff retirement** discussed in section 4.3 is also incorporated into Appendix III.

3.2 Student numbers

Taking the lower student number in any given range, at least 444 biology and 30 forestry students take a module with over 12 plant pathology lectures.

Similarly, at least 218 biology and 88 agriculture/horticulture students take a module with 7-12 plant pathology lectures.

Whilst these numbers are healthy, do they represent all those interested in plant pathology or plant science generally? Was that the only plant-related module in the timetable slot? If so, the numbers may represent all students interested in plant science, only a fraction of whom may go on to study plant pathology.

3.3 Optional or compulsory

The modular nature of courses means that the majority of modules are optional. The data relating to optional/compulsory modules, where obtained, are presented within Appendix II.

3.4 Practical work

It was not always possible to gather data on practical work, however, at least 24 HEI run plant pathology practical classes. These data are presented within Appendix II.

Agriculture/horticulture courses were more likely to involve field walks and diagnostic skills. Biology courses were more likely to be laboratory-based.

Final year plant pathology modules often had no associated practical classes because students were doing final year projects. Many academics said that if students were interested in plant pathology there were opportunities for them to take a plant pathology-based project.

3.5 MSc data

It was intended to include information on MSc courses, however data gathering was patchy. Many academics did not have detailed information, or courses varied from year to year or were being restructured. Rather than present incomplete data that may give a misleading picture, it has not been included.

4. Qualitative data on plant pathology teaching

STUDENTS ENJOY IT

Qualitative data on HEI links to UK institutes and industry are presented in sections 6.4, 6.5, 6.6 and 7.1, 7.2.

In addition, the audit looked at HEI plant pathology teaching 'in the round'. Many academics were happy to talk about various aspects of plant pathology teaching and the fate of their subject in general. Several issues arose which are summarised below in no particular order.

These topics came from the academics themselves, they were not prompted.

Direct quotes are anonymous. Where possible their HEI grouping (1994 Group, Million+, Russell Group, University Alliance) is given, although some HEI are not members of any of these groups.

4.1 Student attitudes to plants and plant courses

There were a wide range of opinions.

Students are not interested in plants

'Students just aren't interested in plants. They all want to study fluffy animals.' Million+

'Once you mention plants they turn off.' University Alliance

This also applied to agriculture courses

'Student numbers on crop courses are lower than those on livestock and business courses even in Edinburgh, which is a predominantly arable farming area.' Agriculture College

A lack of plant science teaching at school is a contributory factor

'Plant-based teaching at school level is often weak. Plant disease or microbes barely get a mention. Why would any university student choose to study something that isn't even worth a mention at A-level?' Russell Group

Students are unaware of major plant science employers

Biology students at the University of St Andrews had not heard of the James Hutton Institute, situated a few miles away.

Students are unaware of the impact of plant disease

One Russell Group academic asks his first year class to name any disease that affects an important crop plant, for example one that provides the majority of their calories, or their favourite alcoholic beverage. They can't. He believes that because we do not experience crop shortages in the UK, society is unaware of plant disease. This means that plant pathology and the work of plant pathologists goes un-noticed.

Plant pathology needs to be made relevant to students

'Plant pathology is very difficult to sell to biology students. It brings together the two worst aspects of the subject: plants and disease.' Russell Group

'The whole thing with plant pathology is that it's not sold well at all. If you call a course 'plant pathology' no one is interested' 1994 Group

Once students have the opportunity to study plants and plant pathology they enjoy it and want to do more

'Students do NOT like plant science but tend to be pleasantly surprised by plant pathology and like it!!!' University Alliance

'We get good feedback from the students. They all want to do biomedicine. Once they do plant science they enjoy it. It's getting them in that's the key.' 1994 Group

'Plant pathology is very popular here. The students enjoy it. They do an optional module in second year. This is their first exposure to plant pathology. They enjoy it and go on to take further modules in the third year... It's down to the quality of the teaching.' Russell Group

Students choose the lecturers they like, independent of course content

'You basically need enthusiastic lecturers who are seen in the first year. When choosing courses in subsequent years students look to see who is taking the course. This is somewhat independent of course content.' Russell Group

These findings are important. They show that a widespread lack of interest in plant science and plant pathology can be overturned with good enthusiastic teaching.

4.2 Changes in teaching levels, specialist options and course structure

Several academics said that there is now less overall teaching and that specialist options, such as plant pathology were being reduced.

'In the past teaching was much more 9 to 5. There was more chance to teach content. It's not like that today' Million+

'There are definitely fewer modules now and less teaching time.' Russell Group

'There are fewer modules overall because each one has to have lots of students' Million+

'Teaching has changed. We're no longer producing students with a specific plant pathology degree, instead we're producing students with broad bioscience and perhaps a slight leaning towards a particular area.' University Alliance

'There are no longer the specialist modules there once were' Agriculture College

This therefore makes it difficult to maintain plant pathology content.

'It's an uphill struggle to maintain plant pathology content, but I'm 58, I'm not going to battle any more'. Million+

Academics said that not enough plant biology is being taught in the early years at HEI.

'The geography students know more [plant science] than the biologists. It's a sad reflection on the importance of plants within the biology syllabus' Russell Group

One academic said she felt that overseas students had received more training in botany and plant science and that they were more aware of the importance of plant pathology within plant science.

Others said the modular nature of current courses enabled students to opt out of plant science. This may then preclude them from taking plant courses in later years.

'The opportunities to get interested in plant pathology aren't there because the first and second year modules aren't there... The relationship has changed, students used to be exposed to a whole lot of stuff and they decided what they were interested in as they went along. Now the students come in with an idea of what they want to do... consequently they aren't exposed to plant pathology.' Million+

However, this is being addressed at one Russell Group HEI where students start on a general biology stream and then opt for different pathways. The HEI is making their final year module on plant pathology compulsory in 2012 because they think *'it is good for spanning these disciplines.'* Importantly, the students don't need to have taken previous modules on plant pathology to do the third year module.

4.3 Retirement was a recurring theme

Plant pathology was no longer taught at HEI because of retirement

There were at least 5 HEI where plant pathology staff had retired and not been replaced. Consequently plant pathology teaching at these HEI had ceased.

'No, not any more. Our plant pathologist retired a few years ago and we haven't replaced him' Million+

'We used to have a professor of plant pathology but when he retired that was it really. It ceased to be taught.'

Staff numbers have reduced because of retirement

There were at least 6 HEI where staff continued to teach plant pathology, but their numbers had been reduced through retirement.

These are highlighted in Appendix III.

'Members of staff have retired and not been replaced' 1994 Group

'We used to have quite a few plant pathologists but he's the only one left now.'

'We used to have a final year module on plant pathology but that person retired.' University Alliance

There are at least 3 HEI with a single plant pathologist

These are highlighted in Appendix III.

Again this makes it difficult to maintain plant pathology content.

'It is difficult to raise the number of

lectures on plant pathology. I am the only one with expertise in plant pathology in the department.' 1994 Group

Together these cases suggest that plant pathology is not a priority area for these HEI. Staff are retiring and not being replaced and if a lone plant pathology academic were to retire or relocate, it is likely that plant pathology teaching would cease at that HEI.

Age profile

One lone academic, nearing retirement, suggested that the audit should include an age profile of all those teaching plant pathology. He believed many of them would be around his age.

Although an age profile was not carried out as part of this survey, it is clear from the responses that plant pathologists are retiring across the UK and not being replaced. In addition, several are nearing retirement. This observation tallies with the situation in some institutes[8].

4.4 The rise of biomedicine

Several academics mentioned the rise in popularity of biomedical science. An American academic said that this is also the case in the USA where plant and animal departments are disappearing to be replaced with Human Biology.

'Plant pathology teaching has reduced over the years with the rise of biomedical sciences.' University Alliance

'No, we lost our plant people to human health stuff. Much to my disgust.'

'It's more biomedical now.' University Alliance

'Plant science isn't wildly popular, not as popular as biomedical modules' 1994 Group

Every week TV dramas show medics and forensic scientists doing good deeds, and young people aspire to these roles. Plant science does not enjoy such a high profile. Where are the comparative opportunities to learn about the role of plant pathologists?

4.5 Applied courses and placements

Agriculture, horticulture and forestry courses

The average age of arboriculture/horticulture students at one HEI was 25. Many students had done something else first which they hadn't enjoyed, and the course represented a life-changing decision to work in the agriculture/horticulture/forestry sector. The students had not necessarily studied biology before. Teaching therefore needed to be tailored accordingly with basic science and lots of emphasis on practical applications of the work.

One forestry academic said that although plant pathology currently formed a small part of the course, he expected this to increase in the near future. He cited the recent spread of *Dothistroma* (Red Band Needle Blight) in pine and *Phytophthora ramorum* in larch as important issues in forestry that teaching courses need to respond to.

Increased interest in placements and applied courses

Several academics had noticed increased interest in student placements and applied courses. They believe the current economic climate is making students consider the more applied aspects of plant science. At least one HEI is setting up a new Applied Biology course in 2012.

'These things come in cycles. Applied Biology is popular again' Russell Group

A lack of plant pathologists with field experience

One academic bemoaned the lack of plant pathologists with practical, field-based expertise.

'The farming industry is desperate for trained plant pathologists who can talk to farmers' University Alliance

4.6 GM, the elephant in the room

One academic, having chatted happily and at some length about his teaching, happened to mention a GM field trial he was involved with. He stopped mid-sentence and after a few moments of silence, abruptly ended the call.

This reaction highlights a major issue within UK plant science today. It applies to plant pathology in particular since many GM projects involve crop protection. If the end result of years of plant pathology research is a field trial mired in controversy and court cases, students (and indeed their parents) may think 'do I really want to be a plant pathologist?'

4.7 New departmental appointments and Impact Factor

One Russell Group academic was frustrated that when new departmental appointments were made, very few plant or non-medical microbiologists even applied. She acknowledged that plants need specialist growth facilities but argued that the same could be said of drosophila or zebra fish. She believed the increasing cost of pathogen licenses is another contributory factor in the lack of pathology applicants.

Another Russell Group academic said that new departmental appointments are driven by RAE/REF. This in turn is dependent on the impact factor (IF) of publications. Plant science is at a disadvantage here in that the small size of the community means that plant papers are simply not cited as often as comparable animal/human papers.

Furthermore, because the highly specialised plant pathology journals have a low IF, scientists will often publish key papers in more general science journals with a much higher IF, thus entrenching the low IF of plant pathology journals. Applied plant pathology papers are at a particular disadvantage because it may be several years before they are cited, thereby missing the narrow 2 year window of citation required for IF calculation. This observation tallies with analysis of publications in other applied scientific fields[16].

4.8 RAE/REF assessments

HEFCE, together with other regional organisations, carry out periodic assessments of UK HEI research. The results determine the core funding given to individual HEI by the UK research councils. In recent years this assessment has taken the form of the RAE. In 2014 RAE will be replaced by REF. A new component of REF will be the 'impact statement' that describes the impact of published research. For the 2014 REF, the impact assessment period runs from 2008 - 2013. Underpinning research published up to 15 years prior to the start of the assessment period will be considered.

Often the impact of research is not felt immediately. This can be especially true of plant science, where many years of field trials or further testing and development may be necessary. So at first glance it appears that plant science academics may be well placed to produce impact statements.

Discussion with a Russell Group academic revealed that staff at his HEI were indeed being internally advised to base impact statements on research done in the late 1990s. However, he thought that even this timeframe may be unrealistic. Furthermore, research published in the last few years may take another 10-15 years to have demonstrable impact by which time the academic may have retired.

Another Russell Group academic mentioned the problems of releasing impact data from work funded by industrial partners because of patent and IP issues.

4.9 MSci degree programmes

One academic said his HEI has been running a MBiolSci programme for around 10 years now. It was originally set up because students were finding it difficult to obtain funding for MSc courses, and because the MBiolSCi is an undergraduate degree, government funding is available.

The HEI entry requirements are strict and at present 25-30/150-160 students take the MBiolSci pathway, but many drop down to a standard BSc during the course. The 4-year course includes a dissertation/project and students also take the first year PhD courses in science communication and advanced statistics.

Interestingly, the academic had noticed that a lot of their PhD students had taken MBiolSci at other UK HEI. He believed around 10 HEI run the course.

4.10 Degree accreditation

The Society of Biology has set up an accreditation process for UK bioscience degrees. Their aim is to bring biology into line with other subjects such as engineering where accredited graduates become members of a professional body.

Accreditation is intended to identify degree courses that provide students with the key skills required to enter academic or industrial research. These include academic rigour and analytical skills, together with substantial experience of working in a research active environment in academia or industry. The most likely outcome is that accredited biology courses will become 4-year courses with a 1-year research project or sandwich placement.

One Russell Group academic believed accreditation would be good for those students who wish to follow a research-based career. However, he believed that biology is seen by many students as a general purpose science qualification, a numerate degree. These students have no interest in doing biology beyond university. The large amount of lab-based work required by accreditation may deter them.

Another Russell Group academic was concerned that accreditation would be too conservation/zoology based and that plants may be marginalised. He believed that many plant scientists are worried by this. If plant science is not part of the accreditation curriculum, plant science teaching may become vulnerable.

'Your topic is not in the curriculum so your teaching is less likely to be valued. You don't produce high impact papers because plant pathology doesn't get into high impact journals. Your research is expensive both in terms of the time to grow plants and the cost of growth facilities and technical support. It's not VAT-exempt because it's not medical. You will be the first to go in any departmental restructuring.'

If HEI do consider accreditation then plant pathologists must lobby to ensure that their subject is included where appropriate. Once an accredited course is in place it may be difficult to add content.

Furthermore, future academic appointments may be made with the accredited course in mind.

4.11 Other Learned Societies

Other Learned Societies are concerned about student numbers.

Whilst discussing the poor uptake on plant courses one Russell Group academic said she believed that the **Society of General Microbiology** are also concerned about the uptake on microbiology courses.

'Once you strip away the medical stuff the numbers are pretty thin, but not as bad as plants though.' Russell Group

Other academics said they were aware of an on-going mycology survey by another Society looking at student numbers.

5. Student teaching resources and training opportunities

GOOD TEACHING INSPIRES STUDENTS

5.1 Teaching resources

Good teaching inspires students. Good teaching requires good starting materials be they images, slides, movies, activities or workshops. They can all help put plant science into context, describe the latest scientific research, and enable educators to engage with their audience.

Plant Science TREE

The Plant Science TREE (Tool for Research Engaged Education) is a major online teaching resource which has been developed from material presented at Gatsby Plant Science Summer Schools. Compiled by research-active academics it contains around 2000 slides, 70 movies/ animations and 25 online lectures.

Teaching Tools in Plant Biology

This is a US-based teaching resource published by the American Society of Plant Biologists (publishers of The Plant Cell) which contains images, research items and slides.

Science and Plants for Schools (SAPS)

Core funded by the Gatsby Charitable Foundation for over 20 years, SAPS provides free online teaching resources for primary, secondary and post-16 children. Many of the resources are activity-based, hands-on projects.

SAPS offers post-16 teachers the opportunity to attend the Gatsby Plant Science Summer School. Applicants can then apply for funding to cover the development of new teaching resources. SAPS also sponsors post-16 teachers to attend the UK PlantSci conference (see section 8.3).

SAPS provides opportunities for plant scientists at any level to get involved in outreach work.

5.2 Undergraduate summer placements

A wide range of summer placement schemes offer plant pathology teaching and training. These are of fundamental importance: they give undergraduate students the chance to DO plant pathology.

It is accepted that within each cohort of students, only a fraction may be interested in plant pathology. In an ideal world they should be given the opportunity to do some. However, summer placements also offer the chance to people who wouldn't otherwise consider plant pathology as a career option. A great example of this is Helen Neale (neé Lovell). Her write up in the autumn 2010 BSPP newsletter is a heartening tale of the power of a good research project to inspire a young scientist to embark upon a previously unplanned career in plant pathology. Helen went on to do a PhD in plant pathology and her paper on *Pseudomonas syringae* pv. *phaseolicola* won the 2011 Molecular Plant Pathology student prize.

A wide range of organisations including the British Mycological Society, BSPP, Carnegie Trust, Gatsby Charitable Foundation, Genetics Society, Nuffield Foundation and the Society for General Microbiology all sponsor student summer placements. A comprehensive list is provided by the University of Leeds Gatsby Plant Science website. Placements are usually for 4-10 weeks.

5.3 Post-16 placements

The Nuffield Foundation fund 4-6 week placements for post-16 students.

5.4 Undergraduate summer schools

Gatsby Plant Science Summer School

The summer school is run for academically able first year undergraduates who are interested in plant science. Together 25 HEI (listed in Appendix IV) contribute a total of 80 students to the course each year. Each HEI has a Gatsby mentor who is given a presentation pack enabling them to deliver a short lecture advertising the course and pre-empting many of the questions students will have. One mentor said she had lots of interest from students following her presentation.

The 4-day practical course contains one day of plant pathology with training from experienced plant pathologists.

The Gatsby Plant Science Summer School represents a major commitment to UK plant science teaching and is highly regarded within the scientific community. Research has shown that the summer school has a profound positive impact upon the students, with many going on

to take plant-related courses[17]. Several academics in this survey viewed these cohorts of students as the future of UK plant science.

Undergraduate Summer Research Training Programme

Together the John Innes Centre, The Sainsbury Laboratory and The Genome Analysis Centre run an 8-week summer school on plant and microbial sciences for up to 16 undergraduates from any scientific discipline. The course involves training, talks and seminars, including topics on plant pathology. In addition, the course includes a research project where students can gain experience in the laboratory. Two to three students each year opt for plant pathology projects.

5.5 Post-16 summer schools

University of Nottingham 'Plants and crops summer school – feeding the world'

New in 2012, this 3-day summer school is aimed at GCSE level students who are interested in science. Note the title, who at this age doesn't want to save the world? Nottingham academics have been involved in previous summer schools, but this is the first plant specific one. There are 15 places and it is sponsored by, amongst others, BASF, KWS Seeds, NIAB TAG, Syngenta and the National Farmers Union. Students will learn about the importance of crops and the challenges in global agriculture. There will be a plant pathology session. There is also an industrial visit to show how plant science is applied in practice.

The course will be run alongside a larger course (50 places) on Food Science. This too is sponsored by a range of industrial partners.

These courses represent key investments by industry in student training.

Sutton Trust summer school programme

The Sutton Trust is a charity that promotes social mobility through education. It funds a wide range of activities and in 2012 is expanding its summer school programme with places for over 1000 students. The host HEI are the Universities of Bristol, Cambridge, Durham, Imperial College London, Nottingham, St Andrews and University College London. Each provides a week-long course.

6. Research institutes - teaching and training

CENTRES OF KNOWLEDGE

Research institutes represent key centres of knowledge and technical expertise. Several research institutes across the UK provide training opportunities for plant pathologists. Their scientists teach at HEI. Students visit research institutes as part of their course, they also do summer placements or sandwich years there. At the graduate level, research institutes provide training for PhD students, visiting scientists and on-going post-doctoral training.

The author contacted scientists at several research institutes for their views on the current state of plant pathology teaching and training opportunities, many of whom responded.

6.1 Research institutes

Food and Environment Research Agency (FERA)

This is a broad ranging government-funded organisation with responsibility for amongst other things, plant disease identification, quarantine and control. FERA run diagnostic plant clinics and work to develop new diagnostic methods and tools.

East Malling Research (EMR)

An independent research institute that receives funding from a variety of sources including BBSRC. Its focus is on perennial crops such as apple. There are currently 3 main research areas:

- Genetics and crop improvement
- Pest and pathogen ecology for sustainable crop management
- Resources efficiency for crop production

Their current strategy document[18] emphasises the need to build upon existing links with the University of Reading and also to develop links with other HEI such as Lancaster, Nottingham and Imperial College London. They propose collaborative research projects, undergraduate summer placements and undergraduate and post graduate research projects.

Institute of Biological, Environmental and Rural Sciences (IBERS)

Formed in 2008 from the merger of the Institute of Grassland and Environmental Research, the University of Aberystwyth's Institute of Biological Sciences and the Institute of Rural Sciences, IBERS carries out research and training in plant biology, agriculture and land use. Eight groups conduct plant pathology research. There has been no overall change in numbers in the last 10 years.

When asked about the impact of phrases such as food security and sustainable agriculture on plant pathology training, one scientist said:

'It will take some time to train the next generation of plant pathologist but I am finding the 'food security' label a useful way to get under/post-graduate students to see the point and show an interest in plant pathology. I am finding the phrase 'sustainable agriculture' less inspiring so seldom use it.'

John Innes Centre (JIC)

An independent centre for plant science and microbiology, the John Innes Centre carries out research and training in a wide range of areas. The Biological Chemistry, Crop Genetics, Metabolic Biology, Cell and Developmental Biology and Molecular Microbiology groups all contain plant pathologists and again, numbers have remained fairly constant for several years now.

When asked about the impact of phrases such as food security and sustainable agriculture on plant pathology training, one scientist said:

'[The] food security/climate change agenda does offer opportunities for crop-based pathologists and I think that there will be a move... from model to crop pathologists but perhaps not an overall increase. There is certainly a need to train crop scientists and crop pathologists would fit into this group.'

The Genome Analysis Centre (TGAC)

Co-located with the John Innes Centre in Norwich, The Genome Analysis Centre provides training and expertise in genomics and bioinformatics. UK research councils are aware of the need for a co-ordinated strategy for UK-wide e-infrastructure. A recent document entitled 'Strategy for software as an infrastructure' [19] lays out some of the areas where concerted efforts are required.

New sequencing technologies enable scientists to study crop plant genomes in a manner previously reserved for simpler model species. For plant pathologists this represents a major step forward in studying crop-pathogen interactions directly.

Rothamsted Research

Perhaps the oldest agricultural research institute in the world, Rothamsted currently has 4 main research areas:

- 20:20 Wheat
- Cropping Carbon
- Designing Seeds
- Delivering Sustainable Systems

Their main site is at Harpenden, Hertfordshire, and there are also facilities at Broom's Barn in Suffolk and North Wyke in Devon.

The James Hutton Institute (JHI)

Formed in 2011 from the merger of the Macaulay Land Use Research Institute and the Scottish Crop Research Institute, the James Hutton Institute also hosts the University of Dundee Plant Sciences Division. It operates several farms and field research stations across Scotland. Approximately two-thirds of its funding comes from the Scottish and UK governments. There are around 30 senior plant pathologists. There has been no overall change in numbers in recent years as retirements have been balanced by new appointments. However, research emphasis has shifted towards bacteria, fungi and oomycetes, and away from viruses, insects and nematodes.

When asked about the impact of phrases such as food security and sustainable agriculture on plant pathology training one scientist said

'I think they draw people into the science as young folk have aspirations to do good e.g. to improve the environment and to increase production to alleviate hunger. But whether this translates into more jobs for trained pathologists I am less sure.'

The Sainsbury Lab

Founded in 1989 by the Gatsby Charitable Foundation, University of East Anglia, John Innes Foundation and BBSRC, The Sainsbury Lab conducts research and training in molecular plant pathology and genetics. Five plant pathology research groups are based there.

6.2 Institute funding

The BBSRC is the main funder of non-medical bioscience in the UK. It supports scientific training at several research institutes including IBERS, EMR, JIC, TGAC and Rothamsted Research.

One Russell Group academic suggested that the recent replacement of institute core funding with strategic funding may result in a shift in influence, with the BBSRC rather than institute directors being able to dictate what the money is spent on.

6.3 Institute mergers and closures

Plant science capacity in the UK has been reduced by closures and mergers of institutes and research stations.

For example:

Horticulture Research International (HRI)

In 1990 the Institute of Horticultural Research, with sites at Wellesbourne, Littlehampton, East Malling and Wye, merged with ADAS experimental stations at Efford, Kirton and Stockbridge. In 2004 HRI became part of the University of Warwick and was known as Warwick HRI. In 2009 the University of Warwick closed HRI and brought some staff into the Biological Sciences Department.

Rothamsted Research

In 1987 the Long Ashton Research Station (LARS) and Broom's Barn Experimental Station merged with Rothamsted Research to form the Institute of Arable Crops Research. LARS closed in 2002 with some staff moving to Rothamsted Research. A well-placed academic has said that Broom's Barn is also due to close. Rothamsted Research itself has subsequently undergone several restructuring programmes with the loss of plant pathologists.

6.4 Institute undergraduate teaching

In this survey academics provided many examples of teaching links between institutes and HEI.

James Hutton Institute

James Hutton Institute scientists have teaching links with a range of HEI.

- University of Dundee: formal links started approximately 10 years ago and now all the university's plant scientists are based at the James Hutton Institute. There are 4 joint appointments.
- University of St Andrews: Lesley Torrance has recently been appointed part-time professor at St Andrews. The research fellow Jens Tilsner is a joint appointment between the two institutions.
- University of Edinburgh: Lesley Torrance is a visiting professor at Edinburgh and Michael Taliansky is an honorary professor there.
- Heriot Watt University: Derek Stewart is a joint appointment between the two institutions.
- University of Aberdeen: several members of staff lecture there and there are joint appointments between the two institutions.
- University of Glasgow: Robbie Waugh lectures there.
- Scottish Agricultural College agriculture students visit the James Hutton Institute.
- The James Hutton Institute hosts Honours student placements from a number of HEI.

John Innes Centre and The Sainsbury Lab

Like the James Hutton Institute, both these have links with HEI. For example scientists from both deliver approximately one third of a final year 20 lecture module at the University of East Anglia. Scientists also lecture at nearby Easton College.

East Malling Research

Canterbury Christchurch University students attend lectures there.

6.5 Institute undergraduate training

Student summer placements

This survey found that many students have the opportunity to do summer placements at research institutes. Several academics stated that if a student were particularly interested in plant pathology they would be able to do a plant pathology-based placement.

For example

- Canterbury Christchurch University student placements at East Malling Research
- University of East Anglia student placements at the John Innes Centre and The Sainsbury Lab
- University of Cambridge student placements at the John Innes Centre and Rothamsted Research
- University of St Andrews student placements at the James Hutton Institute

Sandwich placements are also available at research institutes

For example

- University of Bath sandwich placements at Rothamsted Research

6.6 Institute graduate training

James Hutton Institute

A MRes course 'Crops for the Future' is taught jointly between The James Hutton Institute and the University of Dundee.

Links between the James Hutton Institute and HEI are mainly research-based and are often crystallized in the form of PhD studentships. There are currently around 120 PhD students at the James Hutton Institute, many of them shared with HEI. A joint PhD programme has been running for around 5 years. This takes 8-9 students per year with 50% funding from the HEI and 50% from the James Hutton Institute.

John Innes Centre and The Sainsbury Laboratory

There have been strong links between the John Innes Centre and the University of East Anglia for many years. Staff from both the John Innes Centre and The

Sainsbury Laboratory contribute to the direction and teaching of MSc courses at University of East Anglia. One such course, 'Plant Genetics and Crop Improvement', includes 13 lectures on plant pathology and approximately half the students each year do research projects in plant pathology.

The John Innes Centre, The Sainsbury Laboratory, the University of East Anglia and other organisations in the Norwich Research Park have formed a Doctoral Training Programme in biological sciences, which includes PhD training in plant pathology.

6.7 Institute post-doctoral training

In addition to training their own and visiting scientists, institutes also run training courses. For example, in June 2012 Rothamsted Research ran a 4 day training course for 15 early stage researchers from across the EU. This was funded by the European Cooperation in Science and Technology (COST) framework.

7. Industry – teaching and training

THE INDUSTRIAL VOICE

Plant pathology teaching and training occur in a range of settings, in both not-for-profit and commercial companies.

The author contacted several figures within the UK plant science and biotech industry asking for their views on the current state of plant pathology and training opportunities, but many did not respond.

7.1 Industry undergraduate teaching

This survey found that several HEI employ visiting lecturers from industry. Applied courses such as agriculture, horticulture and forestry in particular invite outside lecturers to teach aspects of a course.

For example:

- Working agronomists are seasonal lecturers on the Bishop Burton College agriculture course
- Members of Forest Research lecture on the Bangor University forestry course
- Members of the consultancy wing of Scottish Agriculture College lecture on their agriculture course
- Members of Oxford Botanic Gardens lecture on the Royal Agricultural College agriculture course

Biology courses also employ outside speakers.

- An outside speaker gives a lecture on insecticides at the University of Leeds
- Canterbury Christchurch University Bioscience and Plant Science students attend lectures at East Malling Research

7.2 Industry undergraduate training

Summer placements

This survey found that many students are able to do summer placements in industry.

For example:

- Aberystwyth University student placements at ADAS
- Bishop Burton College student placements at Mastock and Agrii
- Canterbury Christchurch student placements at East Malling Research and agricultural services companies
- University of Sheffield student placements at Astra Zeneca and in the food industry

Sandwich placements

Students taking a sandwich year have the option to do plant pathology-based work. A few examples are given below, but the list is by no means exhaustive. The University of Bath was particularly strongly placed to offer a range of plant-related placements.

- University of Aberdeen sandwich placements at Forest Research
- University of Bath sandwich placements at ADAS, Eurofins, Syngenta, FERA, NIAB TAG, Kew Gardens, Wakehurst Place, National Botanics Wales
- Harper Adams University sandwich placements at agrichemical companies, Sutton Bridge, NIAB TAG
- Royal Agricultural College sandwich placements at agrichemical companies, field trial units
- University of Hertfordshire sandwich placements at Syngenta, FERA, BASF
- University of West of England sandwich placements at Astra Zeneca, Syngenta, agrichemical and agrifood companies

Several companies including BASF, KWS Seeds, NIAB TAG and Syngenta sponsor student summer schools (see section 5.5).

NIAB TAG also run a student bursary scheme with the Universities of Nottingham, Reading, Harper Adams and Newcastle aimed at encouraging more students into plant science.

7.3 Industry graduate training

Industry sponsors graduate level training in a range of ways.

CASE studentships

These are awarded jointly to a HEI and an industrial partner, with the student spending at least 3 months at the industrial setting. For the HEI, CASE studentships not only bring a student to the lab, they are also key in establishing

industrial links and future collaborations.

One Russell Group academic believed there has been a reduction in the number of CASE studentships awarded over the last 10 years. Another University Alliance academic said he still received industrial interest in fungicide research.

Grant committees

BBSRC welcomes industrial expertise onto grant committees. The industrial voice is an important one.

One Russell Group academic believed this is key to getting more applied or crop-related BBSRC grants approved. He said that academics should be working more closely with industry to ensure that industrial experts sit on BBSRC grant committees.

7.4 Industry funding

Knowledge transfer networks work with industry to drive the commercialisation and development of scientific research. One of their key roles is to identify funding sources.

Plants fall within the Biosciences network, which is focussed in 3 main areas:

- Plant production and performance
- Renewable and sustainable bio-products
- Sustainable food supply and security

The network has links to UK research councils and regional funding agencies. It also works with EU funders such as Eureka Eurostars, 7th Framework, UK Research Office and the Technology Strategy Board.

7.5 Graduate skills

A key question is whether current undergraduate plant pathology teaching provides the knowledge and skills that employers want. Scientists at several organisations were asked about the skill sets provided by current undergraduate teaching, three of whom replied.

RHS Garden Wisley

Wisley is the 'flagship' garden of the Royal Horticultural Society. Wisley perform field trials, cultivation trials and operate a series of model gardens to inspire gardeners. There are 3 full-time and 1 part-time plant pathologists. This number represents an increase of 1 plant pathologist in the last 6 years. The plant pathology group perform research and also have an advisory role. They are part of a larger scientific team that includes horticulturists, soil scientists, botanists and entomologists.

When asked about skills, their head plant pathologist said:

'When we interview for a plant pathologist, no one seems to have a broad knowledge of plant pathogens. A lot of students in plant pathology are trained as molecular plant pathologists and have a detailed knowledge of one pathogen at the molecular level but not at the whole organism level.'

Centre for Agricultural Bioscience International (CABI)

A not-for-profit intergovernmental organisation with 47 member countries, CABI provides scientific expertise and information to support farmers worldwide, enabling them to grow more and lose less. Around 400 staff work worldwide and of these, approximately 50 trained as entomologists and 25 as plant pathologists. Overall about 25 of these staff were trained in the UK.

When asked about skills, one of their senior plant pathologists said that new graduates did have the technical skills required. However, members of staff believe that there has been a decline in traditional plant pathology teaching at HEI. This causes problems for CABI as they need graduates with diagnostic experience, able to recognise plant health problems in the field. They need people who can look beyond a gene and see the bigger picture.

This plant pathologist also highlighted the benefits of sandwich courses, saying that the skill sets gained during these placements are of immense practical value.

In both these cases employers highlighted the need for graduates to be able to see plant pathology at the whole organism level.

National Institute of Agricultural Botany and The Arable Group Limited (NIAB TAG)

A registered charity based in Cambridge, NIAB TAG provides research and

information to the agriculture and horticulture sectors. There are currently 17 plant pathologists, a slight decrease on previous numbers.

When asked about skills, one of their senior plant pathologists said:

'Students were generally taught the right things, but not in much depth. Field experimentation techniques in particular are seldom taught in depth. There are different skill sets in diagnostics and molecular genetics, and these seem to be taught to a greater level in undergraduate courses.'

Again the lack of practical fieldwork experience is highlighted.

8. Raising the profile of plant pathology

One way to raise the profile of plant pathology is through outreach and public engagement work. It is an opportunity to explain why plant pathology is important and why we need plant pathologists.

8.1 Outreach and public engagement

Publicly funded bodies such as HEI are under increasing pressure to be accountable for their research output. Outreach and public engagement are now an important part of their remit. The terminology has also changed. The 'public understanding of science' was felt by some to be too didactic. HEI should be 'engaging' with the public, not teaching them to understand. The process should be seen as a dialogue between equals. For example, the University of Bristol is 'committed to being an engaged university'.

Scientists too recognise this change of emphasis. The BSE crisis left the term 'government scientist' with precious little credibility. Scientists have realised they need to engage and explain their work on for example GM, rather than simply lecture the public.

Research Councils are also increasingly aware of the importance of outreach work. Current BBSRC grants stipulate that the grant holder must perform one day of public engagement/outreach work per year.

Workshops in schools

As part of this project the author attended a public engagement workshop at the University of Bristol run jointly with Lighting up Learning Limited (www.lightinguplearming.com). They in turn work with the STEM network (http://www.stemnet.org.uk/) an organisation sponsored by the Department for Business, Innovation, and Skills, the Department for Education, and the Gatsby Charitable Foundation. The STEM network provides ambassadors who work closely with scientists to develop workshops for schools.

A spokesman for Lighting up Learning recommended late primary school age children (Key stage 2, years 5 and 6) as a key target for workshops. The activities do not necessarily need to fit into part of the school curriculum. Scientists are there to inspire and engage.

A key goal is simply to put scientists in front of children. The reason is clear, as every child knows that scientists are old men with white hair and a lab coat. Here is some pupil feedback from a nanotechnology workshop, reported in the Guardian newspaper in 2012.

'The scientists weren't at all what I was expecting. I thought they would all be wearing lab coats and glasses, but they seemed like pretty normal people.'

'Before the debate, I thought scientists were boring, but they were really interesting and told funny stories about their work... I want to go to university to study nanotechnology now.'

So there is the classic 'lab coats and glasses' expectation, and of course scientists are 'boring'. Just one workshop let the children see that scientists are not boring they are normal people, just like themselves. One child now wants to be a scientist. What a difference a day makes!

A major goal of any outreach work should be to put real scientists in front of children, to show them that plant pathology is relevant to their lives and that it is carried out by people just like them.

Talks

Talks are another way to explain the work of plant pathologists. Some secondary schools run lecture series with invited speakers. These are intended for A-level students but members of the public may also attend. Talks need to be pitched carefully and they need to be done well. For example, a good starting point may be to adapt a first year introductory lecture.

Workshops and public talks may not appeal to everyone. However, there are a range of other ways in which to promote plant pathology and to put it in context.

Public engagement via HEI

Many, if not all HEI, have a press office. These employ people who are paid to promote your work. They produce press releases and can arrange phone and television interviews.

University publications are another outlet for work. For example, the University of Bristol magazine Nonesuch highlights

research and profiles academics. Produced termly, it has a circulation of 125,000, including staff, the local community and research councils.

Public engagement via the media

Commissioning editors have acres of newsprint and hours of airtime to fill each day. They need news stories. However, it is important to remember that the media are there to entertain as well as inform their customers. News stories need to be pitched with this in mind.

Public engagement via social media

Social media now constitutes over a third of all internet use amongst young people[20]. Individual programs may come and go, but social media is here to stay. Although usage amongst academics varies dramatically, young people consider social media an integral part of their lives. Outreach work must consider social media as an outlet. For example, the main ethos of Twitter is sharing, it is all about dialogue.

8.2 What to communicate

Scientists want to communicate their research findings. However, they must recognise that others may not share their wide-eyed enthusiasm. Perhaps scientists should appeal to a more basic instinct. Money.

For example, a 2012 newspaper story about vaccine development described the economic impact of the work first, then went on to say that the work would benefit human and animal health, and lastly added that it would benefit others in developing countries. It is all about the money.

Scientists do not always think of the financial aspects of their work. Perhaps this is an area where plant pathologists should be promoting the important economic benefits of plant pathology research.

8.3 Lobbying

Another way to promote plant pathology is to lobby. This should be done at all levels.

For example the UK Plant Sciences Federation, launched in October 2011 as a special interest group of the Society of Biology, aims to:

- Promote plant and crop science across government, industry and society
- Provide information to inform policy on the funding of plant science
- 'Educate and inspire' the next generation of scientists

The federation is made up of a wide range of member organisations including Learned Societies, plant breeders and industrial companies. BSPP is a member.

Their inaugural UK PlantSci conference was held in April 2012 with the opening address given by Sir John Beddington. The conference publicity stated that it would be of interest to everyone in the plant science sector and went on to list them: cell biologists, industrialists, physiologists, ecologists, plant breeders, soil scientists and agriculturists. There was no mention of plant pathology. Disappointing!

But this is about more than conference posters. As a member of the federation BSPP should work hard to ensure that plant pathology is on the agenda of this important new lobby group.

9. Summary – findings and points for discussion

Governments, policy makers and scientists all recognise that there is a clear need for plant pathology. There is also a clear need to ensure future provision of plant pathology teaching and training to enable the UK to produce plant pathologists able to respond to the issues of food security and climate change.

Of the 103 UK HEI offering biology, agriculture, horticulture or forestry courses at BSc level, 47 provide plant pathology teaching in some form. This ranges from 1-2 lectures to over 12 lectures in any single teaching module. Approximately half of the 47 HEI offer plant pathology practical classes.

Good teaching is key. A widespread lack of interest in plant science can be overturned with good, enthusiastic teaching. There is the opportunity to learn from HEI with good student uptake on plant pathology modules.

Overall, there is less teaching than there used to be and the modular nature of HEI courses means that students can, and do, opt out of plant-based modules. This means that students are not exposed to plant pathology teaching.
Ideally students should encounter plant pathology and other plant sciences in the first year, making them more likely to choose more advanced plant pathology modules in subsequent years.

In terms of practical work, agriculture, forestry and horticulture courses were more likely to involve field walks and diagnostic skills. Biology practical classes were more likely to be laboratory-based. However employers in this survey and elsewhere have highlighted the need for graduates to be able to see beyond the gene and understand plant pathology at the whole organism level.
Developments in molecular biology have revolutionised plant pathology and obviously this has led to a more molecular focus in HEI teaching. However, perhaps the new focus on food security and sustainable agriculture should be seen as an opportunity to re-establish the link between plant pathology and agriculture. This could apply to both lecture content and practical classes.

A wide range of teaching links between HEI and both UK research institutes and industry exist. These bring practical plant pathology knowledge directly into the lecture theatre. Many plant pathology-based student placement opportunities in research institutes and across the agriculture, horticulture and forestry sectors were also identified. These provide students with practical plant pathology experience and enable them to make the link between their course work and plant pathology research and its application in the wider world.

The age profile of HEI plant pathologists is of major concern. The strategic provision of plant pathology teaching needs to be addressed.
This survey presents a snap shot so trends cannot be identified, however it is clear that across HEI academics are retiring and not being replaced. Staff retirement has meant that at least 5 HEI no longer teach plant pathology and staffing levels have been reduced in at least a further 6 HEI. This implies that plant pathology is not considered a priority area across a range of HEI. Furthermore if a lone plant pathology academic were to retire or relocate it is likely that plant pathology teaching would cease at that HEI.
So although substantial numbers of students currently take plant pathology modules, plant pathology teaching may be vulnerable at a sizeable proportion of HEI. It is not known how many HEI will retain the capacity to teach plant pathology in 5-10 years time.

New departmental appointments and RAE/REF assessments are driven in part by the Impact Factor (IF) of scientific publications. The highly specialised, often applied, nature of much plant pathology research means that it is often published in low IF journals. So in terms of this particular measure of esteem, plant pathologists may struggle to compete against scientists from other disciplines. New assessment criteria such as the REF impact statement may not necessarily help plant scientists, particularly those in more applied areas.

Academics should be aware of the issues of degree accreditation and ensure that, where appropriate, plant pathology is included in accredited courses as this may impact on the strategic provision of plant pathology teaching within HEI.

Academics working in applied areas should work closely with industry to enable industrial experts to sit on grant

committees. The industrial voice is an important one and should be part of grant committee deliberations.

Plant pathology does not enjoy the high profile afforded to other areas of biology such as biomedicine or forensic science. This is not helped by that fact that the term 'plant pathology' itself is disappearing. The terms food security and sustainable agriculture abound in mission statements and strategy documents. How can prospective students learn about the importance of plant pathology if it is not clearly presented as a subject in its own right? This needs to be addressed if we are to encourage young people to consider plant pathology as a career option.

There are many ways in which outreach and public engagement work can promote plant pathology to a wider audience. Some grant awards now stipulate public engagement work. BSPP has appointed an Outreach Officer to develop a series of plant pathology-based resources and activities.

Lobbying should be used to ensure that plant pathology is part of the conversation about plant science in the UK.

Today's students are tomorrow's teachers. A reduction in HEI teaching of plant pathology and other highly specialised subjects crucial to UK well being and the economy, will result in fewer teachers able to teach these subjects in future. A vicious circle is developing which must be challenged. A clear and constructive case must be made to policy makers of the importance of plant pathology and the need to teach and train the next generation of plant pathologists.

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Appendix I: HEI offering BSc level courses in biology, agriculture, horticulture and forestry

	Biology	Biosciences	Agriculture	Horticulture	Forestry	C100 - Biology	C110 - Applied Biology	C200 - Botany	C210 - Applied Botany	C240 - Plant Cell Science	C500 - Microbiology	C700 - Molecular Biology	D400 - Agriculture	D410/D415 - Horticulture	D500 - Forestry & Arboriculture	D700 - Agricultural Sciences	D730 - Agricultural Botany
Aberystwyth University	✓	✓	✓			✓		✓			✓	✓					
Anglia Ruskin University	✓																
Askham Bryan College,York			✓	✓										✓			
Aston University, Birmingham	✓																
Bangor University	✓		✓		✓	✓									✓		
Bath Spa University	✓					✓											
Bishop Burton College, Yorkshire			✓														
Bournemouth University						✓											
Canterbury Christ Church University	✓	✓						✓		✓							
Cardiff University	✓					✓					✓	✓					
Coventry University		✓					✓										
Duchy College, Cornwall				✓													
Durham University	✓					✓											
Easton College, Norwich			✓														
Edge Hill University	✓					✓											
Edinburgh Napier University	✓																
Glasgow Caledonian University	✓	✓															
Harper Adams University College			✓										✓	✓			✓
Heriot-Watt University	✓										✓						
Imperial College London	✓					✓	✓				✓	✓					
Keele University	✓					✓						✓					
King's College London												✓					

Appendix I: HEI offering BSc level courses in biology, agriculture, horticulture and forestry

	Biology	Biosciences	Agriculture	Horticulture	Forestry	C100 - Biology	C110 - Applied Biology	C200 - Botany	C210 - Applied Botany	C240 - Plant Cell Science	C500 - Microbiology	C700 - Molecular Biology	D400 - Agriculture	D410/D415 - Horticulture	D500 - Forestry & Arboriculture	D700 - Agricultural Sciences	D730 - Agricultural Botany
Kingston University	✓					✓						✓					
Lancaster University	✓					✓						✓					
Leeds Metropolitan University	✓																
Liverpool Hope University	✓					✓											
Liverpool John Moores University	✓					✓						✓					
London Metropolitan University	✓	✓										✓					
London South Bank University	✓	✓					✓				✓	✓					
Manchester Metropolitan University	✓																
Middlesex University		✓										✓					
Myerscough College, Lancashire			✓	✓									✓				
Newcastle University	✓		✓			✓						✓	✓				
Northumbria University		✓				✓	✓										
Nottingham Trent University							✓					✓					
Oxford Brookes University	✓	✓				✓											
Oxford University						✓						✓					
Plymouth University	✓		✓			✓											
Queen Margaret University, Edinburgh						✓											
Queen Mary, University of London	✓					✓						✓					
Queen's University, Belfast	✓		✓			✓					✓	✓					
Robert Gordon University, Aberdeen		✓															
Royal Agricultural College			✓										✓			✓	
Royal Holloway University of London	✓					✓						✓					

Appendix I: HEI offering BSc level courses in biology, agriculture, horticulture and forestry

	Biology	Biosciences	Agriculture	Horticulture	Forestry	C100 - Biology	C110 - Applied Biology	C200 - Botany	C210 - Applied Botany	C240 - Plant Cell Science	C500 - Microbiology	C700 - Molecular Biology	D400 - Agriculture	D410/D415 - Horticulture	D500 - Forestry & Arboriculture	D700 - Agricultural Sciences	D730 - Agricultural Botany
Scottish Agricultural College		✓	✓	✓										✓		✓	
Sheffield Hallam University	✓	✓				✓						✓					
Staffordshire University	✓					✓											
Swansea University	✓					✓						✓					
Teesside University						✓											
University Campus Suffolk		✓															
University College London	✓											✓					
University of Aberdeen	✓				✓	✓					✓	✓			✓		
University of Bath	✓					✓						✓					
University of Bedfordshire						✓											
University of Birmingham	✓					✓		✓			✓	✓					
University of Bolton	✓					✓						✓					
University of Brighton	✓					✓											
University of Bristol	✓					✓						✓					
University of Cambridge	✓																
University of Central Lancashire												✓					
University of Chester	✓					✓											
University of Cumbria	✓				✓										✓		
University of Derby	✓					✓											
University of Dundee	✓					✓					✓	✓					
University of East Anglia	✓					✓						✓					
University of East London	✓	✓					✓					✓					

Appendix I: HEI offering BSc level courses in biology, agriculture, horticulture and forestry

	Biology	Biosciences	Agriculture	Horticulture	Forestry	C100 - Biology	C110 - Applied Biology	C200 - Botany	C210 - Applied Botany	C240 - Plant Cell Science	C500 - Microbiology	C700 - Molecular Biology	D400 - Agriculture	D410/D415 - Horticulture	D500 - Forestry & Arboriculture	D700 - Agricultural Sciences	D730 - Agricultural Botany
University of Edinburgh	✓					✓		✓				✓					
University of Essex	✓					✓						✓					
University of Exeter	✓	✓				✓											
University of Glamorgan	✓					✓											
University of Glasgow	✓	✓					✓	✓			✓	✓					
University of Gloucestershire	✓					✓											
University of Greenwich			✓	✓													
University of Hertfordshire	✓																
University of Highlands and Islands															✓		
University of Huddersfield	✓											✓					
University of Hull	✓					✓											
University of Kent	✓											✓					
University of Leeds	✓					✓	✓				✓	✓					
University of Leicester						✓					✓	✓					
University of Lincoln	✓		✓			✓											
University of Liverpool	✓					✓	✓				✓	✓					
University of Manchester	✓					✓		✓			✓	✓					
University of Northampton	✓	✓				✓											
University of Nottingham	✓	✓	✓			✓	✓	✓				✓	✓				
University of Portsmouth	✓					✓						✓					
University of Reading	✓					✓					✓	✓	✓				
University of Salford	✓					✓						✓					

Appendix I: HEI offering BSc level courses in biology, agriculture, horticulture and forestry

	Biology	Biosciences	Agriculture	Horticulture	Forestry	C100 - Biology	C110 - Applied Biology	C200 - Botany	C210 - Applied Botany	C240 - Plant Cell Science	C500 - Microbiology	C700 - Molecular Biology	D400 - Agriculture	D410/D415 - Horticulture	D500 - Forestry & Arboriculture	D700 - Agricultural Sciences	D730 - Agricultural Botany
University of Sheffield	✓					✓		✓			✓	✓					
University of Southampton	✓					✓						✓					
University of St Andrews	✓					✓						✓					
University of Strathclyde											✓						
University of Surrey		✓									✓	✓					
University of Sussex	✓					✓						✓					
University of Ulster	✓					✓											
University of Warwick	✓					✓						✓					
University of West of England	✓					✓	✓										
University of West of Scotland		✓															
University of Westminster	✓										✓	✓					
University of Wolverhampton	✓											✓					
University of Worcester	✓			✓		✓			✓					✓			
University of York	✓					✓						✓					
Writtle College, Essex			✓	✓										✓			

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

Aberystwyth University				
Search method: Email	**BSc degree courses:** Biology and Plant Biology		**Plant pathology teaching?** Yes	
Module title: Plant Interactions with Pests and Pathogens				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 20-30	**Number lectures:** 30	**Plant pathology practicals?** Yes
Anglia Ruskin University				
Search method: Website and email	**BSc degree course:** None applicable		**Plant pathology teaching?** No	
Askham Bryan College, York				
Search method: Phone and email	**BSc degree course:** Agriculture and Land Use		**Plant pathology teaching?** No	
Search method: Phone and email	**BSc degree course:** Horticulture		**Plant pathology teaching?** Yes	
Module title: No data				
Year/level: No data	**Optional/compulsory:** No data	**Number students:** No data	**Number lectures:** No data	**Plant pathology practicals?** No data
Aston University, Birmingham				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** No	
Bangor University				
Search method: Phone	**BSc degree course:** Forestry		**Plant pathology teaching?** Yes	
Module title: Forest Health				
Year/level: Year 2	**Optional/compulsory:** Compulsory	**Number students:** 30	**Number lectures:** 20 (some student seminars)	**Plant pathology practicals?** Yes
Module title: Forest Health				
Year/level: Year 3	**Optional/compulsory:** Compulsory	**Number students:** 30	**Number lectures:** 20	**Plant pathology practicals?** No

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

Bath Spa University				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
Bishop Burton College, Yorkshire				
Search method: Phone and email	**BSc degree course:** Agricultural Resource Management		**Plant pathology teaching?** Yes	
Module title: Integrated Farm Management				
Year/level: Level 6	**Optional/compulsory:** Compulsory	**Number students:** 15	**Number lectures:** 12	**Plant pathology practicals?** Yes
Bournemouth University				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** No	
Canterbury Christchurch University				
Search method: Phone and email	**BSc degree course:** BSc Biosciences and BSc Plant Science		**Plant pathology teaching?** Yes	
Module title: Pests, Parasites and Pathogens				
Year/level: Level 6	**Optional/compulsory:** Compulsory	**Number students:** 15-48	**Number lectures:** 20	**Plant pathology practicals?** Yes
Module title: Plant Responses to the Environment				
Year/level: Level 6	**Optional/compulsory:** Compulsory	**Number students:** 15-48	**Number lectures:** 20	**Plant pathology practicals?** Yes
Cardiff University				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
Coventry University				
Search method: Phone	**BSc degree course:** BSc Biological and Forensic Sciences		**Plant pathology teaching?** No	
Duchy College, Cornwall				
Search method: Phone	**BSc degree course:** Horticulture		**Plant pathology teaching?** No data	

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

Durham University				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** Yes	
Module title: Stress and Response to the Environment				
Year/level: Level 3	**Optional/compulsory:** Optional	**Number students:** 90	**Number lectures:** 3	**Plant pathology practicals?** No
Easton College, Norwich				
Search method: Phone and email	**BSc degree course:** Agriculture		**Plant pathology teaching?** Yes	
Module title: Advanced Agronomy				
Year/level: Level 6	**Optional/compulsory:** Optional	**Number students:** 4	**Number lectures:** No data	**Plant pathology practicals?** Yes
Edge Hill University				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
Edinburgh Napier University				
Search method: Phone and email	**BSc degree course:** Biological Science		**Plant pathology teaching?** No	
Glasgow Caledonian University				
Search method: Phone and email	**BSc degree course:** None applicable		**Plant pathology teaching?** No	
Harper Adams University				
Search method: Phone and email	**BSc degree course:** Agriculture		**Plant pathology teaching?** Yes	
Module title: Crop Protection				
Year/level: Level 2	**Optional/compulsory:** Optional	**Number students:** 61	**Number lectures:** 3	**Plant pathology practicals?** Yes
Module title: Crop Protection				
Year/level: Level 3	**Optional/compulsory:** Optional	**Number students:** 50	**Number lectures:** 3	**Plant pathology practicals?** Yes

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

Heriot-Watt University				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** No	
Imperial College London				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
Module title: Molecular Plant-Microbe Interactions				
Year/level: Level 3	**Optional/compulsory:** Optional	**Number students:** 15	**Number lectures:** 18	**Plant pathology practicals?** Yes
Keele University				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
King's College London				
Search method: Website and email	**BSc degree course:** None applicable		**Plant pathology teaching?** No	
Kingston University				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
Lancaster University				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** Yes	
Module title: Environmental Physiology				
Year/level: Level 2	**Optional/compulsory:** Optional	**Number students:** 38	**Number lectures:** 3	**Plant pathology practicals?** No
Module title: Ecophysiology of Host-Pest Interactions				
Year/level: Level 3	**Optional/compulsory:** Optional	**Number students:** 23	**Number lectures:** 4	**Plant pathology practicals?** No
Leeds Metropolitan University				
Search method: Website	**BSc degree course:** None applicable		**Plant pathology teaching?** No	

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

Liverpool Hope University				
Search method: Email	**BSc degree course:** Biology, Human Biology, Biology with Human Biology		**Plant pathology teaching?** Yes	
Module title: Plagues, Pathogens and Populations				
Year/level: Year 2	**Optional/compulsory:** Compulsory	**Number students:** 12-32	**Number lectures:** 4	**Plant pathology practicals?** No
Liverpool John Moores University				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
London Metropolitan University				
Search method: Website and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** No	
London South Bank University				
Search method: Phone and email	**BSc degree course:** Bioscience		**Plant pathology teaching?** No	
Manchester Metropolitan University				
Search method: Phone and email	**BSc degree course:** Microbiology and Molecular Biology		**Plant pathology teaching?** No	
Middlesex University				
Search method: Phone and email	**BSc degree course:** Biosciences		**Plant pathology teaching?** No	
Myerscough College, Lancashire				
Search method: Phone and email	**BSc degree course:** Arboriculture and Horticulture		**Plant pathology teaching?** Yes	
Module title: Pest, Diseases and Weeds				
Year/level: Year 2	**Optional/compulsory:** Compulsory	**Number students:** 20-35	**Number lectures:** 10	**Plant pathology practicals?** Yes

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

Newcastle University				
Search method: Phone and email	**BSc degree course:** Biology, Biology (Cell and Molecular Biology)		**Plant pathology teaching?** Yes	
Module title: Plant Pathology				
Year/level: Year 3	**Optional/compulsory:** Compulsory	**Number students:** 67	**Number lectures:** 19	**Plant pathology practicals?** Yes
BSc degree course: Agriculture				
Module title: Crop Pests				
Year/level: Year 1	**Optional/compulsory:** Compulsory for Agriculture, optional for Biology, Biology (Ecology and Environmental Biology) Biology (Cell and Molecular Biology), Zoology	**Number students:** 46 (41 Agriculture, 3 Biology, 2 Biology [Cell and Molecular Biology])	**Number lectures:** 7	**Plant pathology practicals?** Yes
Northumbria University				
Search method: Phone and email	**BSc degree course:** Applied Biology		**Plant pathology teaching?** No	
Nottingham Trent University				
Search method: Phone and email	**BSc degree course:** Applied Biology		**Plant pathology teaching?** No	
Oxford Brookes University				
Search method: Phone and email	**BSc degree course:** Biology, Environmental Science		**Plant pathology teaching?** Yes	
Module title: Plant Science				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** Around 25	**Number lectures:** 1-2	**Plant pathology practicals?** No data
Module title: Advances in Biotechnology				
Year/level: Year 3	**Optional/compulsory:** For Biology BSc Optional	**Number students:** Around 25	**Number lectures:** 1-2	**Plant pathology practicals?** No data

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

Oxford University				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** Yes	
First year course				
Year/level: Year 1	**Optional/compulsory:** Compulsory	**Number students:** 112	**Number lectures:** 5	**Plant pathology practicals?** No
Module title: Plant Disease				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 95	**Number lectures:** 12	**Plant pathology practicals?** Yes
Module title: Plant Immune System				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 80	**Number lectures:** 6	**Plant pathology practicals?** Yes
Plymouth University				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** Yes	
Module title: Environmental Plant Physiology				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 20	**Number lectures:** 6	**Plant pathology practicals?** Yes
Module title: Crop Production and Protection (Next year this module will be replaced with a Plant Biotechnology module. It will have about the same number of students and there will be some practicals with a theme that will explore some concepts of pathology.)				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 18-30	**Number lectures:** 12	**Plant pathology practicals?** No
Queen Margaret University, Edinburgh				
Search method: Website and email	**BSc degree course:** None applicable		**Plant pathology teaching?** No	
Queen Mary, University of London				
Search method: Email	**BSc degree course:** Biology		**Plant pathology teaching?** No	

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

Queen's University, Belfast (1st and 2nd year taught at College of Agriculture Food and Rural Enterprise)				
Search method: Phone and email	**BSc degree course:** Agricultural Technology		**Plant pathology teaching?** Yes	
Module title: Plant Science				
Year/level: Year 1	**Optional/compulsory:** Compulsory	**Number students:** 26	**Number lectures:** 2-3	**Plant pathology practicals?** No data
Module title: Crop Production				
Year/level: Year 2	**Optional/compulsory:** Compulsory	**Number students:** 20	**Number lectures:** 2-3	**Plant pathology practicals?** No data
Module title: No data				
Year/level: Year 3	**Optional/compulsory:** No data	**Number students:** No data	**Number lectures:** No data	**Plant pathology practicals?** No data
Robert Gordon University, Aberdeen				
Search method: Phone and email	**BSc degree course:** None applicable		**Plant pathology teaching?** No	
Royal Agricultural College				
Search method: Phone	**BSc degree course:** Agriculture		**Plant pathology teaching?** Yes	
Module title: Advanced Crop and Plant Science				
Year/level: Level 6	**Optional/compulsory:** Optional	**Number students:** 6-10	**Number lectures:** No specific number	**Plant pathology practicals?** No
Royal Holloway University of London				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
Module title: Plant Life				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 40	**Number lectures:** 1	**Plant pathology practicals?** No
Module title: Climate Change: Plants and the Environment				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 25	**Number lectures:** 2	**Plant pathology practicals?** No

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

Scottish Agricultural College				
Search method: Phone and email	**BSc degree course:** Agriculture and Applied Bioscience		**Plant pathology teaching?** Yes	
Module title: New Perspectives in Plant Protection				
Year/level: Year 3 (out of 4)	**Optional/compulsory:** Optional	**Number students:** 14	**Number lectures:** 3-6	**Plant pathology practicals?** Yes
Module title: Plant Protection Technology				
Year/level: Year 4	**Optional/compulsory:** Optional	**Number students:** 5	**Number lectures:** 3-5	**Plant pathology practicals?** Yes
Search method: Phone and email	**BSc degree course:** Horticulture		**Plant pathology teaching?** Yes	
Module title: New Perspectives in Plant Protection				
Year/level: Year 3 or 4 (Year 3 in 2011/12)	**Optional/compulsory:** Optional	**Number students:** 5	**Number lectures:** 3-6	**Plant pathology practicals?** Yes
Sheffield Hallam University				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
Module title: Plant Biotechnology				
Year/level: Year 3	**Optional/compulsory:** Compulsory	**Number students:** 25	**Number lectures:** 1-2	**Plant pathology practicals?** No
Staffordshire University				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
Swansea University				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
Teesside University				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** No data	

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

University Campus Suffolk				
Search method: Phone and email	**BSc degree course:** Bioscience		**Plant pathology teaching?** No	
University College London				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** No	
University of Aberdeen				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
Module title: Biology and Ecology of Plant Disease				
Year/level: Year 3 (out of 4)	**Optional/compulsory:** Optional	**Number students:** 25	**Number lectures:** 30	**Plant pathology practicals?** No
BSc degree course: Forestry				
Module title: Biology and Ecology of Forest Health				
Year/level: Year 4	**Optional/compulsory:** Optional	**Number students:** No data	**Number lectures:** Approx. 27 includ. seminars	**Plant pathology practicals?** No
University of Bath				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
Module title: Plant Pathology				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 20-25	**Number lectures:** 22	**Plant pathology practicals?** Yes
Module title: Plant-Microorganism Interactions				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 20	**Number lectures:** 22	**Plant pathology practicals?** No
University of Bedfordshire				
Search method: Phone and email	**BSc degree course:** Biological Science		**Plant pathology teaching?** No	

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

University of Birmingham				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** Yes	
Module title: Plant Biology from Molecules to the Environment				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 50-60	**Number lectures:** 7	**Plant pathology practicals?** No
University of Bolton				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
University of Brighton				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
University of Bristol				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
First year course				
Year/level: Year 1	**Optional/compulsory:** Compulsory	**Number students:** 180	**Number lectures:** 2	**Plant pathology practicals?** Yes
Module title: Plant Disease				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 70	**Number lectures:** 15	**Plant pathology practicals?** Yes
Module title: Agricultural Biotechnology				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 65	**Number lectures:** 5	**Plant pathology practicals?** No

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

University of Cambridge				
Search method: Phone and email	**BSc degree course:** Natural Sciences		**Plant pathology teaching?** Yes	
Module title: Physiology of Organisms				
Year/level: Year 1	**Optional/compulsory:** Optional	**Number students:** 230-240	**Number lectures:** 6	**Plant pathology practicals?** Yes
Module title: Plant and Microbial Sciences				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 50-60	**Number lectures:** 22	**Plant pathology practicals?** Yes
University of Central Lancashire				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** No	
University of Chester				
Search method: Website and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
University of Cumbria				
Search method: Phone and email	**BSc degree course:** Forestry		**Plant pathology teaching?** Yes	
Module title: Silviculture				
Year/level: Year 1	**Optional/compulsory:** Compulsory	**Number students:** 20	**Number lectures:** 2	**Plant pathology practicals?** No
University of Derby				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
Module title: Microbiology				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 30	**Number lectures:** 1-2	**Plant pathology practicals?** Yes

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

University of Dundee				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
Module title: No data				
Year/level: No data	**Optional/compulsory:** Compulsory	**Number students:** 160-170	**Number lectures:** No data	**Plant pathology practicals?** No data
University of East Anglia				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** Yes	
Module title: Plant biology				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 30-40	**Number lectures:** 1	**Plant pathology practicals?** No data
Module title: Molecular Plant-Microbe Interactions				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 12	**Number lectures:** 20	**Plant pathology practicals?** No
University of East London				
Search method: Website and email	**BSc degree course:** None applicable		**Plant pathology teaching?** No	
University of Edinburgh				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** Yes	
Module title: Plant Fungi and Symbiosis				
Year/level: Year 2 (out of 4)	**Optional/compulsory:** Optional	**Number students:** 90	**Number lectures:** 6	**Plant pathology practicals?** Yes
Module title: Plant Physiology				
Year/level: Year 3 (out of 4)	**Optional/compulsory:** Optional	**Number students:** 17-18	**Number lectures:** 5	**Plant pathology practicals?** Yes
Module title: Fungi and Plant Pathology				
Year/level: Year 4	**Optional/compulsory:** Optional	**Number students:** 10	**Number lectures:** 15	**Plant pathology practicals?** No

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

University of Essex				
Search method: Phone and email	**BSc degree course:** Biological Science		**Plant pathology teaching?** Yes	
Module title: Plant and Environmental Biotechnology				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 15	**Number lectures:** 2	**Plant pathology practicals?** No data
University of Exeter				
Search method: Email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** Yes	
Module title: Microbial Effectors of Disease				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 70	**Number lectures:** 3	**Plant pathology practicals?** No
University of Glamorgan				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
University of Glasgow				
Search method: Phone and email	**BSc degree courses:** Biochemistry, Genetics, Molecular & Cellular Biology, Molecular & Cellular Biology (with Plant Science), Molecular & Cellular Biology (with Biotechnology)		**Plant pathology teaching?** Yes	
Module title: Plant Molecular Biology				
Year/level: Year 4	**Optional/compulsory:** Optional	**Number students:** 8-16	**Number lectures:** 6	**Plant pathology practicals?** No data
University of Gloucestershire				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No data	
University of Greenwich				
Search method: Phone and email	**BSc degree course:** International Agriculture		**Plant pathology teaching?** No	
Search method: Phone and email	**BSc degree course:** Horticulture		**Plant pathology teaching?** No data	

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

University of Hertfordshire				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** Yes	
Module title: No data				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 10	**Number lectures:** 4	**Plant pathology practicals?** Yes
Module title: No data				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 7	**Number lectures:** 4	**Plant pathology practicals?** No
University of the Highlands and Islands				
Search method: Phone and email	**BSc degree course:** Forestry		**Plant pathology teaching?** No data	
University of Huddersfield				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
University of Hull				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
University of Kent				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

University of Leeds				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
Module title: Applied Biology and Agriculture				
Year/level: Year 1	**Optional/compulsory:** No data	**Number students:** No data	**Number lectures:** 6	**Plant pathology practicals?** No data
Module title: Food Security				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 40	**Number lectures:** 6	**Plant pathology practicals?** Yes
Module title: Animals as Crop Pests				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 40	**Number lectures:** 6	**Plant pathology practicals?** Yes
Module title: Applied Plant Biology				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 72	**Number lectures:** Number lectures: None - all lab-based	**Plant pathology practicals?** Yes
University of Leicester				
Search method: Phone	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** No	
University of Lincoln				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
Search method: Phone and email	**BSc degree course:** Agriculture		**Plant pathology teaching?** No data	

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

University of Liverpool				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** Yes	
Module title: Diversity of Plants and Microbes				
Year/level: Year 1	**Optional/compulsory:** Compulsory	**Number students:** 300	**Number lectures:** 3	**Plant pathology practicals?** No
Module title: Biology of Microbes				
Year/level: Year 1	**Optional/compulsory:** Optional	**Number students:** 100	**Number lectures:** 1	**Plant pathology practicals?** No
Module title: No data				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 120	**Number lectures:** 1	**Plant pathology practicals?** No
Module title: Microbial Diversity				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 30	**Number lectures:** 5	**Plant pathology practicals?** No
University of Manchester				
Search method: Phone and email	**BSc degree course:** Biology and Plant Science		**Plant pathology teaching?** Yes	
Module title: Microbiology				
Year/level: Year 1	**Optional/compulsory:** No data	**Number students:** 200	**Number lectures:** 2	**Plant pathology practicals?** No
Module title: Plant Pathogen Interactions				
Year/level: Year 3	**Optional/compulsory:** Compulsory for Plant s Science	**Number students:** 30-40	**Number lectures:** 6	**Plant pathology practicals?** No
Module title: Plant Biotechnology				
Year/level: Year 3	**Optional/compulsory:** No data	**Number students:** 30	**Number lectures:** 2	**Plant pathology practicals?** No
University of Northampton				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

University of Nottingham				
Search method: Phone and email	**BSc degree course:** Biology and Plant Science		**Plant pathology teaching?** Yes	
Module title: Introductory Plant Pathology				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 80-120	**Number lectures:** 14	**Plant pathology practicals?** Yes
Module title: Molecular Plant Pathology				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 90-117	**Number lectures:** 20	**Plant pathology practicals?** No
Module title: Plant Microbe Interactions				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 56	**Number lectures:** 20	**Plant pathology practicals?** Yes
Module title: Plant Disease Control				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 56	**Number lectures:** 22	**Plant pathology practicals?** Yes
University of Portsmouth				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
University of Reading				
Search method: Phone and email	**BSc degree course:** Biological Sciences/Agriculture		**Plant pathology teaching?** Yes	
Module title: Ecology and Management of Plant Disease				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 15	**Number lectures:** 15	**Plant pathology practicals?** Yes
Search method: Phone and email	**BSc degree course:** Agriculture		**Plant pathology teaching?** Incidental only	

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

University of Salford				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
Module title: Microorganisms in Action				
Year/level: Level 5	**Optional/compulsory:** Optional	**Number students:** 30-40	**Number lectures:** 6	**Plant pathology practicals?** No
University of Sheffield				
Search method: Phone and email	**BSc degree course:** Biology and Plant Science		**Plant pathology teaching?** Yes	
Module title: Biotechnology and Food Security				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 40-50	**Number lectures:** 5-6	**Plant pathology practicals?** No
Module title: Symbiosis				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** No data	**Number lectures:** 9	**Plant pathology practicals?** No data
Module title: Environmental Regulation in Plants				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 25	**Number lectures:** 6	**Plant pathology practicals?** No
University of Southampton				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
University of St Andrews				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
Module title: Animal-Plant Interactions				
Year/level: 3 (out of 4)	**Optional/compulsory:** Optional	**Number students:** 50	**Number lectures:** 8	**Plant pathology practicals?** No
Module title: Symbiosis Plant-Environment Interactions				
Year/level: 4	**Optional/compulsory:** Optional	**Number students:** 10	**Number lectures:** Student-driven	**Plant pathology practicals?** No

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

University of Strathclyde				
Search method: Phone and email	**BSc degree course:** None applicable		**Plant pathology teaching?** No	
University of Surrey				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** No	
University of Sussex				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
University of Ulster				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** No	
University of Warwick				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** No	
University of West of England				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** Yes	
Module title: Plant Growth and Survival				
Year/level: 2	**Optional/compulsory:** Optional	**Number students:** 40	**Number lectures:** 6	**Plant pathology practicals?** Yes
Module title: Microbiology				
Year/level: 2	**Optional/compulsory:** Optional	**Number students:** No data	**Number lectures:** 1	**Plant pathology practicals?** Yes
University of West of Scotland				
Search method: Phone and email	**BSc degree course:** Applied Bioscience		**Plant pathology teaching?** No	
University of Westminster				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** No data	

Appendix II: Data on plant pathology teaching

Prior to publication all HEI for whom teaching data were to be published were contacted, and given the opportunity to update or correct the data presented.

University of Wolverhampton				
Search method: Phone and email	**BSc degree course:** Biological Sciences		**Plant pathology teaching?** No	
University of Worcester				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
Module title: Infectious Agents and Allergens				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 35	**Number lectures:** 14	**Plant pathology practicals?** Yes
Search method: Phone and email	**BSc degree course:** Horticulture		**Plant pathology teaching?** Yes	
Module title: Plant Breeding and Gene Technology				
Year/level: Year 2	**Optional/compulsory:** Optional	**Number students:** 12	**Number lectures:** 8-10	**Plant pathology practicals?** Yes
University of York				
Search method: Phone and email	**BSc degree course:** Biology		**Plant pathology teaching?** Yes	
Module title: No data				
Year/level: Year 3	**Optional/compulsory:** Optional	**Number students:** 20	**Number lectures:** 1-2	**Plant pathology practicals?** No data
Writtle College, Essex				
Search method: Phone and email	**BSc degree course:** Horticulture		**Plant pathology teaching?** Yes	
Module title: Plant Protection Science				
Year/level: Year 2	**Optional/compulsory:** Compulsory	**Number students:** 45-50	**Number lectures:** 6	**Plant pathology practicals?** Yes
Module title: Crop Growth and Pathology				
Year/level: Year 3	**Optional/compulsory:** Compulsory	**Number students:** 45-50	**Number lectures:** 3	**Plant pathology practicals?** No data
Search method: Phone	**BSc degree course:** Agriculture		**Plant pathology teaching?** No data	

Appendix III:
HEI with plant pathology lectures

Prior to publication, all HEI for whom teaching data were to be published were contacted and given the opportunity to update or correct the data presented.

1-2 lectures	**3-6 lectures**	**7-12 lectures**	**>12 lectures**
Biology courses	Biology courses	Biology courses	Biology courses
Oxford Brookes University **Royal Holloway §** Sheffield Hallam University University of Derby University of Essex **University of York**	**Durham University** **Lancaster University** Liverpool Hope University **University of Exeter** **University of Glasgow** University of Hertfordshire **University of Leeds** **University of Liverpool *§** **University of Manchester** University of Salford * University of West of England	**Oxford University** Plymouth University * **University of Birmingham *** **University of Sheffield** **University of St Andrews**	Aberystwyth University Canterbury Christ Church University **Imperial College London** Newcastle University University of Aberdeen **University of Bath *§** **University of Bristol** **University of Cambridge** **University of East Anglia** **University of Edinburgh** **University of Nottingham** **University of Reading** University of Worcester
Forestry courses	Agriculture and Horticulture courses	Agriculture and Horticulture courses	Forestry courses
University of Cumbria	Harper Adams University Queen's University Scottish Agriculture College Writtle College	Bishop Burton College Myerscough College Newcastle University University of Worcester	University of Aberdeen Bangor University *

- Newcastle University, University of Aberdeen and University of Worcester are listed twice, for biology and agriculture/horticulture/forestry courses
- Four HEI have plant pathology teaching but were unable to give current lecture numbers: Askham Bryan College, Easton College, University of Dundee and the Royal Agricultural College
- HEI that contribute students to the Gatsby Plant Science Summer School are highlighted in bold
- HEI where staff numbers have been reduced through retirement are marked with a *
- HEI known to have a single plant pathologist are marked with a §

Appendix IV: HEI that contribute students to the Gatsby Plant Science Summer School

Durham University
Imperial College London
Lancaster University
Oxford Brookes University
Oxford University
Royal Holloway University of London
University of Bath
University of Birmingham
University of Bristol
University of Cambridge
University of East Anglia
University of Edinburgh
University of Exeter
University of Glasgow
University of Leeds
University of Leicester
University of Liverpool
University of Manchester
University of Nottingham
University of Reading
University of Sheffield
University of Southampton
University of St Andrews
University of Warwick
University of York

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