Project title:	Gooseberry: Plantation survey to determine the causal agents of individual branch & whole bush dieback or death and assessment of factors leading to greater incidence
Project number:	SF 131
Project leader:	Erika F. Wedgwood
Report:	Final report, March 2013
Previous report:	none
Key staff:	Erika Wedgwood, ADAS (Plant pathologist; project director, field & laboratory diagnosis) Sarah Mayne, ADAS (Plant pathologist; processing & isolate identification) Janet Allen, ADAS (Consultant & sampling). Chris Creed ADAS (Consultant & sampling). Harriet Roberts ADAS (Consultant & sampling). Ann Barnes, Fera (Isolate identification)
Location of project:	ADAS Boxworth, Boxworth, Cambridge, CB23 4NN The Food and Environment Research Agency, Sand Hutton, York, YO41 1LZ Gooseberry plantations W, Mid & S England
Industry representatives:	Name: Les Winsor Address: Hillside Farm, Chapel Lane, Willington, Tarporley CW6 0PH Name: Richard Stanley Address: Stanley & Pickford, Rectory Farm, Stanton St John, Oxford OX33 1HF
Date project commenced:	1 April 2012
Date project completed :	31 March 2013

DISCLAIMER

AHDB, operating through its HDC division seeks to ensure that the information contained within this document is accurate at the time of printing. No warranty is given in respect thereof and, to the maximum extent permitted by law the Agriculture and Horticulture Development Board accepts no liability for loss, damage or injury howsoever caused (including that caused by negligence) or suffered directly or indirectly in relation to information and opinions contained in or omitted from this document.

Copyright, Agriculture and Horticulture Development Board 2013. All rights reserved.

No part of this publication may be reproduced in any material form (including by photocopy or storage in any medium by electronic means) or any copy or adaptation stored, published or distributed (by physical, electronic or other means) without the prior permission in writing of the Agriculture and Horticulture Development Board, other than by reproduction in an unmodified form for the sole purpose of use as an information resource when the Agriculture and Horticulture Development Board or HDC is clearly acknowledged as the source, or in accordance with the provisions of the Copyright, Designs and Patents Act 1988. All rights reserved.

AHDB (logo) is a registered trademark of the Agriculture and Horticulture Development Board.
HDC is a registered trademark of the Agriculture and Horticulture Development Board, for use by its HDC division.
All other trademarks, logos and brand names contained in this publication are the trademarks of their respective holders. No rights are granted without the prior written permission of the relevant owners.

The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

Dr Erika F. Wedgwood
Research Scientist
ADAS

Signature .... Date ....

Report authorised by:

Dr Tim O'Neill
Horticulture Research Manager
ADAS

Signature .... Date ....

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

CONTENTS

© Agriculture and Horticulture Development Board 2013. All rights reserved

GROWER SUMMARY

Headline

- A range of fungal pathogens were found associated with gooseberry branch dieback and bush death.

Background and expected deliverables

For many years, a serious problem for commercial gooseberry growers has been the unexplained dieback of either single or multiple branches or death of gooseberry bushes, with symptoms often occurring around the first full cropping year (Figures 1 and 2). This occurs throughout the UK on all current commercial gooseberry cultivars, apparently regardless of plant type or husbandry. As a result, some growers have held back from expanding their crop area despite an increase in demand for the fruit from all markets. Growers have struggled to control losses, often not knowing what pathogen is involved, although both soil (e.g. *Phytophthora* or *Verticillium* spp.) and air-borne fungal infections (e.g. *Eutypa* or *Phomopsis* spp.) are considered to be potential causes.

Figure 1: Whole bush death. No buds break in spring, or start to open and are killed.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Figure 2: Dieback of some branches. In May buds fail to break on some branches, whilst other branches look healthy or may develop smaller leaves. Between June to August: leaf wilting develops on some branches

The aim of this project was to sample a number of cultivars from gooseberry plantations across England, and to survey the range of husbandry techniques used, in order to see what fungi are present in bushes affected by dieback. Knowledge of the incidence of affected bushes and any particular distribution in the field could aid replanting decisions. Information on the presence or absence of particular fungal infections and the way the bushes were being grown and maintained was examined in order to identify any practices being carried out that might be either detrimental or beneficial to the health of plantations.

Summary of the project and main conclusions

Survey of symptoms

Whole gooseberry bushes from a range of current major commercial cultivars were collected from six fruit farms between May and September 2012, according to when the wilting or die-back symptoms became apparent. A further two farms were surveyed, but not sampled. The incidence and severity of the dieback or bush death was assessed and detailed information on the crop husbandry was recorded with the assistance of each grower. Ongoing loss of bushes was reported from all sites. Fourteen samples of dieback from 11 plantations were examined in the laboratory at ADAS Boxworth. Sampled bushes were selected to be typical

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

of the symptoms in each plantation. Symptoms on stems and roots were recorded before and after tissue was cut out for further diagnosis. The initial location of tissue damage leading to the disruption of vascular function varied between samples. Substantial main stem staining or girdling, or root rot had often occurred, with sudden branch dieback happening often at the time when there was either leaf expansion or fruit swelling on other branches on the same bush. In re-visited plantations, two months after sampling bushes with dieback, other bushes from the same plantation were nearly dead. The proportion of bushes with dieback ranged between 15 to 30% in six plantations, and 2 to 7% in another five. Plantations sampled were of the cultivars Invicta, Careless, Pax and Leveller and ranged from one to ten years old. Symptoms had either been observed in plantations not long after planting, or tended to be noticed two to four years later (Table 2).

Fungi associated with dieback

Various pathology techniques were utilised to culture potential pathogens and a large number of different fungi were isolated (Tables 1 and 2). Many fungi were likely to have been secondary colonisers of wounds caused by physical damage, for example *Fusarium* species. Other fungi were probably invading tissue caused by primary pathogens of woody tissue that can be difficult to isolate. There are difficulties in pathogen diagnosis of woody tissue damage because the primary pathogen often grows on further along the stem without initially causing symptoms, leaving the visibly damaged tissue to become colonised by other fungi. Diagnosis of causal fungi was problematic, as many fungi were isolated from inside the stained stem and rotted rot tissue (in particular several differently coloured species of *Fusarium*), and all may have contributed to the main stem and branch rotting and root rots. Symptoms could be categorised into six types depending on the location and internal or external appearance of the tissue damage (Table 1).

Table 1: Summary of gooseberry dieback symptom types and associated potential fungal and Oomycete pathogens on 14 samples – 2012

Symptom type	Associated fungi / Oomycetes	Number of samples with this symptom*
1. Root rot	*Phytophthora, Pythium, Fusarium, Cylindrocarpon*	7
2. Collar rot	*Phytophthora, Pythium, Fusarium*	3
3. Internal stem canker	*Fusarium*	11
4. Main stem wood staining	*Phytophthora, Eutypa,*	8
5. Twig bleaching	*Leptosphaeria,* other pycnidial fungi	13
6. Collapse of new shoot	*Botrytis*	1

* Bushes frequently had more than one symptom, and one sample was of twigs only.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Table 2: Incidence of branch dieback and whole bush death in surveyed gooseberry plantations in 2012 and apparent primary source of dieback on sampled bushes

Bush cultivar	% bushes with die-back	% whole bushes dying	% of total bushes	When dieback was first observed	Plantation age	Symptoms and diagnosis
Invicta	*	*	7-8%	From about 5 years ago	10 years	Stem rot from tying-back (*Fusarium*)
Careless	*	*	1-2%	Not sure	5-6 years	Main stem rot from tying-back (*Fusarium avenaceum*)
Careless	5	-	5%	After 4th year	10 years	Root rot (*Pythium, Fusarium*). Stem rot (*Eutypa* identified by Fera)
Invicta	7%	-	7%	After 4th year	8 years	Main stem girdling (*Pythium*, *Phytophthora* and *Fusarium*)
Leveller	20%	-	20%	*	*	New shoot wilt (*Botrytis, Fusarium*)
Pax	30%	20%	50%	Over the last 3 years	5 years	Root (*Phytophthora* and *Cylindrocarpon*) and stem base rots (*Phytophthora*)
Invicta	5%	1%	5-6%	2-3 years after planting	3 years	Stem rot via wounds (isolate under Fera review)
Invicta	-	20%	20%	not long after planting	1 year	Root rot (*Fusarium*)
Invicta	-	15%	15%	not long after planting	2 years	Root rot (*Cylindrocarpon*)
Invicta	5%	-	5%	mainly after 4 years, some before	4-5 years	Stem rot via pruning wound
Invicta	10%	2%	12%	2-3 years after planting	5 years	Not sampled
Invicta, Hinnon-maki Red & Yellow	5%	2%	7%	2-3 years after planting (branch), 3-4 years (death)	6-7 years	Not sampled. Invicta more susceptible than either Hinnonmaki Red or Hinnonmaki Yellow

Plantations shown shaded together were on the same farm. * Information not provided for this plantation of Leveller.

© Agriculture and Horticulture Development Board 2013. All rights reserved

Staining in the wood that resembled *Verticillium* infection (mottling of the vascular tissue, or a stained vascular ring) and wedge-shaped sectors typically associated with *Eutypa* entry at wounds were seen, however neither pathogen was isolated from these tissues. *Fusarium* sp. was isolated from a V-shaped internal stem lesion and *Eutypa* sp. was instead isolated from diffuse grey xylem (wood) staining. Internally stained woody stems commonly occur following *Botrytis*, *Botryosphaeria* or *Phomopsis* infection (for example in blackcurrant bushes), but these pathogens were not isolated from staining inside gooseberry stems. The pathogen *Fusarium avenaceum* was isolated from black stem staining. *Botrytis cinerea* rot was only seen on green shoots of gooseberry. Pycnidia, including *Leptosphaeria sp*., were present on twigs of most bushes, but could have been secondary in twigs already stressed by tissue death lower down the stems. No *Phomopsis* sp. was isolated from pycnidia.

Phytophthora occurred in some bushes, sometimes causing brown rotting on part of the root system and leading to branch death on that side of the bush. Stem staining by *Phytophthora* root rot produced either a diffuse grey or mottled brown discolouration, with some more concentrated areas, deep in the wood leading up from the roots. Girdling and loss of bark (collar rot) also arose from local *Phytophthora* infection. One sample had severe collar rot, with *Pythium* sp. (normally considered to be a weak pathogen) as well as *Phytophthora* sp. isolated from the softened-bark main stem. Severe root rot from *Phytophthora* was identified leading to the loss of lengths of row. *Cylindrocarpon destructans* was found in some other rotted roots, but was also isolated from apparently healthy roots.

Lateral flow device kits, as available to growers, were utilised to diagnose the presence of *Phytophthora* and *Pythium*. Some isolates from main stem and branch internal staining and twig fruiting-bodies were sent to a second laboratory, The Food and Environment Research Agency (Fera), for further examination or molecular diagnosis. As well as the stem dieback pathogens *Eutypa* and *F. avenaceum*, isolates included *Paecilomyces* and *Ulocladium* which are saprophytic (not pathogenic) fungi.

Distribution of affected bushes within rows

At five sites, all bushes in three adjacent rows were assessed to determine if there was any particular spatial distribution of affected plants. Symptom development on individual bushes between bud break and fruiting was monitored on two of these farms. Some grouping of dieback bushes occurred, but they were equally likely to be scattered singly in rows anywhere along the lengths. At other sites where root rot, rather than initial stem damage was reported, there were clusters of infected plants along the rows.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Starting points for infection and symptom development

The development of branch wilting was attributed to the following sources:

- Staining in die-back branches was frequently traced back to the main stem, rather than from any damage or infection at the site of wilting;
- Browning from branch stubs, leading down into the main stem, was often a source of infection;
- Twisting of main stem or pulling back of branches to wires is likely to have caused stress cracks allowing pathogen entry and gradual rotting over several years;
- Root rotting caused wilting in the same way as direct main stem infection;
- Healthy vascular tissue often remained on one side of the main stem to allow leaves to emerge, but branches on the affected side of the main stem received insufficient water in hot weather (particularly during fruiting) and wilt followed suddenly.

Husbandry practices

Husbandry surveys were collated and examined in relation to the various types of damage and potential pathogens found in samples. Two surveys were completed by growers in addition to those where samples were taken. The range of damage locations on bushes and potential pathogens recorded was too diverse to allow matching of practices to problems across several sites. No particular good or bad practices were identified – all growers had losses and it was only particular bushes that showed symptoms amongst others given the same management. One bush-specific management activity, which would justify further investigation, is plant management at planting. At this time, if branches are pulled back under tension to wires or pruned off then a slow canker can develop. Similarly, sharply bending the roots of transplants to fit the planting hole could allow entry of ubiquitous soil fungi and these can slowly reduce root area and rot can spread up into the main stem. It is also possible that when bushes are pruned in winter wounds are slower to heal and these may become infected, particularly if the bush is pruned with tools used to cut out infection in other plants.

Financial benefits for growers

There are an estimated 180 ha of gooseberries in the UK with a market price range of £3,000 to £4,800 per tonne. Given a yield of 10 tonne/ha, the farm-gate value of the gooseberry crop in the UK is probably around £5.4 to £8.6 million. One of the main reasons that the UK market share for gooseberries has been unable to expand has been the loss, or fear of loss, of bushes to dieback. Growers have stated that there are demands for both

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

fresh and processing which cannot currently be met by British grown Assured Produce fruit. There is also a buoyant market for this crop via PYO, farm shops and other direct-from-farm retail outlets. If dieback could be reduced the production of gooseberries could be increased to meet the demand.

Growers have previously reported that on average 5-10% of their bushes once established and fully cropping (especially cv. Invicta) die and another 5 to 10% of bushes suffer dying back of one or two branches (either failing to break bud or wilting and dying between bud burst and the start of harvest). This means that if losses due to dieback are on average 10% per annum then the problem could be costing the industry £540,000 to £860,000 per annum.

Action points for growers

- All pathogens detected in this work can be carried in or on planting stock, so if producing your own stock, ensure cuttings taken are only from visibly healthy plants and if any problems develop get them diagnosed;
- Plant cuttings in soil without previous root problems or crop debris, or use fresh growing media and stand pots / trays off the soil;
- Examine planting material for root death (a Lateral flow device can be used to confirm *Phytophthora*) and for cankers where stems have been pruned off – do not plant affected plants;
- Wherever possible, do not plant gooseberry in fields where *Phytophthora* or *Verticillium* was present in previous crops, as their resting bodies survive many years in the soil;
- *Eutypa* enters the vascular system at wounds so it is advisable to prune during the growing season, when wounds are more likely to heal quickly, rather than in November;
- Many other fungi colonise wounds, especially if wounds are open in mild humid weather, so growers should minimise pruning or do it when it is dry;
- Pathogens can be carried on pruning tools so aim to sterilise tools in the field after working on diseased tissue;
- When tying branches to wires, aid to avoid straining them and avoid creating wounds as these allow pathogen access;
- Clear away pruning material from crops as soon as possible and destroy it so that spores cannot spread from infected debris to the crop;

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

- Utilise information on the symptoms and lifecycles of the main pathogens of gooseberry and control measures available in the HDC Gooseberry Grower Guide.

© Agriculture and Horticulture Development Board 2013. All rights reserved

SCIENCE SECTION

Introduction

Background

There are an estimated 180 ha of gooseberries in the UK with a market price range of £3,000 to £4,800 per tonne. Given a yield of 10 tonne/ha, an average value of £39,000/ha, the farm-gate value of the gooseberry crop in the UK is probably around £5.5 to £8.6 million. One of the main reasons that the UK market share for gooseberries has been unable to expand has been the loss, or fear of loss, of bushes to dieback. Growers have stated that there are demands for both fresh and processing which cannot currently be met by British grown Assured Produce fruit. There is also a buoyant market for this crop via PYO, farm shops and other direct-from-farm retail outlets. If dieback could be reduced the production of gooseberries could be increased to meet the demand.

Gooseberry bushes should survive over 20 years, but there are currently significant incidences of premature losses (within three or four years of planting). Plants appear healthy at planting and appear to establish satisfactorily, but dead branches and/or bushes occur within a few years. Quite often there is a sudden collapse of gooseberry bushes in June and July. Growers questioned prior to this project reported that, once established and fully cropping, on average 5-10% of their bushes (especially cv. Invicta) die and another 5 to 10% of bushes suffer dying back of one or two branches (either failing to break bud or wilting and dying between bud burst and the start of harvest). This means that if losses due to dieback are on average 10% per annum then the problem could be costing the industry £595,000 to £665,000 per annum.

The problem occurs throughout the UK, with reports from across the small range of current commercial cultivars of gooseberry, on a range of types of planting material. Soil type and crop husbandry, including method of bush training or timing of pruning employed, have been considered as potential influences in bush susceptibility. Over the years growers have adopted a range of training and husbandry practices (e.g. summer pruning and training upon a trellis) in part in an attempt to lessen the impact of dieback, but with no apparent success. However, until the current project there had been no survey to enable these and other husbandry measures to be examined in relation to the prevalence of the problem in particular plantations.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

A number of foliar or stem pathogens are capable of causing dieback in gooseberry (*Ribes uva-crispa*), other Ribes species and other woody crops; for example *Eutypa lata*, *Diaporthe strumella* (*Phomopsis*)*, Nectria cinnabarina, Botrytis cinerea, Botryosphaeria ribis, Chondrostereum purpureum* (Gardner, 1977; Munkvold, 2001; Anon, 2008, HDC Gooseberry grower guide)*.* It is possible that *Diaporthe strumella* (*Phomopsis*) (which is being reported from blackcurrants with similar dieback symptoms) may be a further contributor to losses from gooseberry dieback. *Phomopsis* also causes die-back in grapes (Erinick *et al.*, 2003; Nita *et al.*, 2007). Pathogens may arrive with planting stock (UK origin gooseberry planting material is in short supply and as a consequence much is imported from Poland and Belgium) or infect in the field, particularly via wounds. Symptoms such as cankers leading to dieback can take several seasons to become visible on woody material.

If soil-borne pathogens such as *Verticillium* or *Phytophthora* are introduced with the plants at the time of planting, wilting may not occur until some time later, following the stresses of lifting from the propagation bed and replanting and the movement into an environment favouring disease development. Commercial fruiting plantations of gooseberries are often on sites rejected for strawberry or cane fruit production because the soil contains an unacceptably high level of inoculum of soil borne pathogens. However, what levels of soil inoculum provide particular risks of plant loss in gooseberries is unknown.

Once the symptoms and identity of particular pathogens have been recognised in a plantation then treatment in the current crop, or avoidance in future crops, can be planned. Husbandry procedures related to an understanding of the pathogen epidemiology are likely to play a part. Eutypa dieback occurs on grapevines, apple and currants, but there is no treatment currently available in the UK. In other EU countries various products have been investigated on grapevines and some shown to help control, including the biological control agent *Trichoderma.* HDC project SF12-226 is investigating fungicide (including the biofungicide Prestop (*Gliocladium catenulatum)* efficacy against Phomopsis dieback on blackcurrants. In grapevine, research has shown that weather conditions affect infection by *Phomopsis* and forecasting has been used to regulate fungicide application intervals. There is scant published or “grey” literature on gooseberry dieback and, although pathogen information from other crops is likely to be useful in gooseberry cultivation, crop-specific development work will be required to ensure the best measures are put in place.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Project aim

To determine the incidence, severity and causal pathogens of the dieback of branches or the sudden death of gooseberry plants in commercial fruiting plantations and provide information towards managing the losses.

Project objectives

Objective 1

- To evaluate the extent of loss of branches and/or bushes in a sample of established commercial fruiting plantation
- To note the locations, varieties and husbandry of affected and unaffected gooseberry plants and the nature of the symptoms
- To follow the development of symptoms over a year on a selection of bushes
- To sample affected tissue, record the symptoms and damage distribution on the bush, and determine the fungal pathogens present

Objective 2

- To carry out surveys of plantation management practices

Objective 3

- To utilise site sample and survey information to produce guidance on where changes in management or awareness of site conditions could lead to reduced dieback and bush death

Methods

Objective 1: Incidence, distribution and severity of dieback in plantations

Visits were made during 2012 to six farms with commercial fruiting gooseberries. Initial visits were timed to be able to record and sample whole bushes (including roots) whose branches had either failed to produce new leaves after the winter or where leaves were dying soon after emergence. From one to three bushes were sampled from each farm to obtain material with symptom/s typical of the site. Care was taken to use clean tools when digging up sample bushes to avoid introducing any pathogens. The bushes selected were checked in-field for *Armillaria*, *Phytophthora* root rot and coral spot (*Nectria cinnabarina*). The proportion of bushes with dieback, and/or which were dying, was estimated and any particular distribution pattern of the affected bushes noted both within the row and across each plantation. Photographs were taken. Where bushes had several wide branches it was

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

necessary to cut them from the bush to fit in the sack, but ensuring that it was possible to match up the cut end. In total thirteen bushes and the shoots from a fourteenth bush (BX 12/54) were dispatched for next day arrival at ADAS Boxworth.
On one farm in southern England (source of BX 12/42 cv. Invicta) all the bushes within three adjacent crop rows of the same variety were each categorised as: healthy, with dieback or dead. Any gaps (which were probably from grubbed out bushes) were also recorded. When dieback and death had reached its peak for the growing season, a repeat visit was made to the surveyed rows. The same row recording procedure was carried out on a farm in the west of England in three plantations (sources of BX 12/50 cv. Careless, BX 12/51 cv. Invicta & BX 12/54 cv. Leveller). A single survey of three rows was also carried out on cv. Invicta on a farm in the south Midlands (source of BX 12/61 & BX 12/78).

Records were taken of externally visible symptoms such as leaf wilting (including an estimate of the % of the bush affected) and the extent of any internal staining or rotting revealed on sectioning the roots or stems. Each bush received a plant clinic number (BX 12/…..). Isolations, or incubations of the intact plant material, were carried out as appropriate to determine the possible causal pathogens. Incubations were carried out at 20°C under 16 hours illumination per day. Some direct microscope examination of sectioned tissue was also made where pycnidia were already present. The focus of this work was to identify the main groups of fungi associated with dieback and bush death, resources were not available to identify each isolate to species level. Selective agars and specific techniques were used in order to favour the growth of fungal species which can cause die-back such as *Phomopsis, Botrytis, Eutypa, Nectria, Armillaria*, *Verticillium* and *Phytophthora* species (see Appendix 1). Detailed records were made of the fungal colonies (colour on agar, aerial mycelium type and any microscope study of spores) which grew from the different pieces of sample tissue and these were compared with descriptions from various reference sources. The plates and sub-cultures were re-examined over several months to be able to record fruiting bodies which required an extended period of development. Lateral flow devices for the Oomycetes *Phytophthora* and for *Pythium* species were utilised (Pocket Diagnostic kits manufactured in the UK by Forsite Diagnostics, Sand Hutton, York, YO41 1LZ). Ten fungal isolates (not Oomycetes) were sent to the Fera plant clinic to see if their identity could be determined.

Objective 2: Plantation survey

A survey form was prepared (Appendix 7) for use by the visiting ADAS consultant. Information was obtained from growers about the history and maintenance of the plantation, including any fungicide usage. Where fields/plantations on a farm had different histories or husbandry then a separate survey form was completed. The survey included quantification

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

of the proportion of bushes with one or more branches dying-back and the proportion of whole bushes dying. Survey forms were also completed by a number of growers who had experienced loss of gooseberry bushes, but who were not included in the sample collection.

Objective 3: Knowledge transfer

The site sample and survey information was utilised to look for similarities in e.g. husbandry (cultural and chemical), bush age and between infected, less affected and uninfected varieties. Consideration was given to where changes in management or awareness of site conditions could lead to reduced dieback and bush death. Descriptions and photographic images of the main symptoms observed and any causal pathogens identified have been included in the report to guide any future sampling and diagnosis by growers.

Results

Objective 1: Symptoms and associated fungi

Gooseberry bushes will be affected by weather conditions that either cause drought stress, waterlogging or freezing. 2011 was an exceptionally dry year in most parts of England, particularly the South and East. The winter was not unusually severe (unlike 2010/11). After unusually hot weather in April 2012 and a late frost in May, in many areas the year became exceptionally wet (with floods) across the whole of England.

The commonest variety sampled was cv. Invicta, with bushes ranging from one to 10 years old (Table 3). From the eight husbandry questionnaires, most gooseberries are planted as one or two year old bare-root plants (field grown), with the use of pot-grown or direct sticking of cuttings being uncommon. Most plants thus have up to a couple of years growing in another location on the farm or in the nursery of a propagator. Dieback or plant death can be noticed a couple of years after planting, although in the two 10 year old plantations in the survey it was five to six years before problems were reported (Table 4).

Bushes sampled were selected to be representative of the symptoms in the plantation at that time. Some bushes sampled once leaves should have been fully emerged had already lost 75% or more of their canopy to dead shoots (e.g. BX 12/50 and BX 12/59) rather than there being more recent leaf wilting (e.g. BX 12/42 and BX 12/51). Wilting could affect over 50% of the bush, but was normally less initially. Bushes from plantations sampled in May and June, plus one sampled in August, had dieback or wilting on one or more branches, leaving one or two branches that were principally unaffected, rather than there being either failure to break bud or wilting across the whole bush.   This mixture of healthy and dead/dying branches in

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

the first half of the year applied equally to bushes that had stem damage as to those that had root rot (Table 2). It was not possible from the initial appearance of the bush stems (before probing tissue) to say where the location of the original damage was that had led to branch death or leaf wilting. For example, BX 12/51 had healthy roots but the main stem was being girdled by a rot that had caused one branch to fail in 2011, another to appear healthy, but the third branch to be producing shorter shoots. BX 12/58 had *Phytophthora* root rot and similarly had one healthy branch, one with small, wilted leaves and two branches that had not grown in the current year.

Table 3: Locations of 14 gooseberry plantations sampled across England and sample reference codes, bush ages, varieties and sample dates - showing the proportion of the bush that had died (no green tissue), and the proportion of leafed branches which had wilted

Sample code	Location	Bush age	Variety	Sample date	% Dieback of bush	% Wilt of bush
BX 12/42	S. England	10 yrs	Invicta	22.05.12	2	50
BX 12/44	E. England	5-6 yrs	Careless	06.06.12	5	all, by arrival**
BX 12/50	W. England*	10 yrs	Careless	19.06.12	80	20
BX 12/51	W. England*	8 yrs	Invicta	19.06.12	15	75
BX 12/54	W. England	not recorded	Leveller	19.06.12	n.a.	wilting shoots
BX 12/58	S.E. England 1	5 yrs	Pax	27.06.12	45	5
BX 12/59	S.E. England 1	5 yrs	Pax	27.06.12	75	1
BX 12/61	S. Midlands*	4 yrs	Invicta	29.06.12	5	0
BX 12/72	S.E. England 2	1 yr	Invicta	21.08.12	0	0, all reddish
BX 12/73	S.E. England 2	1-2 yrs	Invicta	21.08.12	25	75
BX 12/74	S.E. England 2	5 yrs	Invicta	21.08.12	25	5
BX 12/78	W. England*	8 yrs	Invicta	28.08.12	100	no leaves
BX 12/79	W. England*	10 yrs	Careless	28.08.12	100	no leaves
BX 12/81	S. Midlands*	4 yrs	Invicta	05.09.12	80	all, by arrival **

*These plantations were sampled in June 2012 and in late August/early September 2012

**The leaves on BX 12/44 & BX 12/81 were thought likely to have wilted in the post.

© Agriculture and Horticulture Development Board 2013. All rights reserved

Table 4: Plantation survey results: Incidence of branch dieback and whole bush death in 2012
Primary symptoms and potential causes of dieback following laboratory diagnosis of gooseberry bushes sampled from the plantations

Farm location (ADAS site surveyor)	3-row survey in this crop	% bushes with die-back	% whole bushes dying	% of total bushes affected	When dieback was first observed	Plantation age & size	Bush sample codes & cultivar	Symptoms and diagnosis
S. England 1 (J. Allen)	Yes	*	*	7-8%	From about 5 years ago	10 years 0.5 ha	BX 12/42 Invicta	Stem rot from tying-back (*Fusarium*)
E. England (J. Allen)	No	*	*	1-2%	Not sure	5-6 years 0.7 acres	BX 12/44 Careless	Stem rot from tying-back (*Fusarium avenaceum*)
	Yes	5	-	5%	After 4th year	10 years 0.5 ha	BX 12/50 & 79 Careless	Root rot (*Pythium, Fusarium*). Stem rot (*Eutypa lata*)
W. England (C. Creed)	Yes	7%	-	7%	After 4th year	8 years 0.5 ha	BX 12/51 & 78 Invicta	Main stem girdling (*Pythium* and *Phytophthora*)
	Yes	20%	-	20%	*	*	BX 12/54 Leveller	New shoot wilt (*Botrytis, Fusarium*)
S.E. England 1 (H. Roberts)	No	30%	20%	50%	Over the last 3 years	5 years 2 ha	BX 12/58 & 59 Pax	Root (*Phytophthora* and *Cylindrocarpon)* and stem base rots (*Phytophthora*)
S. Midlands (J. Allen)	Yes	5%	1%	5-6%	2-3 years after planting	3 years 0.25 ha	BX 12/61 & 81 Invicta	Stem rot, possibly via wounds (isolate under Fera review)
	No	-	20%	20%	not long after planting	1 year 0.47ha	BX 12/72 Invicta	Root rot (*Fusarium*)
S.E. England 2 (E. Wedgwood)	No	-	15%	15%	not long after planting	2 years 0.55 ha	BX 12/73 Invicta	Root rot (*Cylindrocarpon destructans*)
	No	5%	-	5%	mainly 2012, some before	4-5 years 0.7ha	BX 12/74 Invicta	Stem rot via pruning wound
S. England 2 (J. Allen)	No	10%	2%	12%	2-3 years after planting	5 years 0.6 ha	no sample	-
E. Midlands (J. Allen)	No	5%	2%	7%	2-3 years after planting	6-7 years 0.6 ha	no sample	-

* Information not provided; - Symptom either not reported by grower or no sample provided.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Table 5: Plantation survey results: Bush training and pruning carried out in gooseberry plantations

Location & ADAS contact	Bush management	When is post-harvest pruning carried out?	Is Summer pruning carried out?
S. England 1 (J. Allen)	On trellis, fan trained	September - October just as the current season's growth has come to an end	Yes, current season's growth cut back whilst actively growing to approx 30-50% its length just prior to onset of picking the fruit.
E. England (J. Allen)	Not reported	Jan or Feb every 2 to 3 years	No
W. England (C. Creed)	Free standing on a good leg, 0.3 m plus	Oct Nov then on and off through winter, good strong growth used for cuttings.	No
S.E. England 1 (H. Roberts)	Trained onto posts and 4 wires, fan training 4 to 5 branches on to wire using raspberry clips and wire ties	Any wide branches are hedge cut after harvest in June/July	Shark (carfentraxone-ethyl) used to control new growth from base of plants in April/May.
S. Midlands (J. Allen)	On trellis, fan trained	In January or February	Yes, using a hand held hedge cutter just prior to onset harvest. Current season's growth reduced to half or one third its length on either side of the rows but tops of bushes left intact.
S.E. England 2 (E.Wedgwood)	Two legs onto wire with leader.	November onwards.	Not done unless pruning dead plants.
S. England 2 (J. Allen)	Bushes branch from a 0.3 to 0.4 m leg. As bushes grow leader branches are selected and trained back onto wires	Feb-March prior to bud break. Dead, damaged or diseased branches removed. New basal growths selected and trained to replace old fruiting branches. Oldest or weak fruiting branches removed.	Just prior to harvest, hand held hedge cutter used to cut back 30-50% of new growth to expose fruits, improve air flow, and improve coverage of sprays applied. During the growing season all basal shoots removed annually via hand cutting/pulling/application of contact herbicide when very small
E. Midlands (J. Allen)	Free standing on short leg 0.3 to 0.45 m. Bush tops pruned to have an open centre (open goblet shape).	They are generally pruned in the autumn i.e. September as soon as the leaves start to fall	No

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Internal stem browning causing dieback

All the samples with internal brown areas (with dense staining in the outer stem tissue and penetrating inwards) and healthy roots could trace the origin of the decay to an opening in the bark. It was frequently seen that only a small area of the cross-section of a branch or trunk when cut through was still white. For example, BX 12/74 was sampled in August and had produced a full amount of leaves on one branch and then died. As it was sampled the branch broke away to show that three-quarters of the wood was dead. Damage to the main stem of BX 12/42 and branches of BX 12/44, BX 12/61 and BX 12/79 were all believed to have been caused by stress fractures from pulling the stems back to fix onto the training wires (although BX 12/79 was mainly affected by rotted roots). The farm in W. England (samples BX 12/50, BX 12/51 and BX 12/54) without this sort of damage does not fan train to wires. A primary pathogen, *Fusarium avenaceum,* was identified from the stem staining of BX 12/44 (by Ann Barnes, Senior Diagnostician – Mycology, Fera) and fungal entry may have been aided by the damage to the bark. As in BX 12/44, extensive black staining and rotting leading to bark cankering was also seen on the main stem of BX 12/78, from which a yellow-coloured Fusarium was also isolated (but not sent for identification). The internal branch browning on BX 12/74 of a branch with slight dieback originated below near where a stem had been pruned off at the top of the main stem. BX 12/81 was wounded on the main stem with browning coming in from it and this was probably of greater importance to the plant than having some rotten roots as it was producing new shoots separate to the original bush.

A symptom distinct from the “stress” wounds occurred on the cv. Invicta samples from W. England, where the bark was coming away from the main stem (in the case of BX 12/51 the bark was soft) with dark staining girdling it underneath and spreading upwards. The roots were healthy (BX 12/51) or nearly so (BX 12/78). An isolate from the stem staining of BX 12/78 was identified as a non-pathogenic fungus, *Paecilomyces* sp.*,* and so unlikely to have caused the primary damage.

In BX 12/50 there was diffuse staining across the inside of the main stem. It was thought to have originated from the rotting roots. However, an isolate from the stem was identified morphologically as *Eutypa lata* (by Fera). V-shaped sectoring of the stained tissue, when viewed in a cross-section of the stem, would more usually be seen with this pathogen.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Root browning

Samples from one of the farms in S.E. England (BX 12/58 and BX 12/59) had severe root rot, with positive Lateral Flow Device (LFD) tests for *Phytophthora* from the roots and stem base. A mottled staining with darker areas carried up into the main stem. The bushes were formed from four or five branches coming direct from the roots. The dead branches were completely brown, and the branches with small leaves or starting to wilt had a brown ring inside. A partial brown ring was visible in the branch cross-section in the apparently healthy branches. A stem isolate from BX 12/59 sent to Fera was identified as non-pathogenic *Paecilomyces* sp*.,* and so the primary causal fungus was not determined.

In some cases (e.g. BX 12/81) there appeared to be a good root system, but once cut open the tissue was seen to be black and rotten. In three samples (BX 12/50, BX 12/73 and BX 12/81) it appeared as if the roots had been pushed into a small planting hole as they were bending upwards rather than being spread out. This would have reduced the bushes' ability to take up water from deeper below the soil surface and wounded roots would allow entry of various organisms to feed. The rotted roots from these bushes (in contrast to BX 12/58 and BX 12/59) did not have *Phytophthora* sp. infection. BX 12/50 roots had *Pythium* sp. and *Fusarium* sp. BX 12/73 had *Cylindrocarpon destructans* and nothing positive was found in the roots of BX 12/81.

Table 6: Symptoms recorded on gooseberry samples following dissection in the laboratory

Sample No.	% Dieback of bush	Internal brown areas in stem	Internal diffuse staining in stem	Main stem bark girdling	Root rots	Pycnidia on 2011 twigs
BX 12/42	2	**Y** at crack	Y	N	N	Y
BX 12/44	5	**Y** at crack	N	**Y**	N	Y
BX 12/50	80	N	**Y**	N	**Y** bent	Y
BX 12/51	15	Y	N	**Y**	N	Y
BX 12/54	n.a.	n.a. green shoot only	N	soft brown shoot base	n.a.	n.a.
BX 12/58	45	Y	Y	N	**Y**	Y
BX 12/59	75	Y	Y	N	**Y**	Y
BX 12/61	5	**Y** at crack	N	N	N	Y
BX 12/72	0	Y slight	Y stem base	N	**Y**	Y
BX 12/73	25	N	N	N	N + **Y** bent	Y
BX 12/74	25	**Y** at pruning	N	N	N	Y
BX 12/78	100	Y	N	**Y**	N, a few Y	Y
BX 12/79	100	Y at crack	Y	N	**Y**	Y
BX 12/81	80	**Y** at wound	Y	Y	N + Y misshapen	Y

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

The damage believed to be the principal cause of dieback is underlined for each sample.

Whitened twigs with pycnidia

All bushes had whitening of the one year old (2011) twigs which showed up black specks of fungal fruiting bodies (Table 6). These were principally pycnidia, i.e. the asexual phase of a fungus with spores usually released in a cirrhus (in a mass squeezed out through a pore) in wet weather. Spores with three cross-walls resembling those of *Leptosphaeria coniothyrium* (cane blight) and some single-walled spores were seen but not identified. No *Phomopsis* sp. or *Diaporthe* sp. spores were seen in the fruiting bodies. Not all bodies were mature enough to have produced spores. Isolates from twigs of BX 12/73 and BX 12/81 were sent to Fera laboratories. The isolate from BX 12/81 was identified as non-pathogenic *Ulocladium* sp.. The tissue was green under the white epidermis and it appeared that, although pycnidia often tend to form in whitened areas, all the whitening was not related to disease. There were sometimes dead buds in the whitened areas, but it was usually found that there was damage leading to a loss of vascular flow (water and nutrients) in the older part of the stem which could have caused the bud or young shoot death. Summer pruning pre-harvest was carried out where BX 12/42 was collected, but the substantial area of whitened 2011-growth twigs with pycnidia and no 2012 growth, was on the one branch that was stained internally at its base following main stem damage and internal browning. The wilt of leaves which emerged on the 2011 twigs and failure to produce any new extension shoots was likely to have followed the main stem damage. Pruning of current season twigs might only have facilitated fungal surface colonisation of the weakened twig growth. An exception was in one sample where cutting under the bark around a dying shoot showed browning that resembled that described for *Botryosphaeria* spp., but a confirmatory isolate was not obtained. Pink coloured colonies of *Fusarium* were isolated from affected bud tissue without pycnidia, but the fungi were not identified to species level and could have been secondary colonisers.

The results for individual gooseberry bush samples are detailed on the following pages.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

BX 12/42. Dieback of one branch above crack across main stem and around stub
cv. Invicta, 10 years old, Southern England

In late May, one stem had healthy leaves and fruit. The second stem had no 2012 twig growth, wilted leaves and pycnidia on 2011 branches, with red staining 100 mm up from main stem fork. At the main stem Y fork there was a stained third stub, then staining for 200 mm down inside the main stem with the largest amount of browning where the main stem was twisted open (with some bark grown inwards). Many fungi were isolated, including a white-coloured *Fusarium*. The roots were healthy, although a red-coloured *Fusarium* was isolated.

Images

1. Affected wire trained bush prior to sampling
2. Pycnidia found on pale upper twigs
3. Cross section of upper branch showing v-shaped staining
4. Main stem cross section showing v-shaped staining

1

2

3

4

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

BX 12/44. Branch dieback following wounding of the main stem cv. Careless, 6 years old, Eastern England

In early June this bush had both healthy (fruiting) and dead branches. Twigs from 2011 were white, with pycnidia. There was staining in the main stem which appeared to have entered at the point where the bush was trained to a wire. A yellow-coloured *Fusarium* sp. was isolated from the stem browning and subsequently identified (by Fera) as the pathogen *Fusarium avenaceum*. The roots were healthy, with no fungi isolated.

Images

1. Main stem damage from external injury
2. Black wood staining and dying wood at point of damage
3. V-shaped staining across one side of main stem (*Fusarium avenaceum* isolated)

1

2

3

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

BX 12/50. Sudden death of all branches following root rot. Eutypa lata present in stem
cv. Careless, 10 years old, Western England

In mid-June all three branches of this bush had dieback. New shoots had grown 20 - 10 mm and then wilted before leaf expansion. Some dwarfed expanded leaves and small desiccating fruit present. Staining was found in the main stem. Roots were soft and black.

Images

1. Bush in field with 80% dieback, and the remainder wilting
2. Circular stem staining (*Eutypa lata* isolated)
3. 2012 growth and fruit showing rapid dieback
4. Main root bent, blackened and rotted (LFD for *Phytophthora* –ve, *Fusarium* present)


1


2


3


4

© Agriculture and Horticulture Development Board 2013. All rights reserved

BX 12/51. Collar rot of main stem. Roots healthy
cv. Invicta, 8 years, Western England

In mid-June, this bush had extensive soft rotting which almost entirely girdled its trunk. Of three branches, one was dead (the buds did not open in the previous year). One of the other branches had short new shoots, with most leaves small or dying on the previous year's wood and a few tiny fruit. The third branch had two stems with healthy current season's growth, but one stem had slightly smaller leaves on the previous year's wood, with some leaves bronzing and others green but wilting. V-shaped staining was found leading from the rotten area on the main stem up into affected branches.

Images

1. Bush in field with dead arm. Pycnidia on whitened twigs (but only *Fusarium* isolated)
2. Branch of bush showing stunted leaves
3. Extensive main stem rot girdling 80% of circumference (*Pythium* isolated)
4. Main stem showing V-shaped lesions (Principally *Pythium*, but *Fusarium* also seen)

1

2

3

4

© Agriculture and Horticulture Development Board 2013. All rights reserved

BX 12/54. Botrytis soft rot
cv. Leveller, mature bushes, Western England

A few shoots were taken in mid-June from bushes with dieback. Some shoots had girdling soft rot, and all had a rot spreading up from the base at the junction with last year's growth.

Images

1. 2012 shoots which had produced normal leaf growth
2. Portion exhibiting wilting and browning (*Botrytis cinerea* and *Fusarium* sp. isolated)
3. Dying, rotting, branch bases (cherry-red, and pink-coloured, *Fusarium* spp.)

1

2

3

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

BX 12/58. Phytophthora root and stem rot
cv. Pax, 5 years old, South-Eastern England

This bush had one healthy branch (with fruit), but other branches had either grown little in 2010, not broken bud in 2011 or had produced leaves which were dying by June 2012. Roots had a soft black rot on the dead side of the bush; those on the other side were healthier. Vascular staining in the wood diminished in severity towards the upper branches.

Images

1. Bush in field trained to wire with one healthy side (left side)
2. Leaf browning and wilting
3. Brown staining in main stem cross-section just above roots
4. Circular vascular staining inside branch 100 mm above roots
5. Soft outer surface to rotted root (*Phytophthora* spp. confirmed by +ve LFD)

1

2

3

4

5

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

BX 12/59 Phytophthora root and stem rot
cv. Pax, 5 years old, South-Eastern England

This bush was from the same plantation as BX 12/58. It had four equally sized branches arising from two stems close to the roots, with extensive dieback and some wilted leaves. The least affected branch had bronzed leaves. Varying degrees of internal stem staining in a circular pattern was present in all stems. Stem base material tested +ve for *Phytophthora* spp. Roots had a soft black outer surface (*Cylindrocarpon destructans* isolated).

Images

1. Wire trained bush in field with extensive dieback
2. Leaf spotting, wilting and discolouration
3. Internal staining in all four branches (cut off 100 mm above the roots)
4. Partial rings of brown staining in the wood of main stems

1

2

3

4

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

BX 12/61. Die back after physical damage
cv. Invicta, 4 years old, South Midlands

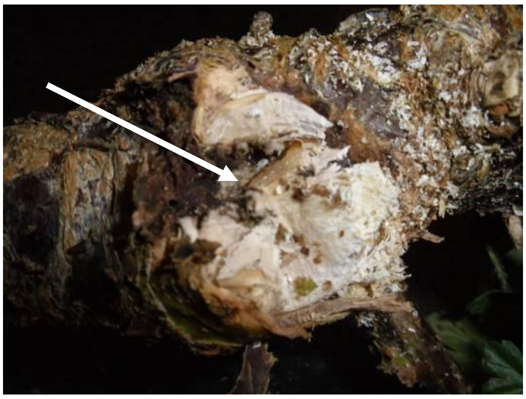
Rotting above the main stem joint had occurred in two branches where they would have been pulled back to the wire, so branches were starting to detach. Staining/cankering was local to the main stem/branch junction. No pathogens were identified. There was bronzing on the leaves of the detaching branches. Whitened 2011 twigs had been trimmed and had pycnidia, but were green under the epidermis. Roots looked healthy (although *Cylindrocarpon destructans*, *Fusarium* sp. and *Pythium* sp. were isolated)

Images

1. Wire trained bush in field in late June 2012
2. Bronzing leaves on the detaching branches
3. Larva (with brown head capsule) in the cankered tissue at junction with main stem
4. Internal branch staining and cankering a little higher above the main stem

1

2



3

4

© Agriculture and Horticulture Development Board 2013. All rights reserved

BX 12/72 Root rot
cv. Invicta, 1 year old, South-Eastern England (2nd farm surveyed)

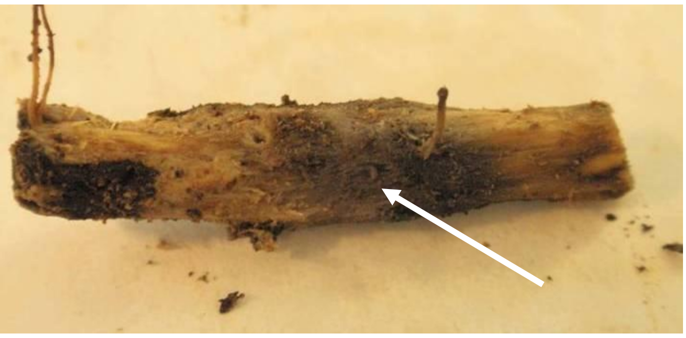
This was a single stemmed young plant. The leaves showed spotting and discolouration. The roots were very poor and dark inside and there was rotting at the stem base (although some new roots were being produced from here). Staining continued into the stem from the roots.

Images

1. Leaf spotting & discolouration in August 2012
2. Stem staining principally around the outer margin, but also more centrally
3. Dark stem base staining (bark removed) with roots rotted off (peach-coloured *Fusarium* sp. isolated)

1

2



3

© Agriculture and Horticulture Development Board 2013. All rights reserved

BX 12/73. Poor establishment, with rotted roots containing Cylindrocarpon sp. cv. Invicta, nearly 2 years old, South-Eastern England (2nd farm surveyed)

This sample showed red discolouration of leaves and unbroken buds. Root rot was present in about half of the bush's roots, in the bottom portion closest to the stem.

Images

1. Young bush in field in August 2012 showing leaf bronzing and yellowing
2. Discoloured & wilted, dying, leaves
3. Unbroken buds on the previous year's twig growth
4. The root ball had grown well (probably before bare-root planting in the field), but there was now severe rot throughout the roots closest to the stem (*Cylindrocarpon destructans* isolated, but neither *Phytophthora* sp. nor *Pythium* sp.)

1

2

3

4

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

BX 12/74. Branch break above main stem
cv. Invicta, 5 years old, South-Eastern England (2nd farm surveyed)

One branch had died and readily became detached on sampling at a point 24 cm up from the main stem. Another branch had slight dieback. Discoloured, spotted and wilting leaves, as well as unbroken buds were present on some upper branches. Some leaves look healthy. V-shaped staining in the upper stem may have entered via a branch pruning wound. The roots were substantial and appeared healthy, although *Cylindrocarpon* sp. was isolated.

Images

1. Wilted arm of bush in field in August causing 25-30% bush dieback
2. Severely wilted leaves on the dead branch
3. Main stem showing V-shaped internal staining
4. Branch with V-shaped internal staining


1


2


3


4

© Agriculture and Horticulture Development Board 2013. All rights reserved

BX 12/78. Collar rot causing total bush death, possibly after bark wounding cv. Invicta, 8 years old, Western England (same plantation as BX 12/51)

By August, dieback of 2012 growth had occurred as well as failure of 2011 buds to break. Dieback was 100%. It appeared as if a wound to the main stem had allowed pathogen entry. Wood staining was traced up to the affected branches. A few roots were rotted (*Pythium* sp).

Images

1. Bush showing rapid dieback symptoms in the field
2. Main stem damage (*Alternaria* sp. and a yellow-coloured *Fusarium* sp.)
3. Extent of main stem damage and staining under bark
4. Staining continued in to upper branches (isolate sent to Fera identified as a non-pathogenic *Paecilomyces* species)

1

2

3

4

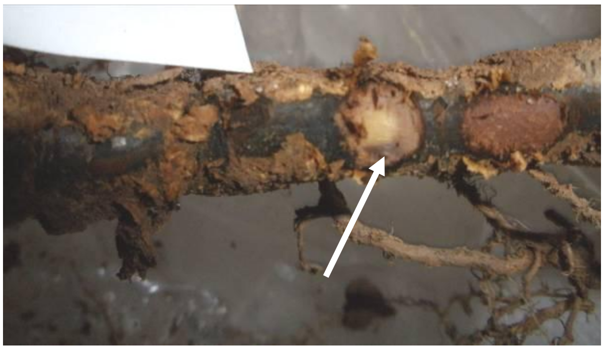
© Agriculture and Horticulture Development Board 2013. All rights reserved

BX 12/79. Root rot leading to whole bush death
cv. Careless, 10 years old, Western England (same plantation as BX 12/50)

By August, there was total dieback of this bush and wood staining was the worst observed. Root rot was severe. Staining in the main stem was traced up through branches. New shoots arising underground from the stem base. Several *Fusarium* species were found, the colony colours were: Stained main stem - both orange and yellow colonies (also Pythium sp.), roots – yellow colonies, twig – cherry-red colony.

Images

1. Severe root rot with cut area showing staining inside (*Pythium* sp. and *Fusarium* sp.)
2. Upper branch staining. Note old branch stub adjacent to affected stem.
3. Very dark, circular staining found in main stem sections (*Fusarium* spp. isolated)



1

2

3

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

BX 12/81. Root rot and main stem damage leading to total bush death cv. Invicta, 4 years old, South Midlands ((same plantation as BX 12/61)

By September 2012, most of the bush had died. Shoots were re-growing from the stem base underground. A main stem wound or sunken area, was visible and seemed to be the point where staining of the wood was focussed. Staining was traced up through the bush. The roots were rotted and misshapen.

Images

1. Wire trained bush in field showing dieback, with shoot regrowth from below ground
2. Main stem damage. Bark was missing, but it was not soft. (cherry-coloured *Fusarium* sp. isolated, (another isolate pending identification at Fera)
3. Staining and dying stem internal wood
4. Staining traced to upper branches

1

2

3

4

Objective 2: Plantation survey

The distribution of dieback and death on three farms and the possible relationships with potential pathogens and plantation management

Surveys of three adjacent rows were carried out on 22 May and 14 August 2012 in southern England at the source of cv. Invicta sample BX 12/42 and on 19 June and 28 August 2012 in western England at the plantations which provided samples of cv. Careless (BX 12/50 and BX 12/79), cv. Invicta (BX 12/51 and BX 12/78), and cv. Leveller (BX 12/54). A single record of affected plants within rows was also made of cv. Invicta on a farm in the south Midlands on 5 September 2012 (source of BX 12/61 & BX 12/78). The distributions of affected and healthy bushes are shown in Tables 8 to 12 (where each table column represents a crop row), and Table 7 provides a key to the abbreviated descriptions of symptoms given.

Table 7 Abbreviations used in Tables 8 to 12 to categorise the symptoms of the dead and dying gooseberry bushes in four plantations in which row surveys were carried out in 2012

Abbreviation	Symptoms seen in row
B. Dying	One or some branches were dying (dying back)
Dieback	Parts of branches were dying (no bud break or wilting leaves) or dead
Dying / Dead	All branches on bush were dying or dead (more advanced than dieback)
B. Dead	One or some branches dead (having died back)
Regrowth	Bush dying or dead but new shoots were growing from the base
Gap	Dead bush had been removed
Replanted	Gap filled with a new bush that was still healthy when surveyed

The plantations surveyed all contained well established bushes with branches meeting along the rows. New shoot growth and expansion of leaves by the second visit could both obscure dead branches and make them stand out more clearly. During the second survey on occasion a bush was either missed or included, so that the row position records for the two dates do not always match, however the overall pattern for that month was not affected.

Further symptoms often became visible when bushes were uprooted and the stems sectioned in the laboratory. Where a plant pathogen (air, water-splash or soil-borne) was diagnosed then its arrival and subsequent spread within rows might show a distribution pattern (scattered or grouped) related to e.g. microclimate effects along rows (leaf and soil wetness and temperature). The diagnosis of the cause of dieback on bushes removed from the plantation was examined in relation to any worsening of the health of bushes in the surveyed rows over the summer and any patterns of distribution of affected bushes.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Observations were also made of the distribution and incidence of affected bushes at the other plantations when visited to sample bushes for plant clinic diagnosis at ADAS Boxworth.

Southern England survey site

This plantation was planted in 2002 with bought-in bare-root bushes, grown on the flat at 0.5 m spacing in the row and trellis trained to a fan. Bushes were summer and winter pruned. There was 7% bush or branch loss across the site, with symptoms being noticed about six years after planting. Within the surveyed area some bushes that had appeared healthy in May had a dead branch by August (12 weeks later) so that around a third of bushes were affected in some way (Table 8). There were a number of lengths of three to six affected bushes, but also some dead bushes without any affected ones close by.

Table 8: Records from two assessment dates in 2012 of dieback and bush losses in a plantation of gooseberry cv. Invicta in S. England. This plantation was the source of sample BX 12/42 which had internal main-stem and branch cankering and healthy roots

Position along row	Row 14			Row 15			Row 16	
	22 May	14 August		22 May	14 August		22 May	14 August
1	Healthy	Healthy		Dead	Dead		B. Dying	Dead
2	Healthy	Healthy		B. Dead	B. Dead		B. Dying	B. Dying
3	Healthy	Healthy		Healthy	Healthy		Replanted	Replanted
4	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
5	Healthy	Healthy		Healthy	Healthy		Dying	Dying
6	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
7	Dead	Regrowth		Dead	Dead		Healthy	Healthy
8	Healthy	Healthy		Healthy	Healthy		Dead	Dead
9	B. Dead	B. Dead		Healthy	Healthy		Healthy	Healthy
10	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
11	Healthy	Healthy		Dead	Dead		Healthy	Healthy
12	Healthy	Healthy		Healthy	Healthy		Dead	Dead
13	Healthy	Healthy		Healthy	Healthy		B. Dying	B. Dying
14	Healthy	Healthy		Healthy	Healthy		B. Dying	B. Dying
15	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
16	Regrowth	Regrowth		Healthy	Healthy		Healthy	Healthy
17	Healthy	Healthy		Healthy	B. Dead		Healthy	B. Dead
18	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
19	Replanted	Replanted		Healthy	Healthy		Healthy	Healthy
20	Healthy	Healthy		Dead	Dead		Healthy	B. Dead
21	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
22	Dead	Dead		Healthy	Healthy		Healthy	Healthy
23	Dead	Dead		Healthy	Healthy		Healthy	Healthy
24	Healthy	Healthy		Dying	Dead		Healthy	B. Dead
25	Healthy	Healthy		Dead	Healthy		Dead	Dead

© Agriculture and Horticulture Development Board 2013. All rights reserved

26	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
27	Healthy	Healthy		Dead	Dead		Healthy	Healthy
28	Healthy	Healthy		Dying	Sampled		Healthy	B. Dead
29	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
30	Healthy	Healthy		Replanted	Replanted		Healthy	Healthy
31	Healthy	Healthy		Replanted	Replanted		Healthy	Healthy
32	Dead	Dead		Healthy	Healthy		Healthy	Healthy
33	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
34	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
35	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
36	Healthy	Healthy		Healthy	Healthy		B. Dead	B. Dead
37	Healthy	Healthy		B. Dead	Healthy		B. Dead	B. Dead
38	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
39	Healthy	Healthy		Replanted	Replanted		Healthy	Healthy
40	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
41	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
42	Regrowth	Dead		Healthy	Healthy		Replanted	Replanted
43	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
44	B. Dead	Regrowth		Healthy	Healthy		Dead	Dead
45	Regrowth	Regrowth		Replanted	Replanted		Healthy	B. Dead
46	Healthy	Healthy		Dead	Dead		Healthy	Healthy
47	Healthy	Healthy		Healthy	Healthy		Dead	Dead
48	Healthy	Healthy		Dead	Dead		Healthy	Healthy
49	Healthy	Healthy		B. Dead	B. Dead		B. Dead	B. Dead
50	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
51	Healthy	Healthy		Dead	Dead		Healthy	Healthy
52	Dead	Dead		B. Dead	B. Dead		Healthy	Healthy
53	Healthy	Healthy		B. Dead	Dead		B. Dead	B. Dead
54	Dead	Dead		Healthy	Healthy		Regrowth	Regrowth
55	Healthy	Healthy		Healthy	Dead		Replanted	Replanted
56	Replanted	Replanted		Regrowth	Regrowth		Dead	Dead
57	Healthy	Healthy		B. Dead	B. Dead		Healthy	Healthy
58	B. Dead	B. Dead		B. Dead	B. Dead		Healthy	Healthy
59	Dying	Dying		Replanted	Replanted		Healthy	Healthy
60	Dying	Dead		Replanted	Replanted		Healthy	Healthy
61	Healthy	Healthy		Healthy	Dying		Dead	Dead
62	B. Dying	B. Dying		Healthy	Dying		Healthy	Healthy
63	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
64	Healthy	Healthy		Dead	Dead		Healthy	Healthy
65	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
66	Healthy	Healthy		Healthy	Healthy		Regrowth	Regrowth
67	B. Dead	B. Dead		Healthy	Healthy		Replanted	Replanted
68	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
69	Healthy	Healthy		Healthy	Healthy		Dead	Dead
70	Healthy	Healthy		Dead	Dead		Healthy	Healthy
71	Dead	Dead		Healthy	Healthy		Healthy	Healthy
72	B. Dying	B. Dying		Healthy	Healthy		Healthy	Healthy

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

73	Replanted	Replanted		Replanted	Replanted		B. Dead	B. Dead
74	Healthy	Healthy		Replanted	Replanted		Healthy	Healthy
75	Dead	Dead		Healthy	Healthy		Healthy	Healthy
76	Healthy	Healthy		Healthy	Healthy		B. Dead	B. Dead
77	Replanted	Replanted		B. Dead	B. Dead		Healthy	Healthy
78	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
79	Healthy	Healthy		Healthy	Healthy		Dead	Dead
80	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
81	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
82	Dead	Dead		Dead	Dead		B. Dead	B. Dead
83	Dying	Dead		Dead	Dead		Healthy	Healthy
84	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
85	Healthy	Healthy		Healthy	Healthy		Dead	Dead
86	B. Dead	B. Dead		Healthy	B. Dead		Healthy	Healthy
87	B. Dying	B. Dying		Replanted	B. Dead		B. Dead	B. Dead
88	B. Dead	B. Dead		Replanted	Replanted		Healthy	Healthy
89	Dead	Dead		B. Dead	B. Dead		Healthy	Healthy
90	Dead	Dead		Dying	Dying		Healthy	Healthy
91	Dead	Dead		Healthy	B. Dead		B. Dead	B. Dead
92	Healthy	Healthy		B. Dead	B. Dead		Healthy	Healthy
93	Healthy	Healthy		Dead	Dead		Healthy	Healthy
94							Healthy	Healthy
95							B. Dead	B. Dead
96							Healthy	Healthy
97							Healthy	Healthy
98							Healthy	Healthy
99							Replanted	Replanted
100							Replanted	Replanted
101							Healthy	Healthy
102							Healthy	Healthy
103							Dead	Dead
104							Dying	Dying
105							Healthy	Healthy

The bush sample taken in May, BX 12/42, had one of its two branches with smaller, down-rolling leaves and no fruit. It had a cracked-open twisted main stem with browning just below and just above leading into the wilting branch. Browning was also spreading into the main stem from a branch stub at the top of the main stem. *Fusarium* sp. and an unidentified fungus with a brown mottled colony on agar were isolated. Infection may have occurred via branch pruning to achieve a fan shape and via main stem wounds, which could have arisen when pulling the bush onto the wire. The roots were healthy, so allowing re-growth. *Eutypa* sp. is one example of a pathogen known to produce stem cankers via wounds.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

It is possible that infection of the main stem occurred years ago by the extent of browning. The plantation is pruned between September and October as the current season's growth comes to an end, which could be better than pruning into November when wounds are slow to heal. In addition, this farm carries out pruning to take the current season's growth back to approximately one third of its length just prior to the onset of picking. Damage to soft growth in summer could introduce fungi such as *Botrytis*, but this does not seem to have occurred.

Western England survey site

Three varieties, Careless, Invicta and Leveller on the same farm were assessed (Tables 9 to 11). Bushes were planted in flat beds using 2 year old bare-root cuttings grown on the farm. They were grown on 300 mm main stems with branches (usually four) that were not wire trained. Pruning was done in October/November and strong growth was used to produce cuttings. There was no pre-harvest summer pruning. The soil is freely-draining, but is likely to have become waterlogged during the persistent rain from April onwards in 2012.

i) cv. Careless

Over the whole 0.5 ha plantation, 5% of cv. Careless had dying branches. Bushes were planted in 2002 and dieback was noticed from about five years after planting. Three adjacent rows were assessed (Table 9) at the same time as a recently wilted bush (BX 12/50) was sampled on 19 June 2012. BX 12/50 had two branches which had dying new shoots and some small fruit, and a third branch which had stunted browning leaves. The assessment area originally contained 165 bushes with 1.2 m spacing in the row. The same rows were re-assessed 10 weeks later on 28 August 2012 and a nearly dead bush (BX 12/79) sampled. There were too few affected bushes in the recording area to draw conclusions about distribution patterns.

Sample BX 12/50 had softened and internally blackened roots. There were internal vascular rings of staining at the branch bases on the main stem, but the main stem (foot) bark was sound. *Eutypa lata* was isolated from the stained main stem. The later sample BX 12/79 also had rotted roots. They initially appeared healthy, but most were rotten inside. There were distinct black rings of staining at the base of the foot, becoming browner where it reached up into the branches. These symptoms of sudden death and staining in sample BX 12/79 were like those of Verticillium wilt, but only *Pythium* sp. and *Fusarium* sp. were isolated.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Table 9: Records from two assessment dates in 2012 of dieback and bush losses in a 10 year old plantation of gooseberry cv. Careless in W. Midlands. This plantation was the source of samples BX12/50 and BX12/79 which had rotted roots and internal stem staining

Position along row	Row 1			Row 2			Row 3	
	19 June	28 August		19 June	28 August		19 June	28 August
1	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
2	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
3	Healthy	Healthy		Dieback	Healthy		Healthy	Healthy
4	Healthy	Gap		Healthy	Dieback		Healthy	Healthy
5	Healthy	Healthy		Dieback	Healthy		Healthy	Healthy
6	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
7	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
8	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
9	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
10	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
11	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
12	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
13	Healthy	Healthy		Healthy	Healthy		Dieback	Healthy
14	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
15	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
16	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
17	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
18	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
19	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
20	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
21	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
22	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
23	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
24	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
25	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
26	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
27	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
28	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
29	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
30	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
31	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
32	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
33	Healthy	Healthy		Healthy	Healthy		Dead	Healthy
34	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
35	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
36	Healthy	Healthy		Healthy	Healthy		Healthy	Dead
37	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
38	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
39	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
40	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
41	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
42	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
43	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
44	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
45	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
46	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

47	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
48	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
49	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
50	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
51	Healthy	Healthy		Dieback	Healthy		Healthy	Healthy
52	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
53	Dieback	Healthy		Healthy	Healthy		Healthy	Healthy
54	Healthy	Healthy		Healthy	Healthy		Gap	Gap
55	Healthy	Healthy		Healthy	Healthy		Gap	Gap

ii) cv. Invicta

Over the whole 0.5 ha plantation 7% of cv. Invicta (planted in 2004) had dying branches. Dieback was noticed from about five years after planting and some bushes had died and been taken out. Three adjacent rows of cv. Invicta were assessed at the same time that bush BX 12/51 was sampled (with a healthy and dead branch and two others with some dieback) on 19 June 2012 during fruiting. The same rows were re-assessed on 28 August 2012 and a nearly dead bush (a few fruit had been produced) BX 12/78 was sampled (Table 10). The assessment area originally contained 240 bushes with 1.4 m spacing in the row.

Table 10: Records from two assessment dates in 2012 of dieback and bush losses in a 12 year old plantation of gooseberry cv. Invicta in W. Midlands. This plantation was the source of samples BX 12/51 and BX 12/78 which had main-stem collar rot and healthy roots

Position along row	Row 1			Row 2			Row 3	
	19 June	28 August		19 June	28 August		19 June	28 August
1	Healthy	Healthy		Healthy	Healthy		Healthy	Dieback
2	Gap	Gap		Healthy	Healthy		Healthy	Healthy
3	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
4	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
5	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
6	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
7	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
8	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
9	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
10	Healthy	Dieback		Healthy	Healthy		Healthy	Healthy
11	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
12	Healthy	Healthy		Healthy	Healthy		Dieback	Healthy
13	Dieback	Dieback		Healthy	Healthy		Healthy	Healthy
14	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
15	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
16	Healthy	Healthy		Healthy	Healthy		Healthy	Dieback
17	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
18	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
19	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
20	Gap	Gap		Healthy	Healthy		Healthy	Healthy
21	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
22	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

23	Healthy	Healthy		Gap	Healthy		Healthy	Healthy
24	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
25	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
26	Healthy	Healthy		Dieback	Healthy		Healthy	Healthy
27	Healthy	Healthy		Healthy	Dead		Healthy	Healthy
28	Healthy	Healthy		Dieback	Healthy		Healthy	Healthy
29	Healthy	Healthy		Healthy	Gap		Healthy	Healthy
30	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
31	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
32	Healthy	Healthy		Healthy	Dieback		Healthy	Healthy
33	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
34	Healthy	Dieback		Healthy	Healthy		Healthy	Healthy
35	Dieback	Healthy		Gap	Gap		Healthy	Healthy
36	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
37	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
38	Healthy	Healthy		Gap	Gap		Healthy	Healthy
39	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
40	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
41	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
42	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
43	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
44	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
45	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
46	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
47	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
48	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
49	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
50	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
51	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
52	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
53	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
54	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
55	Healthy	Healthy		Gap	Healthy		Healthy	Gap
56	Healthy	Healthy		Healthy	Healthy		Dead	Healthy
57	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
58	Healthy	Healthy		Healthy	Healthy		Healthy	Gap
59	Healthy	Healthy		Gap	Healthy		Gap	Healthy
60	Healthy	Dead		Healthy	Healthy		Healthy	Healthy
61	Healthy	Dieback		Healthy	Healthy		Healthy	Healthy
62	Dead	Healthy		Healthy	Healthy		Healthy	Healthy
63	Dieback	Healthy		Healthy	Healthy		Healthy	Healthy
64	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
65	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
66	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
67	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
68	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
69	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
70	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
71	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
72	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
73	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
74	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy

© Agriculture and Horticulture Development Board 2013. All rights reserved

75	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
76	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
77	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
78	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
79	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
80	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy

Affected bushes and gaps were found throughout the rows. In row 2 newer losses were occurring towards the centre of the row and within 3 m of removed bushes, but most other new dieback was not associated with previous loss.

Both of the Invicta samples (BX 12/51 and BX 12/78) had severe collar rot with soft sunken areas on the bush main stem starting at the base with internal brown staining spreading up into the branches. The roots were mainly healthy. Infection could have originated from splash-up from the soil, but the pathogen does not appear to have spread in run-off water between the roots of neighbouring bushes. When bushes were taken out, infested soil or debris could have scattered locally in row 2 and caused the higher number affected there.

iii) cv. Leveller

Over the whole plantation 20% of cv. Leveller had dying branches. Dieback was noticed from about five years after planting, with several bushes in the surveyed rows having died and been taken out. Three adjacent rows of cv. Leveller were assessed at the same time as taking a sample (BX 12/54) of shoots (not a whole bush) on 19 June 2012. The same rows were re-assessed on 28 August 2012, but were not re-sampled (Table 11).

Table 11: Records from two assessment dates in 2012 of dieback and bush losses in a plantation of gooseberry cv. Leveller in W. Midland. This plantation was the location of sample BX 12/54 which had new shoots with a rot.

Position along row	Row 1			Row 2			Row 3	
	19 June	28 August		19 June	28 August		19 June	28 August
1	Dead	Dead		Healthy	Healthy		Dead	Dead
2	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
3	Gap	Gap		Healthy	Healthy		Gap	Gap
4	Gap	Gap		Healthy	Healthy		Healthy	Healthy
5	Gap	Healthy		Healthy	Healthy		Healthy	Healthy
6	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
7	Healthy	Healthy		Healthy	Dieback		Healthy	Healthy
8	Healthy	Dieback		Healthy	Healthy		Healthy	Healthy
9	Healthy	Healthy		Healthy	Healthy		Gap	Gap
10	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
11	Healthy	Healthy		Healthy	Gap		Healthy	Healthy
12	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
13	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
14	Healthy	Gap		Healthy	Healthy		Healthy	Healthy

© Agriculture and Horticulture Development Board 2013. All rights reserved

15	Gap	Healthy		Healthy	Healthy		Healthy	Dieback
16	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
17	Dieback	Dieback		Healthy	Healthy		Healthy	Healthy
18	Dieback	Healthy		Gap	Gap		Healthy	Dieback
19	Dieback	Healthy		Healthy	Healthy		Healthy	Healthy
20	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
21	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
22	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
23	Healthy	Dieback		Dieback	Healthy		Healthy	Healthy
24	Healthy	Healthy		Healthy	Healthy		Dieback	Dieback
25	Healthy	Healthy		Dieback	Dieback		Dieback	Healthy
26	Healthy	Healthy		Dieback	Healthy		Dieback	Dieback
27	Healthy	Healthy		Dieback	Dieback		Dieback	Healthy
28	Dieback	Dieback		Healthy	Dieback		Dieback	Healthy
29	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
30	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy
31	Healthy	Healthy		Healthy	Dieback		Healthy	Healthy
32	Healthy	Healthy		Healthy	Healthy		Healthy	Healthy

In June the ends of two rows had dead bushes, with three gaps near where bushes had probably died and been removed in row 1. In both rows 1 and 3 there was a healthy bush between the dead bush and a gap, rather than there being a continuous line of affected bushes. There were some groups of three neighbouring bushes all showing dieback (e.g. row 3 positions 24 to 28) and this could indicate the spread of a soil-borne disease, localised splash spread of spores or transfer of infection on pruning equipment. As no roots were sampled it was not possible to determine if they were infected. Further dieback was recorded by August (e.g. positions 25 and 18 in row 3), but it was on isolated bushes not closely associated with locations of earlier loss.

South Midlands survey site

A third plantation of cv. Invicta was visited on 29 June and 5 September to take samples BX12/61 and BX12/81 and a distribution survey was carried out on the latter date. The bushes were bought-in as 1 year old bare-root plants in 2009, planted on a slight ridge in free draining soil with 0.5 m spacing in the row and fan trained on trellis wires. 5% of bushes in the plantation had dieback, with symptoms having been noticed two to three years after planting. Bushes were summer and winter pruned.

The sample BX12/61 taken in June had local internal browning where one of the three branches was only partially attached to the main stem (a sawfly larva was inside the crack in the rotted tissue), but the leaves were not wilting. The leaves on the whole bush were bronzed, but new shoots were not dying back. All four branches had been trained by being

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

bent inwards. The 2011 twig growth had been pruned off and the stubs were white with black spore bodies. The roots were healthy.

The September sample, BX12/81, was dead but with new shoots from the base of the main stem. The main stem had bark missing from a large area around a wound, but the remaining bark was not rotted. There were internal dark areas in the two branches and main stem. The branch staining was sometimes only local, e.g. concentrated at the buds. The roots were mainly healthy. Infection e.g. by *Eutypa* sp. may have occurred via wounds (Munkvold, 2001), the healthy roots allowing re-growth. *Botryosphaeria* sp. cankers are seen around buds (Kenaley *et al*., 2011).

There was a low number of affected plants and their distribution was both as singles and within 3 m of each other. There was no disease progression from gaps where bushes had been removed (hygiene recommendations would have been to remove affected material to prevent any multiplication and spread of any disease). It is possible that bushes were being lost at random across the plantation wherever wounds were being created by, for example, pruning to get leaders or by pulling branches back into a cupped fan to fit into the small planting gaps within each row.

Table 12: Records from one assessment date in 2012 of dieback and bush losses in a 3 year old plantation of gooseberry cv. Invicta in S. Midlands. This was the source of samples BX12/61 and BX12/81 which had wounds open to fungal invasion leading to cankers.

Position along row	Row 2		Row 3		Row 4
	5 September		5 September		5 September
1	Healthy		Healthy		Healthy
2	Healthy		Healthy		Healthy
3	Healthy		Healthy		Healthy
4	Healthy		Healthy		Healthy
5	Healthy		Healthy		Healthy
6	Healthy		Healthy		Healthy
7	Gap		Healthy		Healthy
8	Healthy		Healthy		Healthy
9	Healthy		Healthy		Healthy
10	Healthy		Healthy		Healthy
11	Healthy		Healthy		Healthy
12	Healthy		Healthy		Healthy
13	Healthy		Healthy		Healthy
14	Gap		Healthy		Healthy
15	Gap		Healthy		Healthy
16	Healthy		Gap		Healthy
17	Healthy		Healthy		Healthy
18	Healthy		Healthy		Healthy
19	Healthy		Healthy		Healthy

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

20	Healthy		Healthy		Healthy
21	Healthy		Healthy		Healthy
22	Healthy		Healthy		Healthy
23	Healthy		Healthy		Healthy
24	Healthy		B. dead		Healthy
25	Healthy		B. dead		Healthy
26	Healthy		Healthy		Healthy
27	Healthy		Healthy		Gap
28	Healthy		Healthy		Healthy
29	Healthy		Healthy		Healthy
30	Healthy		B. dead		Healthy
31	Healthy		Healthy		Healthy
32	Healthy		Healthy		Healthy
33	Healthy		Healthy		Healthy
34	Healthy		Healthy		Healthy
35	Healthy		Healthy		Healthy
36	Healthy		Healthy		Healthy
37	Healthy		Healthy		Healthy
38	Healthy		Healthy		Healthy
39	Healthy		Healthy		Healthy
40	Dead		Healthy		Healthy
41	Healthy		Healthy		Healthy
42	Dead		Healthy		Healthy
43	Healthy		Healthy		Healthy
44	Healthy		Healthy		Healthy
45	Healthy		Healthy		Healthy
46	Healthy		Healthy		Healthy
47	Healthy		Healthy		Healthy
48	Healthy		Healthy		Healthy
49	Healthy		Healthy		Healthy
50	Healthy		Healthy		Healthy
51	Healthy		Healthy		Healthy
52	Healthy		Healthy		Healthy
53	Healthy		Healthy		Healthy
54	Healthy		Healthy		Healthy
55	Healthy		Dying		Healthy
56	Healthy		Weak		Healthy
57	Healthy		Healthy		Healthy
58	Dying		Healthy		Healthy
59	Healthy		Healthy		Healthy
60	Healthy		Healthy		Healthy
61	Healthy		Healthy		Healthy
62	Healthy		Healthy		Healthy
63	Healthy		Healthy		Healthy
64	Healthy		Healthy		Healthy
65	Healthy		Healthy		Healthy
66	Healthy		B. dead		Healthy
67	Healthy		Healthy		Healthy
68	Healthy		Healthy		Healthy
69	Healthy		Healthy		Healthy
70	Healthy		Gap		Healthy
71	Healthy		Healthy		Healthy

© Agriculture and Horticulture Development Board 2013. All rights reserved

72	Healthy		Healthy		Healthy
73	Healthy		Healthy		Healthy
74	Healthy		Healthy		Healthy
75	Dying		Healthy		Healthy
76	Healthy		Healthy		Healthy
77	Healthy		Healthy		Healthy
78	Dead		Healthy		Healthy
79	Healthy		Healthy		Healthy
80	Healthy		Healthy		Healthy
81	Healthy		Healthy		Healthy
82	Healthy		Healthy		Healthy
83	Dead		Healthy		Healthy
84	Healthy		Healthy		Healthy
85	Healthy		Healthy		B. dying
86	Healthy		Healthy		Healthy
87	Dying		Healthy		Healthy
88	Healthy		Healthy		Healthy
89	Healthy		Healthy		Healthy
90	Healthy		Healthy		Healthy
91	Healthy		Healthy		Healthy
92	Healthy		Healthy		Healthy
93	Healthy		Healthy		Healthy
94	Healthy		Healthy		Healthy
95	Healthy		Gap		Healthy
96	Healthy		Healthy		Healthy
97	Dead		Dying		Healthy
98	Healthy		Healthy		Healthy
99	Healthy		Healthy		Healthy
100	Healthy		Healthy		Healthy
101	Healthy		Dying		Healthy
102	Healthy		Healthy		Healthy
103	Healthy		Healthy		Healthy
104	Healthy		Healthy		Healthy
105	Healthy		Healthy		Healthy
106	Healthy		Healthy		Healthy
107	Healthy		Healthy		Healthy
108	Healthy		Healthy		Healthy
109	Healthy		Healthy		Healthy
110	Healthy		Healthy		Healthy
111	Healthy		Healthy		Healthy
112	Healthy		Healthy		Healthy
113	Healthy		Healthy		Healthy
114	Healthy		Healthy		Healthy
115	Healthy		B. dead		Healthy
116	Healthy		Healthy		Healthy
117	Healthy		Healthy		Healthy
118	Healthy		Healthy		Healthy
119	Healthy		Gap		B. dying
120	Healthy		Healthy		Healthy
121	Healthy		Healthy		Healthy
122	Healthy		Healthy		Healthy
123	Healthy		Healthy		Healthy

© Agriculture and Horticulture Development Board 2013. All rights reserved

124	Healthy		Healthy		Regrowth
125	Dying		Healthy		Healthy
126	Healthy		Healthy		Healthy
127	Healthy		Healthy		Healthy
128	Healthy		Healthy		Healthy
129	Healthy		Healthy		Healthy
130	Healthy		Healthy		Healthy
131	Healthy		Healthy		Healthy
132	Healthy		Healthy		Healthy
134	Healthy		Healthy		Healthy
135	Healthy		Healthy		Healthy
136	Healthy		Healthy		Healthy
137	Healthy		Healthy		Healthy
138	Healthy		Healthy		Healthy
139	Healthy		Healthy		Healthy
140	Healthy		Healthy		Dying
141	Healthy		Healthy		Healthy
142	Healthy		Healthy		Healthy
143	Healthy		Gap		Healthy
144	Healthy		Healthy		Healthy
145	Healthy		Healthy		Healthy
146	Healthy		Healthy		Healthy
147	Gap		Healthy		Healthy
148	Healthy		Healthy		Healthy
149	Healthy		Healthy		Healthy
150	Healthy		Healthy		Healthy
151			Healthy		

Pattern of affected bushes

Overall, therefore, of the five plantations surveyed to see the distribution of symptoms in three adjacent rows, there were groups of around three to five dying or dead bushes in the S. England plantation where the sampled Invicta bush, BX 12/42, had a cracked main stem, and in the W. England plantation of cv. Leveller where the shoot sampled, BX 12/54, had Botrytis. However, both also had scattered bushes, as seen in the other three plantations with a lower proportion of affected bushes. However, where *Phytophthora* and *Pythium* root rot was identified in cv. Pax, (samples BX 12/58 and BX 12/59), from the second farm surveyed in S.E. England there were clusters of affected bushes. There were also exceptionally long lengths of dying plants (50-70 plants) in adjacent rows in one area of a recent planting of Invicta in the second farm sampled in S.E. England, where *Cylindrocarpon* was isolated from rotted roots (BX 12/73). Where root rot was not a problem (based on the sampled bushes) then neither the affected clusters nor affected scattered plants showed any particular distribution in relation to position along the rows. This suggested that if dieback was caused by disease then microclimate and spore production differences did not exist

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

along rows and hence increase dieback incidence at particular positions. Other factors such as husbandry practices must therefore be causing dieback to arise at these locations.

Survey of husbandry practices on gooseberry plantations

The information from the survey of growers in 2012 with dieback and bush death in their gooseberry plantations has been summarised in the following tables and reference should be made to these for full comparisons of husbandry between farms:

Table 4: Incidence of branch dieback and whole bush death in gooseberry plantations in 2012 and apparent primary source of dieback on sampled bushes
Table 5: Bush training and pruning carried out in gooseberry plantations
Appendix 2: Previous cropping and any recent pre-crop use of a partial soil sterilant
Appendix 3: Soil type, drainage and bed design
Appendix 4: Varieties planted, when planted, source of planting material and spacing within and between rows
Appendix 5: Irrigation and fertiliser use
Appendix 6: Fungicide use in the surveyed gooseberry plantations in 2012

All but the W. England grower bought-in their bare-root planting stock and all growers had bushes with either or both stem and root rot problems in the samples. However, as the stock was not tested on arrival it is not possible to say whether or not the material arrived with the fungi and water-moulds detected, or whether they were colonised from the soil on the sample site. Most growers, except one in E. England, were using fields previously cropped with fruit (with no soil sterilant used) and in which resting spores of species such as *Fusarium* spp. and *Phytophthora* spp. could have been present. Many of the fungi found in or on the plant tissue lacked host specificity. Some growers used flat beds, others raised beds with about half the growers covering them with black polymulch. The S.E. England site growing cv. Pax with *Phytophthora* sp. root rot used raised beds and these should have made conditions less favourable for the pathogen. All the sampled sites used trickle irrigation and were on freely draining soil.

Sites with stem damage being the dominant cause of dieback in samples (Tables 4 and 6) used September-October or January-February winter pruning. This was no different to those whose samples did not have internal cankers from wounds. Not all growers carried out summer pruning, but there was no link with particular damage symptoms. All sampled sites trained the bushes as fans to wires and so if this technique was contributing to the problem

© Agriculture and Horticulture Development Board 2013. All rights reserved

then it was not causing a problem for some reason on other farms, nor was it a currently visible problem across all of the bushes in the affected plantations.

All growers reported that the incidence of bushes with dieback was increasing annually. It was currently common in around 5 to 8% of the bushes, with up to 2% dead in addition. However, the Pax variety with root rot in S.E. England had 30% loss and the Leveller variety plantation in W. England (where only a wilting shoot was sampled) had 20% of bushes with dieback. Losses tended to be noticed two to three years after planting, which could indicate that infection occurred in the young plant (before or after planting in the present position) as infection of woody tissue and roots is usually much slower than that of soft tissue, such as in herbaceous crops (unless a vascular wilt is involved).

Fungicide application was made to bushes on all the farms, most commonly against powdery mildew pre-harvest (March to May). An alternation of the products Systhane 20 EW (myclobutanil), Stroby WG (kresoxim-methyl), Teldor (fenhexamid), Fortress (quinoxyfen) and Nimrod (bupirimate) was generally used. Orosorb (citrus oil) was used frequently on the sites in S. England and W. England. Post-harvest pesticide applications were not possible on some farms because of nearby picking of other crops, but were not used anyway on other farms. It is not known if post-harvest fungicides are in use on farms that did not complete a questionnaire and may be free from dieback.

Overall, no specific husbandry measures were strongly highlighted as being associated with the incidence of particular fungi, water-moulds or damage symptoms. There were many different types of dieback problems (Table 1) and insufficient growers were able to be surveyed within the resources of this project to be able to say that those having a particular type of problem could be due to a practice they were using that was not common to others. Recommendations for reducing dieback based on the project findings have, however, been given as grower action points.

Discussion

Findings of this and other HDC research in 2012 on other diebacks of fruit bushes were compared and discussed at a meeting of field and laboratory specialists in February 2013. The mixture of fungi isolated from gooseberry, including species considered to be opportunistic pathogens (or working as part of a complex of species, such as *Fusarium*) and probably not causing major damage, reflected the findings of the blueberry project SF 132. In blueberry, fungi such as *Ceratocystis* spp., *Coniothyrium* spp., *Cytospora* spp., *Fusarium* spp. and *Phoma* spp. were found within the 60 samples taken, and considered unlikely to be

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

primary pathogens. However, in gooseberries there seems to be a greater dominance of dieback from the main stem or lower branch arms upwards than dieback from branch tips. There was no involvement of *Phomopsis* spp. in the gooseberry bushes sampled, whereas this fungus was the most commonly isolated from blueberry samples (from 30% to 40%) and is consistently isolated from dying-back blackcurrant stems and pruning debris. *Botrytis cinerea* was found on 15% of blueberry samples but only noted as causing primary damage on some current year's growth of gooseberry. *Eutypa lata* was not isolated from blueberry, but was found in one gooseberry stem. *Botryosphaeria* spp. (a genus with a mixture of 10 to 15 species) was present in 8% of blueberry samples, and may have been causing some of the twig die-back seen around gooseberry buds.

Botryosphaeria spp. and *Eutypa lata* were found to be the principal causes of dieback and death in the National Gooseberry collection (Geoff Denton, RHS pers. comm.). The bushes are now not pruned in October / November and this has reduced the problem. *Fusarium solani* causing root rot or cankers is frequently associated with damage or a stress event caused by other biotic or abiotic agents, but has been recorded as a causing dieback with red sapwood staining in box elder (Demirci and Maden, 2006). Red stem staining was seen in BX 12/42 and *Fusarium* isolated. *Fusarium* cankers causing red staining under the bark more usually arise in hardwood hosts with low vigour, entering in the dormant season, with the host then producing callus tissue to wall it off in the growing season. However, other pathogens such as *Nectria cinnabarina* that invade wounds and branch stubs can then invade in subsequent dormant periods. *Fusarium avenaceum* was isolated from black stem staining in BX 12/44. It is possible that this dieback pathogen may have been among the many *Fusarium* spp. isolates obtained from most stem and root samples, but as many *Fusarium* species are secondary it was not possible to have all isolates identified. In trees, pathogens such as *Botryosphaeria* spp., *Phytophthora* spp. and *Cytospora* spp. are able to invade rapidly causing elongate cankers that can girdle branches in a single season as the host is unable to produce sufficient callus to stop the advance (Moorman, 2013).

Phytophthora spp. were isolated from blueberry plants with dieback sampled for project SF 132. *Phytophthora* spp. (principally *P. cactorum*, but sometimes *P. megasperma* and *P. cambivora*) can cause collar or crown rots in over 80 host genera, with for example apple trees becoming affected (some varieties in particular) from the soil line up to about 0.7 m causing the bark to soften and the wood to become reddish brown (Babadoost, 1988). Rapid girdling occurs, with branches on one side initially showing dwarfing and bronzing. The pathogen germinates in bark crevices or at the root collar and does not require an entrance wound. These symptoms match those reported from one of the samples, BX 12/51 (where

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

unidentified species of *Pythium* and *Phytophthora* were isolated), and in contrast to diseases causing root rots and internal staining of the wood it would be possible for farm staff to inspect the main stem of bushes for this cause of die-back so that bushes can be removed in winter before infective swimming spores are released in the spring or early summer.

The fungi and water-moulds (*Pythium* and *Phytophthora* species) present, and their relative dominance on a particular farm, will depend on what has been introduced on planting material, the abundance of quite generalist fungi such as *Botrytis cinerea*, *Botryosphaeria* spp., and *Eutypa* spp. on hedgerow species and other fruit crops and debris in the vicinity. Husbandry activities that produce wounds to aid entry when particular spores are being released and there is the humidity (or soil water in the case of water-moulds) necessary for infection (such as November pruning) will then determine which fungus or fungi colonise the tissue and the damage location. The relatively small number of fourteen gooseberry samples able to be taken within the current project has meant that there are almost as many diagnoses as farms and so the matching of particular husbandry measures to the presence of a particular pathogen has not been possible.

Fungicide application was made to bushes on all the farms, most commonly against powdery mildew and thus pre-harvest (March to May). There is thus no incidental control of stem canker pathogens outside this period. Recommendations for post-harvest application of products are needed that will be effective against the spores of pathogens that take several months to produce fruiting bodies and so may be mature in autumn or winter. However, when fungicides are applied they have only perhaps 14 days when they are effective protectants and so information on critical application periods is required. Where growers have fruit on other crops being picked in the same field (e.g. for Pick Your Own) post-harvest applications may however, not be possible until winter. It is possible that biological products such as Serenade ASO (*Bacillus subtilis*) and Prestop (*Gliocladium catenulatum*) could be utilised.

There were indications that treatment of the bushes in their first few years affected their survival four or more years later. Poor root systems will reduce the ability of the plants to survive in situations of environmental stress. Cuttings need to be grown in soil or growing media free from pathogens. If cuttings (or transplanted plants) failed in a location before then it likely they will fail again as root or stem base diseases develop. Several plantations in the survey had gapped-up lost plants. Lateral flow devices (LFDs) can be used for on-site testing for *Pythium* and *Phytophthora* species (it is also possible before planting to “bait” the soil to check infestation by these water-moulds), but laboratory diagnosis would be needed

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

to check for the presence of *Verticillium* spp., *Fusarium* spp. or *Cylindrocarpon destructans*. When plants are received from the nursery as bare-root or potted plants they should be inspected to see if the roots are brown and soft. If the roots are infected then not only will the affected plant suffer, but spores (particularly the swimming spores of *Pythium* and *Phytophthora*) will spread in drainage water to neighbouring plants. When planting, it is necessary to ensure that there is a wide and deep enough hole for the root system of the young plant because roots that are bent up or around can develop cracks that can be invaded by soil organisms. One farm reported that they planted bushes through woven plastic mulch. This practice could make ensuring a good root run more difficult if the mulch is not pulled back enough to give a sufficiently large area to dig a planting hole for transplants with large root masses. Roots growing within a small area will reduce the area of water catchment and the bush may be more likely to rock in the wind and suffer other damage.

When cuttings are taken they need to be healthy. Pathogens can spread through plant tissue without causing any visible damage i.e. latent infection (it is to the pathogen's advantage to keep the host alive, and it is the host that may produce callus tissue to try to stop the attack). Bushes used for taking cuttings should thus be selected to be those growing vigorously and without any dieback. Care should be taken that pruning wounds are made when they will heal quickly. Fungicide application to the bushes after taking cuttings may be worth considering so that any invading spores landing on the plant are killed, but good spray coverage will be needed to give protection.

A frequent contributor to fungal invasion appeared to be training bushes to wires in a fan shape in order to make picking easier than a bush form. There was also evidence of some late removal of branches at the top of the main stem. Planting stock was used that had been grown with cup shaped branching, necessitating pulling back two of the branches to the wire. It is possible that as most growers now train to wires, that propagators could be asked to prune to a flatter shape. Pruning wounds can allow fungal entry, with those at the top of the main stem seem to allow fungal spread across the top of the main stem and into the selected leader branches. The smaller the diameter and the younger the branch cut the less surface area for a spore to land on and infect. Cutting at an angle to facilitate water run-off may not always be possible, but it can mean that when a spore germinates the germ tube desiccates before host penetration. When pruning out diseased stems, the cut should be made as far back as possible from the area of visibly affected tissue, as pathogens colonise fresh tissue without initial symptoms. With summer pruning of the current season's growth just before harvest, particularly if with a hedge cutter, there is likely to be more chance of infection if it is wet and spores are thus being splash-released from nearby and then can

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

land on wet open wounds. Pruning equipment used to be available that dispensed a product to kill fungi on the blade to stop cross-infection and was thus more practical than manually wiping a blade between cuts. Information on materials that can be used to disinfect blades (products, dilution rate and replenishment interval and immersion times) is needed.

It is possible that weed control measures could affect pathogen establishment. Where weeds grow up they will provide a humid environment around the main stems which will aid pathogen colonisation. Damage by mechanical weed control, or possibly the killing of new basal shoots with herbicide could allow pathogen entry. Plastic mulch covers may therefore offer an advantage. Irrigation and fertilisation were given to bushes, but water sensors to be able to water according to demand, and ensuring the nutrients given are appropriate for each plantation, will ensure that plants grow well and are less likely to succumb to disease infection.

The age of the tissue (up to 10 years old) meant that many micro-organisms had colonised it and it was impossible and unnecessary to identify them all. Many of these organisms were not consistently isolated from the tissue in a sample and this suggested that they were not primary pathogens (saprophytically feeding on tissue killed by other means). However, even pathogenic species known to invade healthy tissue (such as the *Eutypa lata*, *Phytophthora* spp., *Pythium* spp., *Fusarium* spp., and *Cylindrocarpon destructans* recorded in various samples) will utilise wounds to gain entry through protective bark and the tannin-rich outer root cells. Tissue with low vigour will succumb to infection without the need for local wounds and it was probable that much of the superficial colonisation by fungi producing spore bodies on the twigs followed vascular disruption (leading to poor water and nutrient flow) elsewhere on the bush. It was possible that the severe freezing in the winter of 2010/2011 and the dry weather throughout 2011 (although plantations were trickle irrigated) increased the chance of stem tissue splitting and affected plant vigour. Dry conditions continuing into spring 2012 would have meant that plants with reduced vascular tissue through stem cankers or root rot would have collapsed. The incessant rain later in 2012 would have encouraged infection leading to more root rot and collar rot and the rapid loss of branches and whole plants.

Further research and knowledge transfer work on gooseberries is required following on from this survey and sampling project. A review of overseas research on the epidemiology and control of dieback diseases in other woody crops such as vines would probably give information useful to gooseberries. Experiments on gooseberry husbandry techniques and fungicide (including biological products) efficacy and application timing related to fungus lifecycles and tissue susceptibility periods would be of benefit to UK growers. There is a

© Agriculture and Horticulture Development Board 2013. All rights reserved

minimal amount of published information on gooseberry production and the cycle of poor knowledge leading to reducing production which then leads to less money being spent on the crop needs to be broken if current and future demand for the fruit is to be met.

Conclusions

1. There was no common cause of the dieback seen in the fourteen bushes sampled in 2012. Although all samples had dieback, once examined there were different locations of internal stem staining symptoms, and roots were sometimes affected as well. Frequently staining on one side of the main stem (often from a wound) led up into the branch on the side that was wilting. Wilting was often sudden, occurring for example on buds not long opened and on fruit as it was swelling.

2. A range of symptoms and organisms were recorded. Symptoms and the potential causal pathogens fell into six categories:

i) <u>Root rot</u>, where *Phytophthora*, *Fusarium*, *Cylindrocarpon* and/or *Pythium* species were isolated and at times may have been working together as a root rotting complex. Infection was noted in three cases where roots had been sharply bent to fit into a small planting hole.

ii) <u>Collar rot</u>, usually associated with *Phytophthora*, but *Pythium* was more commonly isolated.

iii) <u>Internal stem cankers</u>, principally seen where there had been physical damage to the main stem or branches by bending back, or by external wounding, or by leaving pruning stubs (such as for leader selection) at the top of the main stem. Isolations rarely produced anything consistent, although unidentified *Fusarium* species were common. One isolate was confirmed as the pathogen *Fusarium avenaceum*.

iv) <u>Staining across the wood</u>, up the main stem. Isolations rarely produced anything consistent, but *Phytophthora* was identified in two of the samples and *Eutypa lata* in one.

v) <u>Bleaching and black spore bodies</u> on the previous year's twigs causing surface damage. A number of body and spores types were recorded, including of *Leptosphaeria* sp., but <u>not</u> of *Phomopsis* sp. or *Diaporthe* sp..

vi) <u>Collapse of new shoots</u> with basal soft brown rot. Botrytis was isolated.

© Agriculture and Horticulture Development Board 2013. All rights reserved

3. Two patterns of loss to dieback and death were seen in the field related to whether or not damage arose from the roots, or from damage to the main stem or branches:

i) <u>Rotted roots on examination</u>

- 10-30% of plants in plantations of one to four years, often the losses started from planting. Lengths of row, scattered along rows, were affected in clusters of approximately five plants (although 40 together were seen at one site)

ii) <u>Healthy roots on examination</u>

- 2-15% loss / dieback of bushes in plantations two to ten years old, mainly occurring in the last two years. Bushes with dieback were sometimes near a dead bush or missing bush, but otherwise were random along rows

Losses in this pattern of symptoms tended to be noticed two to three years after planting, which could still indicate that infection occurred in the young plant (before or after planting in the present position), as infection of woody tissue and roots is usually much slower than that of soft tissue (unless a vascular wilt is involved).

4. The plantation surveys where stem infection was found in samples (with fungi including *Fusarium spp.*, *Botrytis cinerea* and *Eutypa lata* present) had scattered individual affected plants, but where the incidence was high some row lengths of three to five bushes at varying stages of dieback and bush death occurred. Where root rot (with either *Phytophthora* spp. and *Pythium* spp. or *Cylindrocarpon destructans* in sampled roots) was found, affected plants tended to be adjacent to others. No pattern of affected bushes e.g. in relation to the distance along rows from the headlands was reported.

5. No specific husbandry measures were identified as being associated with the incidence of particular fungi or damage symptom. There were insufficient sites / too many different dieback problems to be able to say that those having a particular type of problem could be due to a particular practice because those without the problem used other husbandry techniques. Many practices and timings were similar, and where they differed, for example pruning in January or February rather than in September to October, the summer pruning of current seasons' growth, or the use of polythene mulch over beds there was no apparent relationship between these and the presence or absence of stem or root damage in the samples received.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Knowledge and Technology Transfer

A Powerpoint presentation “Gooseberry Dieback Survey: Progress report SF 131” was given by Erika Wedgwood at the East Malling Research / HDC Fruit Day on 21 November, 2012 and reported in Horticulture Week 18 December 2012 – 7 January 2013 pg 27.

A meeting of diagnosticians and agronomists at Fera Laboratories, York on 11 February 2013 was attended to discuss the project and the results from other HDC dieback projects.

A summary of this work was provided for the HDC publication for the Agronomists Day at East Malling Research on 5 March 2013.

Glossary

Pythium and *Phytophthora* species are not classified as fungi, but as water-moulds (Oomycetes). They produce motile (flagellate) spores called zoospores which disperse in water.

References

Anon. 2008. Crop Walkers’ Guide. Bush Fruit. HDC.

Babadoost, M. 1988. *Phytophthora* collar rot of apple. University of Illinois Report on Plant Disease No. 812 September 1988.

Carter, M. V. and Tabot, P. H. B. 1974. *Eutypa armenica*. Commonwealth Mycological Institute Descriptions of Pathogenic Fungi and Bacteria No. 436. (Note this is now *E. lata*).

Demirci, F and Maden, S. 2006. A severe dieback of box elder (*Acer negundo*) caused by *Fusarium solani* (Mart.) Sacc. In Turkey. Australasian Plant Disease Notes, 1: 13-15. CSIRO publishing. www.publish.csiro.au/journals/apdn

Ellis E. and Ellis J. P. 1985. Microfungi of Land Plants. An Identification Handbook. Croom Helm.

Erinick O., Madden L. V., Ferree D C. and Ellis M A. 2003. Temperature and Wetness-Duration Requirements for Grape leaf and Cane Infection by *Phomopsis viticola.* Plant disease 87: 832-840.

Gardner, R. 1977. Bush Fruit. MAFF ADAS Bulletin 4. HMSO.

HDC Project SF 12. Blackcurrants: Control of Phomopsis dead arm in flailed down plantations. Annual Report 2012. Horticultural Development Company.

HDC Project SF 132. Progressive die-back symptoms in blueberry: Identification and control. Annual Report 2012. Horticultural Development Company.

Kenaley, S. C., Hudler, G. W., O’Brien, D. D., Cameron, K. D., Smart, L. B. 2011. Botryosphaeria canker. Cornell University College of Agriculture and Life Sciences. (Online content only) http://willow.cals.cornell.edu

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Moorman, G. W. 2013. Cankers of Hardwood Deciduous Trees. Plant Disease Fact Sheet Penn State Extension. (online content only)
http://extension.psu.edu/plant-disease-factsheets/all-fact-sheets/cankers

Munkvold, G. P. 2001. *Eutypa* dieback of grapevine and apricot. Plant Health Progress. (online content only)
http://www.plantmanagementnetwork.org/pub/php/diagnosticguide/dieback

Nita, M., Ellis, M. A. L. L. Wilson, L. L. and Madden, L. V. 2007. Evaluation of a Disease Warning System for Phomopsis Cane and Leaf Spot of Grape: A Field Study.
Plant Disease 90:1239-1246

http://www.plantmanagementnetwork.org/pub/php/symposium/melhus/manage

Punithalingham, E. 1979. *Phomopsis viticola*. Commonwealth Mycological Institute Descriptions of Pathogenic Fungi and Bacteria No. 635.

Punithalingham, E. and Holliday, P. 1973. *Botryosphaeria ribis*. Commonwealth Mycological Institute Descriptions of Pathogenic Fungi and Bacteria No. 395.

Punithalingham, E. and Waller, J. M. 1973. *Botryosphaeria obtusa*. Commonwealth Mycological Institute Descriptions of Pathogenic Fungi and Bacteria No. 394.

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Appendices

Appendix 1. Summary of procedures carried out in the diagnosis of infection by fungi and water-moulds causing wilts and diebacks in gooseberry

Diagnosis of cause/s of root damage:

<u>*Phytophthora / Pythium* species</u>

i) Isolation of surface sterilised root sections onto P5ARP agar

ii) Floats in autoclaved pond water to stimulate sporangia production

iii) Lateral flow device kits (LFDs) for *Pythium* and *Phytophthora* were utilised

<u>*Cylindrocarpon destructans* & *Fusarium* species</u>

i) Isolation from surface sterilise root sections onto Potato Dextrose Agar (PDA)

ii) Root float dishes may contain cigar-shaped brown spores of *Cylindrocarpon* or sickle-shaped spores of *Fusarium*

There are many species of *Fusarium*, with a range of abilities to colonise various tissues. It was not possible in the time available to key-out the *Fusarium* species present in the majority of tissue samples (which could be secondary rather than primary colonisers). Colony colour on agar is used to assist in identification e.g. *Fusarium solani* (pale pink) and *Fusarium culmorum* (cherry red, often with yellow) and so this was recorded.

<u>*Verticillium dahliae*</u>

i) Discoloration of the xylem (sapwood) by toxins from the fungus decreases upwards The fungus may be above the staining, but higher wilting/dieback reflects xylem damage below, not the pathogen presence there

ii) Isolation onto PDA of slices sawn through the stem at various heights, surface sterilised well, & incubated

iii) Damp boxes made of whole lengths of stem to produce mycelial growth

<u>*Armillaria* species (Honey fungus)</u>

i) Examination for black “bootlaces” around roots and under bark once the disease is well developed

Diagnosis of diebacks caused by cankers or wounds:

i) Isolation from the margins of stained internal tissue, surface sterilised then incubated on PDA

ii) Damp chamber incubation of whole twigs, followed by microscope examination of fruiting bodies

<u>*Phomopsis / Diaporthe* spp.</u>

i) Dissection to find firm brown decay of the wood within affected branches, particularly at the base, with an associated brown pith decay. Pith decay will often extend beyond the limits of wood decay. Symptoms will be found on parts of the crown below affected branches

ii) Examination of the tops of the main roots for browning

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

iii) Damp chambering for several weeks will produce black *Phomopsis* pycnidia in damp chambers are followed by black long-necked *Diaporthe* perithecia. *Diaporthe pungens* & *D. strumella* have been found on gooseberry

Eutypa lata

i) Enters vascular system via wounds to cause a leaf stunt/wilt. Examination for V-shaped internal cankers progressing from a wound along the branch back towards the main stem causing a "dead-arm"

ii) Black perithecia spore bodies can form in canker bark and may be encouraged to form by damp-chambering

Nectria cinnabarina (Coral spot)

i) This enters the vascular system via wounds and salmon / red coloured pustules can be seen to have formed on die-back twigs

Botryosphaeria ribis

i) Black pycnidia spore bodies form on stem cankers not long after infection

Botrytis cinerea (Grey mould)

i) Browning, then grey sporulation, on fresh tissue which can be encouraged by damp chambering in the light

ii) Bleached old stems can develop sclerotia resting bodies over several weeks

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Appendices 2 to 5 tabulate results from the questionnaires answered by growers.

Appendix 2. Previous cropping and any recent pre-crop use of a partial soil sterilant

Location & ADAS contact	Previous cropping	Partial soil sterilant usage
S. England 1 (J. Allen)	Black & red currants, gooseberries & runner beans	Not known for this or previous crop
E. England (J. Allen)	Site B: Potatoes Site W: Rape	None before this, not know previously
W. England (C. Creed	cv. Invicta: raspberries 2 x cabbage gooseberries cv. Careless: strawberries 2 x cabbage, gooseberries	None before this or previous crop
S.E. England 1 (H. Roberts)	Plums and before that apples	None before this or previous crop
S. Midlands (J. Allen)	Strawberries	Methyl bromide pre gooseberries as *Verticillium* history
S.E. England 2 (E.Wedgwood)	Not recorded	None before this or previous crop
S. England 2 (J. Allen)	2005-2006 = Potatoes. Before this runner beans for 2 years. Prior to this autumn fruiting raspberries for 10 yrs	None before this or previous crop
E. Midlands (J. Allen)	Strawberries & or various vegetable crops including possibly potatoes.	None before this or previous crop

© Agriculture and Horticulture Development Board 2013. All rights reserved

Appendix 3. Soil type, drainage and bed design

Location & ADAS contact	Soil Type	Soil Drainage	Single or multi rows	Bed type	Polymulch under bushes and weed control
S. England 1 (J. Allen)	Sandy Loam	Freely draining but can sometimes be subject to short term water be subject to short term water logging.	Not specified	Flat	No polymulch
E. England (J. Allen)	Sand stones loam	Site B: Very freely draining	Single Rows	Site B: Raised beds	No polymulch
		Site W: Freely draining but can sometimes be subject to short term water be subject to short term water logging.		Site W: Flat beds	
W. England (C. Creed)	Sandy Clay Loam	Freely draining but can sometimes be subject to short term water be subject to short term water logging.	3 row beds	Flat	No polymulch
S.E. England 1 (H. Roberts)	Clay Loam	Freely draining but can sometimes be subject to short term water be subject to short term water logging.	Single rows	Raised beds	Woven plastic mulch laid over beds
S. Midlands (J. Allen)	Very light loamy sand over lying sand.	Very freely draining. i.e. never subject to water logging.	Single rows	On a slight ridge.	Woven plastic is laid over the soil surface of the beds and the bushes planted through it
S.E. England 2 (E.Wedgwood)	Sandy Loam	Freely draining but can sometimes be subject to short term water be subject to short term water logging.	Single rows	Raised beds	No. polymulch
S. England 2 (J. Allen)	Contains a great deal of stone.	Freely draining but can sometimes be subject to short term water logging. One section of plantation very subject to waterlogging.	Single rows	Raised beds	Black polymulch covers soil surface in crop rows, bushes planted through this. Grassed down alleys, weed control along bases of beds where polymulch meets grassed alleys using residual & contact herbicides.
E. Midlands (J. Allen)	Silty loam overlying clay subsoil.	Slowly draining and susceptible to short term water logging.	Single rows	On Flat	No polymulch. Contact & residual herbicides to create a strip of soil approx 1.5m wide. Grassed down alleys

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Appendix 4. Varieties planted, when planted, source of planting material and spacing within and between rows

Location & ADAS contact	Varieties grown	Plantation planting years	Planting material used	Source of planting material	Spacing
S. England 1 (J. Allen)	Invicta	2002 in bush sample area 2004 in other half	2002 planted = 1 yr old bare rooted bushes. 2004 = Rooted cuttings	Bought-in, possibly from R. W. Walpole	In row 0.5 m Between rows 3.1 m
E. England (J. Allen)	Site B: Careless	Site B: 2002	Rooted cuttings	Trevor Moore	In row: 18 inches Between row 8ft
	Site W: Invicta	Site W: 2008			
W. England (C. Creed)	Careless, Invicta, Leveller	Careless: 2002 Invicta: 2004	2 year old bare rooted bushes	Own production bushes are produced for sale	In row: Careless 1.2 m Invicta = 1.4 m Between rows, all 3 rows 1.6 m. 4.8m bed
S.E. England 1 (H. Roberts)	Pax	2007. Have been gapped up since	Rooted cuttings. 2 rows of ex-potted rooted cuttings, now bigger & healthier.	Hargreaves Plants	In row: 0.7 m Between rows: 1. 5 m bed to bed. beds: 1 m
S. Midlands (J. Allen)	Invicta	2009	1 year old bare rooted bushes	Hargreaves Plants	In: 0.5m Between rows: 2.2m
S.E. England 2 (E.Wedgwood)	Invicta	2008	1 year old bare rooted bushes	Hargreaves Plants	In row: 1 m Between row: 2.5 m
S. England 2 (J. Allen)	Invicta	February 2007	2 year old bare rooted bushes via two batches, 2nd batch only 1 yr old.	Initial planting R. W. Walpole (ex Polish nursery). Gapping up either R. W. Walpole or T. Moore.	In row: 1 m Between rows: 3.6 m
E. Midlands (J. Allen)	Invicta, Hinnonmaki Red & H. Yellow	2005-06	1 year old bare rooted bushes	Hargreaves Plants	In row 1.5 m Between rows 2.4 m

© Agriculture and Horticulture Development Board 2013. All rights reserved

Appendix 5. Irrigation and fertiliser use

Location & ADAS contact	Irrigation used	Method	Fertiliser application	Nitrogen per annum
S. England 1 (J. Allen)	Yes	Trickle irrigation lines laid down every row	Granular base fertiliser only	81 kg/ha
E. England (J. Allen)	Yes	Trickle irrigation lines laid down every row	A combination of granular base and fertigation	Not known
W. England (C. Creed)	No	N/A	Granular base fertiliser only	75 kg/ha
S.E. England 1 (H. Roberts)	Yes	Trickle irrigation lines laid down every row	Fertigation only	Not known
S. Midlands (J. Allen)	Yes	Trickle irrigation lines laid down every row	A combination of granular base and fertigation	60-80 kg
S.E. England 2 (E.Wedgwood)	Yes	Trickle irrigation lines laid down every row	Fertigation only	Not known
S. England 2 (J. Allen)	Regularly late spring, summer, early autumn.	Trickle irrigation lines laid down every row	A combination of granular base and fertigation	70-80 kg. Part applied as base dressing prior to onset of crop growth in March about 30kg/ha, the rest via fertigation from mid-late May - end of July/early August.
E. Midlands (J. Allen)	Rarely irrigated	Fixed overhead sprinklers	Granular base fertiliser only	80 kg

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

Appendix 6. Fungicide use in the surveyed gooseberry plantations in 2012.

Location & ADAS contact	Fungicide use and dose rate/ha	Application dates
S. England 1 (J. Allen)	Systhane 20 WG at 0.330L for powdery mildew & leaf spot.	24/3/12, 14/4/12 & 30/7/12
	Stroby WG at 0.2kg for leaf spot control.	4/4/12
	Switch at 1kg for botrytis & powdery mildew.	10/4/12 & 4/5/12
	Teldor at 1.25kg for botrytis .	21/4/12 17/5/12 & 30/5/12
	Fortress at 0.2L for powdery mildew.	21/4/12 & 17/5/12
	Nimrod at 1L for p. mildew.	23/5/12
	Orosorb (Citrus oil) at 4L/ha for powdery mildew.	8/6/12, 18/6/12 27/6/12, 1/7/12 & 10/7/12
E. England (J. Allen)	Corbel, Teldor, Systhane	
W. England (C. Creed)	Corbel , Radspor, Fortress, Switch . Potassium bicarbonate + Orosorb mix	Each applied twice Reapplied continuously
S.E. England 1 (H. Roberts)	Corbel, Stroby, Systhane, Serenade ASO, Fortress, Teldor, Nimrod, Potassium bicarb.	
S. Midlands (J. Allen)	Systhane 20 EW at 330ml/ha Stroby WG at 2L/ha Switch at 1kg + Nimrod at 1.5L/ha Teldor at 1.5kg + Fortress at 250ml/ha Fortress at 250ml/ha Nimrod at 1.5L/ha Fortress at 250ml/ha	17/3/12 31/3/12 30/3/12 11/4/12 2/5/12 23/5/12 29/5/12
S.E. England 2 (E.Wedgwood)	Systhane mainly, Stroby/Corbel also used	
S. England 2 (J. Allen)	Teldor at 1.5kg + Calypso at 250ml Teldor at 1.5kg + Nimrod at 1.1L Fortress at 250ml Nimrod at 2L Orosorb at 4L	26/4/12 11/5/12 16/5/12 26/5/12 9, 17, 23 & 30/7/12 during harvest
E. Midlands (J. Allen)	Systhane 20EW Stroby WG Teldor + Fortress Systhane 20EW + Switch Teldor + Fortress Fortress Nimrod Systhane 20EW	22/03/12 3/04/12 16/04/12 26/04/12 4/5/12 17/5/12 27/5/12 6/6/12

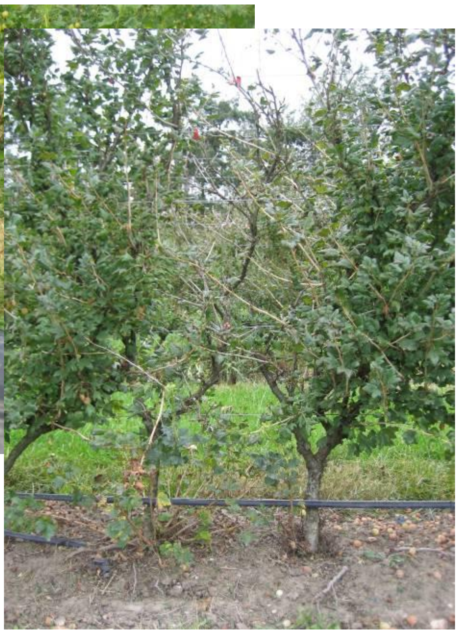
In the East Midlands and S. England 2 plantations the last fungicide applications were about 14 days before harvest. Post-harvest applications were then not possible as PYO customers were harvesting other fruit nearby until early August.

Appendix 7. Survey form used to obtain information on plantation husbandry.

HDC Project: Gooseberry: Plantation survey to determine the causal agents of individual branch & whole bush dieback or death and assessment of factors leading to greater incidence

Dear colleague we would be grateful if you could collect the following information for the gooseberry plantation that you are monitoring & collecting plant samples from for the above project.

Individual branches of bushes affected by this problem, may fail to break bud, break bud slowly or unevenly, their foliage wilt and then die prior to during or soon after harvest. The main stem and roots of the plants remain alive and produce new apparently healthy shoots or branches either that or the following year. Or all of the branches of affected bushes may fail to break bud, break bud slowly, their foliage wilt and eventually the whole bush including the main stem and roots die.



© Agriculture and Horticulture Development Board 2013. All rights reserved

Location of plantation:

Name of owner or company

Address:

Address (where plantation is located):

Name of field of gooseberry plantation which is to be surveyed:

Plantation details

What area is planted?

What is the soil type?

Does the soil drain freely (please √ which describes the soil best)

- *Very freely draining i.e. never subject to water logging*
- *Freely draining but can sometimes be subject to short term water logging*
- *Slow draining and susceptible to short term water logging*
- *Badly drained*

Are the bushes planted in single rows or multi row beds?

Are the bushes planted on the flat or into ridges or raised beds?

Is polymulch or woven plastic mulch laid over the soil surface of each crop row?

Are the bushes irrigated?

If so how (please √ which method of irrigation applies)

- Fixed overhead sprinkler lines
- Mobile overhead sprinkler lines used several times each summer
- Hose reel irrigator used
- Trickle irrigation lines laid down every row
- A combination of the above used (if so what systems)

How is fertiliser applied to the bushes (please √ which applies)*?*

- Granular base fertiliser only
- Fertigation only

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

- A combination of the above

How much nitrogen is applied per annum?

What varieties are planted in the plantation?

When were the bushes planted?

What was planted (please put a tick against the planting material used to establish the plantation)?

Unrooted cuttings
Rooted cuttings
1 year old bare rooted bushes
2 year old bare rooted bushes
Other than the above (please describe)

Where were the plants obtained?

Were they sourced on farm?

Were they bought in, if so from whom were they purchased?

What is the spacing?

In row:

Between rows:

How are the bushes managed?

Free standing on leg or on trellis cordon or fan trained (please briefly describe system being used:

Are the bushes winter pruned & if so when?

Are the bushes summer pruned if so when & how is this carried out by hand or using a hedge cutter?

Symptoms displayed by bushes *(please put a tick against whichever applies)*

Are some of the branches of the bushes dying?

Are all the branches and the stem and roots of bushes dying?

What % of the bushes in the plantation; are displaying the following symptoms:

- Branches of bush dying

- Branches, stem and roots of bush dying

© *Agriculture and Horticulture Development Board 2013. All rights reserved*

N.B. please enter % affected against both of the above if the plantation contains bushes which are displaying both of the above symptoms

When were the bushes first observed to be suffering from?

Dieback of branches

Whole bushes dying

Has the problem increased in its severity each year since the first affected plants were found?

What crops were previously grown in the plantation?

What was the last crop before the gooseberries?

Soil treatments

Was a partial soil sterilant used prior to planting the gooseberries if so what was used?

Was a partial soil sterilant used prior to planting the crop before the gooseberries were planted, if so what was used?

Disease control in present plantation

What fungicides are currently used in the affected plantation?

Any other observations *(Please enter any other comments or observations about the bushes and the way in which they are grown which you feel may affect the problem)*

Please make sure that you complete the sample form supplied with this questionnaire and send it with the bushes you have lifted during your current visit to the plantation to Erika Wedgewood at ADAS Boxworth.

Thank you for completing this questionnaire, can you now please email this to Erika Wedgewood cc to Janet Allen

© *Agriculture and Horticulture Development Board 2013. All rights reserved*