CONTRACT REPORT

Roses: An examination of causes of 'Spring Dieback' in containerised bush roses

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AUTHENTICATION

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

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CONTENTS

	Page No.
PRACTICAL SECTION FOR GROWERS	
Objectives and background	1
Summary of Results	2
Benefits from study and recommendations for future R & D	3
EXPERIMENTAL SECTION	
Introduction	4
Materials and Methods	
Questionnaire	5
Disease assessments on growers' holdings	7
Results	
Questionnaire	8
Spring dieback	8
Cold storage dieback	10
Nursery visits	12
Isolations	
'Spring dieback' material	14
Cold storage dieback material	14
Discussion	17
Recommendations for further work	19
References	20
Appendices	21
Acknowledgements	27

PRACTICAL SECTION FOR GROWERS

Objectives and background

Dieback-type symptoms in certain varieties of bush rose have long been seen in small numbers of plants and these can be allotted to a number of different causes worldwide. Work at GCRI in Littlehampton during the late 1970s (Thomas, 1980) described a rose dieback which was very similar to 'spring dieback'. In this study, isolations from affected plants did not yield any pathogens, and because the problem only occurred infrequently, with no evidence of spread, either within or between nurseries, it was concluded that, under the prevailing conditions at that time, the disorder posed no serious threat to UK rose growers. However, in recent years, the problem does appear to have become more widespread and frequent, with losses on both commercial growers' holdings and at garden centres causing some concern. This increased incidence of 'spring dieback' may be due to the introduction of more 'susceptible' varieties, but may also be linked to the increasing containerisation of bush roses in the autumn/winter for spring/summer sales.

The symptoms of 'spring dieback' are very poor spring shoot growth, accompanied by little or no new root development (see Plate 1, Appendix I). New emerging shoots often fail to develop (eg. from new growth of potted roses in spring). Sometimes buds do break and new leaves unfurl, but then fail to develop further and may wither and die. In other cases, the bushes remain stunted and 'behind', frequently showing poor sized leaves which often typically curl downwards at the edges. Normally, when affected plants are turned out of their pots, little or no new root development is present. Previous attempts to isolate possible causal pathogens at HRI Efford were unsuccessful, although several species of opportunistic colonisers were seen (eg *Fusarium* spp. and *Pythium* spp.). There is anecdotal evidence to suggest that a major factor in the incidence of the condition is a reduction in vigour, possibly resulting from depletion of carbohydrate reserves at the latter part of the previous season's growth. This has implications for defoliation treatments and also the possible effects of late season epidemics of foliar pathogens.

The objectives of this pilot study were to carry out a survey and a small number of detailed disease assessments in order to:

a) clearly identify and define the problem known as 'spring dieback';
b) assess the scale and economic impact of 'spring dieback';
c) identify possible causes and therefore methods of avoidance of 'spring dieback''
d) identify areas where future research is needed to help deal with the problem.

Summary of Results

A questionnaire was sent out to rose growers which was designed to collect information on the nature and occurrence of two symptom types and to assess whether they were linked. These were described as 'spring dieback' as outlined above and 'cold storage dieback', a problem seen with the cold storage of cv. 'Sweet Dream'. In addition to the questionnaire, isolations were taken from plants affected by cold storage dieback and by spring dieback and detailed assessments were made of the effects of plant 'condition' in the autumn on overwintering and subsequent spring dieback in small groups of plants on two commercial nurseries and at HRI Efford.

The results showed that spring dieback and cold storage dieback do not seem to be related. Spring dieback appears to be a physiological problem, possibly induced by a depletion of the plant's vigour in the previous autumn, whereas cold storage dieback appears to result from the direct action of *Pythium* infections in storage.

A reasonable response was received to the questionnaire, and 28% of respondents did not consider spring dieback to be a significant problem. The remaining 72% of respondents unanimously considered the problem to cause between 1 and 5% losses overall. The response on losses in 'problem' varieties was more varied, but averaged between 10 and 50%, depending on the year. The severity of spring dieback was perceived to vary from year to year by most respondents, although the results were not sufficiently clear to draw any conclusions and identify individual 'problem' years. There is strong evidence that 'spring dieback' is variety-specific and 37% of respondents said that this had influenced their choice of varieties. The most frequently listed 'problem' varieties, which some growers now avoid, were 'Blue Moon', 'Elizabeth of Glamis' and 'Piccadilly'. Interestingly, 53% of respondents said that they were still growing problem varieties, largely due to customer demand. Problem varieties in this category included those already mentioned as well as 'Apricot Silk' and 'Just Joey', but by far the most popular 'problem variety' was 'Whisky Mac'. This result indicates that it is probably commercially worthwhile to develop strategies for avoiding spring dieback in popular but susceptible varieties.

The majority of growers questioned felt that damage and depletion by disease (especially powdery mildew and rust) in the preceding autumn was an important factor in the incidence of spring dieback. Other factors were suggested, for example drying out of roots after lifting, mowing back too late, lifting too early after hard pruning and too long a period between lifting and potting. Most of these factors would be likely to deplete plants' reserves as they go into dormancy, and it is possible that the subsequent loss of vigour in the spring leads to expression of dieback symptoms in susceptible varieties. This is supported by the detailed observations. Verification of this requires further investigation, but could lead to some straightforward

guidelines for avoiding spring dieback when growing susceptible varieties. Isolations from plants with 'spring dieback' symptoms consistently showed the absence of pathogens in affected tissues. This supports the proposition that 'spring dieback' is a physiological problem and further research should be focused on the impact of reducing plants' vigour on the expression of 'spring dieback'.

Only a small number of respondents to the questionnaire had any experience of cold storage. However, enough information was collected to indicate that cold storage dieback is not related to spring dieback. Cold storage dieback does not appear to be variety-specific, although some varieties (e.g. 'Flower Carpet') are resistant. Isolations from plants with cold storage dieback indicated that this problem could be the result of infection by *Pythium* sp., although further work is required before control measures can be recommended.

Benefits from study and recommendations for future R & D

This study has shown that 'spring dieback' is a widespread problem in UK rose production. The problem is variety-specific and in 'problem' varieties can cause serious losses. The study has also shown that spring dieback and cold storage dieback are separate problems caused by different agents. Cold storage dieback apparently results from infection by *Pythium* sp. whereas 'spring dieback' appears to be a physiological problem. In order to develop control strategies for these diseases further research is required to:

'Spring Dieback'

- assess the impact of late season powdery mildew and rust epidemics on 'spring dieback';
- assess the impact of autumnal defoliation and pruning treatments on 'spring dieback';
- determine the importance of carbohydrate reserves and their depletion on the expression of 'spring dieback';
- assess the impact of drying out and root death during containerisation on the development of 'spring dieback'.

'Cold storage dieback'

- identify the stage at which infection occurs in cold storage dieback;

INTRODUCTION

Recent work assessing methods for scheduling the production of containerised bush roses ready for market (HNS 65) has shown that certain varieties such as 'Trumpeter', 'Blue Moon', and 'Dearest' are prone to a condition which has been described as 'spring dieback'. Dieback-type symptoms in certain varieties of bush rose have long been seen in small numbers of plants and in-depth studies of diebacks of roses (Thomas, 1980) identified a number of causes worldwide. Thomas (1980) described a condition similar to spring dieback, classifying it under the general heading 'rose dieback'. As isolations from affected material did not yield any pathogens, and the problem only occurred infrequently with no evidence of spread, either within or between nurseries, it was concluded that, under the prevailing conditions at that time, the disorder posed no serious threat to UK rose growers. However, in recent years, the problem does appear to have become more widespread and frequent, with losses on both commercial growers holdings and at garden centres causing some concern. The increased incidence may be due to the introduction of more 'susceptible' varieties, but may also be linked to the increasing containerisation of bush roses during the autumn/winter for spring/summer sales.

The symptoms of 'spring dieback' are very poor spring shoot growth, accompanied by little or no new root development (see Plate 1, Appendix I). New emerging shoots often fail to develop (eg. from new growth of potted roses in spring). Sometimes buds do break and new leaves unfurl, but then fail to develop further and may wither and die. In other cases, the bushes remain stunted and 'behind', frequently showing poor sized leaves which often typically curl downwards at the edges. Normally, when affected plants are turned out of their pots, little or no new root development is present. Attempts to isolate possible causal pathogens at HRI Efford have so far been unsuccessful, although several species of opportunistic colonisers have been seen (eg *Fusarium* spp. and *Pythium* spp.). The appearance of 'spring dieback'-affected tissues tends to be indicative of a physiological problem. There is anecdotal evidence to suggest that a major factor in the incidence of the condition is a reduction in vigour, possibly resulting from depletion of carbohydrate reserves at the latter part of the previous season's growth. This has implications for defoliation treatments and also the possible effects of late season epidemics of foliar pathogens.

The objectives of this pilot study were to carry out a survey and a small number of detailed disease assessments in order to:

a) clearly identify and define the problem known as 'spring dieback';
b) assess the scale and economic impact of 'spring dieback';
c) identify possible causes and therefore methods of avoidance of 'spring dieback''
d) identify areas where future research is needed to help deal with the problem.

MATERIALS AND METHODS

Questionnaire

A questionnaire was prepared with the assistance of Margaret Graham of HDC. This contained an introduction, a brief summary of the symptoms of 'spring dieback' (including a description of a problem associated with cold storage which could possibly be linked with spring dieback), and a series of questions. The questions were aimed at identifying the nature and scale of each respondent grower's production, the scale of disease problems (if any) on each holding, and collecting anecdotal evidence to help identify possible causes. The format of the questionnaire is illustrated in Appendix II, and the text and questions were as follows.

Introduction: Producers frequently experience problems with poor performance of roses in spring. This takes several forms, and it is blamed on a variety of causes. Rose growers have requested the Horticultural Development Council to fund research which will give industry the means to reduce spring dieback. The first stage of the research is a survey, where we aim to find out in more detail now spring dieback affects the rose growing industry. We are seeking your assistance. We would greatly appreciate it if you could fill in this questionnaire and return it in the pre-paid envelope.

Background: We suspect that a number of separate factors are involved in what has been lumped together under the general title of 'Spring Dieback' (sometimes known as canker). There are two groups of distinct symptoms that we are particularly interested in for the purposes of this survey. They are described below. The syndromes may be linked to one another.

Descriptions:

A. 'Spring dieback' proper

- New emerging shoots fail to develop (e.g. from new growth of potted roses in spring).
- Sometimes buds break and new leaves unfurl, but then fail to develop further.
- Buds that have formed may wither and die.
- In other cases, the bushes remain stunted and 'behind'. These bushes often have poor leaf size.
- Little or no new root is present when bushes are turned out of their pots.

B. 'Cold storage dieback'

- Problems with cold-stored material, particularly when bare root plants are held for an extended period.
- Stem blackening and/or development of purple blotches on stem (often extending back from cut ends) and sometimes on or around the bud union.
- In severe cases, the whole shoot blackens and plants can die.
- Cv. Sweet Dream is particularly prone to this problem.
- When affected plants are potted up and unhealthy parts of shoots removed, subsequent development is usually normal.

Questionnaire section: Name & address of nursery. (If you fill in your name and address, we can keep you up to date on the results of the survey. If you prefer to remain anonymous, we will understand.)

How many containerised bush roses do you produce annually?

(Please answer each question separately for the two symptom types (spring dieback and cold storage dieback) using the spaces provided.

If you do not use cold storage, please tick this box □ and ignore the questions in the cold storage dieback column.

1) What proportion of losses would you associate with this problem as a year to year average? For all cultivars (containerised). On 'problem' cultivars.

2) Has the problem influenced your choice of cultivars? YES/NO

3) If yes, please list which cultivars you have stopped growing because they had 'dieback' problems in containers.

4) Are there cultivars with dieback problems that you are still growing (e.g. because of high customer demand)? YES/NO

5) If you answered yes to 4, please list the cultivars

6) Does the problem vary significantly from year to year? YES/NO
List any years which have been particularly problematic. List any years which have been relatively trouble-free.

7) Are there any particular agronomic/cultural factors you suspect may influence the problem? Defoliation? Nutrition? Disease? Production of large numbers of hips in the preceding season? Cold storage? Other (please specify). With cold storage dieback: Time in storage? Humidity in storage? Storage temperature?

8) Do you have any comments or observations you wish to add which might help us in assessing this problem?

Thank you for your time. Please return this form in the envelope provided. All answers and information received will be treated as confidential.

A list of 108 rose growers and potentially interested HDC levy-payers was prepared from lists of HDC members and a copy of the above questionnaire, accompanied by a business reply envelope, was sent to each of these. The replies were collected by the HDC and sent on to HRI Efford for opening, processing and analysis.

Disease assessments on growers' holdings

Detailed assessments of 'spring dieback' were carried out on small numbers of plants on three holdings (including HRI Efford). Assessments were of two types:

a) Isolations from affected plant material (79 plants in total, 8 varieties)

b) Observations of ten selected plants on each holding: recording their condition in late Autumn 1996 and their performance in the following spring of 1997.

Isolations were also carried out on samples taken from 20 plants affected by 'cold storage dieback' and taken from cold storage at HRI Efford and two commercial nurseries.

RESULTS

Questionnaire

Of the 108 questionnaire forms sent out, 83 were sent to rose producers on the HDC member list and 25 were sent to voluntary HDC members with a possible interest in rose production. In response to this, 28 forms were returned completed, and two detailed reports from nurseries were sent in letters, amounting to 30 responses in total. Also, in addition to this, there were three replies stating that they were no longer involved in rose production. There was no response from the voluntary HDC members and so the overall response was only considered in terms of the rose growers contacted and amounted to 36%.

The scale of production by respondents ranged from 500 to 1.2 million bushes and 0 to 40,000 standards per annum, with the average production per nursery at about 87,000 bushes and 4,200 standards. All respondents answered questions in section A on spring dieback, but only 5 indicated any experience of cold storage by answering questions in section B on cold storage dieback.

Spring dieback

Spring dieback was considered not to be a problem by only 28% of all respondents. The remaining 72% unanimously considered the problem to cause between 1-5% losses overall. However, losses of 'problem varieties' varied greatly from 1-5% to 50-75% with the majority falling between 10 and 50%. This may, to some degree, be dependent on the choice of varieties grown by each respondent. In response to the question as to whether the incidence of 'spring dieback' has influenced their choice of varieties, respondents were split almost 50:50, with 40% answering 'no', 37% answering 'yes', and 23% not answering at all. When asked to list 'problem varieties' now avoided, some varieties were frequently mentioned, most notably 'Blue Moon', 'Elizabeth of Glamis' and 'Piccadilly' (Table 1). Interestingly, the proportion of growers who were still growing 'problem varieties', largely due to customer demand, was 53%, as opposed to 20% who were not, with 27% not answering. The list of varieties in this category still included the three varieties mentioned above, but the variety with the widest popularity, despite dieback problems, was 'Whisky Mac'. Several growers stated that, although they produced 'problem varieties' in response to demand, the numbers they grew were less than they might be because of the risks of dieback problems.

Opinion was divided on whether the incidence of spring dieback varied from year to year, with 47% saying it did, 33% saying it didn't, and 20% not answering the question. The second part of this question requested a listing of years when spring dieback had been particularly problematic, and those which had been relatively trouble free. This was probably the most

subjective question of the questionnaire, and the resulting answers, which should be treated with caution, were contradictory in a lot of cases. The years 1987, 1990, 1991, 1993*, 1994*, 1995*** and 1996*** were suggested as those when spring dieback was particularly prevalent (years marked with asterisks were mentioned by 2 or more respondents).

A summary of the replies on possible causal factors of spring dieback is given in Table 2. The most commonly suggested factor was disease in the preceding season. Three respondents qualified this by suggesting that late season rust and powdery mildew epidemics could have an adverse impact on plants' over-winter survival. One other respondent suggested a similar effect from late summer/early autumn defoliation by downy mildew. The possible involvement of *Botrytis* was also suggested by two respondents. No-one considered the over-production of hips in the preceding season to be of any importance. Cold storage was considered to be a possible factor by 13% of respondents and 27% considered some form of cold damage (i.e. wind-chill or very cold air temperatures in spring; e.g. -8° in April 1997) to be important. Defoliation in the preceding autumn and levels of nutrition were both considered to be important factors by 13% of respondents. Other potentially important factors identified were the level of dehydration of roots post-lifting and the timing of lifting bushes; some growers had shifted their lifting time from late autumn to January and had experienced a noticeable drop in the incidence of spring dieback. At the end of the questionnaire was a section for overall comments on the spring dieback problem. This received a good response, with a wide range of comments, which are summarised as follows:

Factors which possibly increase spring dieback

- Herbicide use
- Mowing back too late
- Lifting too early
- Drying out roots after lifting
- High wind exposure
- Hard pruning
- Putting bare roots into storage without fungicide treatments
- Mild autumns - leaves remain longer, encouraging late-season foliar disease
- Cold - wet springs

Factors which possibly reduce spring dieback

- Lifting and potting on same day
- Use of controlled release fertiliser in potting medium
- Lifting and potting later (i.e. Christmas onwards, as opposed to late autumn)

Cold storage dieback

The section of the questionnaire concerning cold storage dieback was only filled in by 5 respondents. Overall losses due to cold storage dieback were estimated to be between 0 and 25%. there was no clear evidence, from the answers to the questionnaire, of any particular varieties being more susceptible to this disorder. However, estimates of losses on 'problem varieties' were higher, at between 0 and 75%. Only one out of the five respondents said that the disorder influenced their choice of varieties, having decided not to use var. Piccadilly for cold storage. However, two respondents said that they were using 'problem varieties'. Of these, one stated varieties with problems varied from year to year, and the other suggested 'Sweet Dream', 'Red Devil' and 'Royal William' as potential 'problem varieties'. There was no indication of variation between years in the severity of the problem as yet.

The factors thought to have the greatest influence on the problem were disease and time in store, although defoliation and conditions in the store were also considered to be important. As yet no in-depth assessment of varietal susceptibility is possible. However, there was some evidence to suggest that some varieties, for example var. 'Flower Carpet', cold store well, and very rarely show dieback symptoms when potted up. The areas suggested where improvements might be made with further investigation were in the management of chemical dips/drenches prior to storage and the effects of storage temperatures below 0°C on the disease.

Table 1: Spring dieback: summary of 'problem varieties'

Varieties avoided due to problems	Varieties suffering with problems, but still grown due to customer pressure
'Bettina'	'Apricot Silk'*
'Blue Moon'**†	'Blessings'
'Diorama'	'Blue Moon'***†
'Elizabeth of Glamis'**†	'Dearest'
'Gingernut'	'Elizabeth of Glamis'**†
'Golden Sun'	'Freedom'
'Golden Treasure'	'Just Joey'*
'Harry Wheatcroft'	'King's Ransom'
'High Hopes'	'Mischief'
'Orange Silk'	'Piccadilly'†
'Piccadilly'*†	'Queen Elizabeth'
'Sarah'	'Silver Wedding'†
'Silver Wedding'†	'Stirling Silver'
'Topsi'	'Strawberry Fayre'
'Uncle Walter'	'Sunblest'
'Whisky Mac'†	'Superstar'
'Wisbech Gold'	'Wedding Day'
	'Whisky Mac'****†
	'Zephirine Drouhin'

* More than a single reference as a 'problem variety' in this category
† Variety referred to in both categories

Table 2: Breakdown of replies on possible causes of spring dieback of bush roses

Possible causes		% of respondents suggesting this as possible factor
No answer		17%
Defoliation		13%
Nutrition		13%
Disease*		23%
Over production of hips in preceding season		0%
Cold storage		13%
Other - Dehydration post lifting		17%
Lifting too early in autumn		10%
Cold spring/High wind-chill		13%
* Suggested disease problems were	Rust & powdery mildew late autumn	10%
	Downy mildew	3%
	Botrytis	7%

Nursery Visits

On each of the three nurseries visited, a small group of plants was selected in the autumn for observation over winter. Each group was deliberately selected to represent a range of states of health, from good to poor. Observations of which types of plant tended to suffer from spring dieback were taken into account when selecting plants. The 'condition' of each plant was recorded in autumn and in the following late spring/early summer and these records are summarised in Table 3. For the summaries presented, plants were divided into three broad categories, based on their condition in spring/summer 1997:

Good = marketable;
Poor = not marketable and showing symptoms of spring dieback;
Dead.

Not surprisingly, the size of plants in autumn, in terms of the number of shoots, appeared important in terms of survival over winter. In the healthiest plants, no new 'main' shoots developed, with all the new growth coming on the established branches, whereas in some of the poorer 'spring dieback' plants, small, thin shoots did develop from the base of the plant. The incidence of purple lesions around the petiole bases appeared important, with more affected shoots on plants in the 'poor' and 'dead' categories. Isolations from these lesions yielded *Botrytis cinerea* in both autumn and spring from nursery A and *B. cinerea* in the autumn only from nursery C, but no pathogens were isolated from material collected from nursery B in either autumn or spring/summer (although powdery mildew, which cannot be isolated using agar plating techniques, was seen). At Nursery A, it may be reasonable to suggest that a large number of the plant deaths resulted from the confounding effects of over wintering and sustaining a heavy infestation of *B. cinerea* However, the incidence of *B. cinerea* and the size of the lesions at nursery C did not indicate that *B. cinerea* was the primary cause of plant death.

Plants selected for observation at nurseries A and B were badly affected by late season powdery mildew epidemics. The amount of disease was higher at nursery B and could have been a major factor in the poor survival of these plants. Powdery mildew appeared to have less impact on plants at nursery A, although the amount of infection was still higher in plants classed in the 'poor' and 'dead' categories.

Table 3: Summary of the condition of small samples of plants at 3 separate nurseries determined in autumn 1996 and the following spring/summer 1997.

Autumn				Spring/Summer			
Mean No. shoots	Mean No. shoots with purple lesions	Mean powdery mildew Score (0-5)	No. of plants	Plant condition	Mean No. shoots	Mean No. new shoots	Mean No. dead shoots
Nursery A: no. plants assessed = 20, cv. 'Blue Moon'							
19/11/96				**15/4/97**			
4.5 (0.5)*	0 (-)	1 (1.0)	2	Good	4.5 (0.5)	0 (-)	0 (-)
3.7 (0.4)	1.8 (0.6)	1.7 (0.5)	9	Poor	4.3 (0.3)	0.7 (0.2)	2.3 (0.3)
3.9 (0.6)	2.4 (0.7)	1.6 (0.7)	9	Dead	3.9 (0.6)	0 (-)	3.8 (0.5)
Nursery B: no. plants assessed = 10, cv. 'Superstar'							
6/12/96				**27/6/97**			
4.7 (0.9)	1 (0.6)	1.3 (0.9)	3	Poor	3 (0.6)	0.3 (0.3)	1.7 (0.9)
3.9 (0.4)	1.7 (0.2)	2.9 (0.6)	7	Dead	Not recorded		
Nursery C: no. plants assessed = 10, cv. 'Stirling Silver'							
18/12/96				**3/7/97**			
3.7 (0.3)	0 (-)	0 (-)	3	Good	3.3 (0.3)	0 (-)	0 (-)
3.3 (0.8)	1.0 (0.4)	0 (-)	4	Poor	3.8 (0.5)	1.3 (0.6)	0.8 (0.5)
2.3 (0.3)	1.0 (0.6)	0 (-)	3	Dead	Not recorded		

* Values in brackets are standard errors

Isolations

'Spring dieback' material

A number of media were used [Potato Dextrose Agar, *Fusarium*-selective agar (Pettitt *et al*, 1993), Phycomycete-selective agar (Pettitt & Pegg, 1991), King's B for bacteria (King *et al*, 1954) and sterile pond water 'floats'] for isolations from samples of plant material collected from nurseries A, B and C. A summary of the isolations carried out on spring dieback material and from plants involved in nursery observations is presented in Table 4. Firm conclusions cannot be drawn from the information presented in Table 4, although no pathogen species were isolated from tissues of plants showing the 'classic' symptoms of spring dieback. Samples of plant material collected in autumn and winter from the three observation trials at nurseries A, B and C were selected following suggestions that these plants were possible candidates for spring dieback in the following spring. In the majority of these isolations, confirmed pathogens were not isolated and no firm conclusions could be drawn. However, *Botrytis cinerea* was often isolated from purple lens-shaped lesions around petiole bases, especially at nursery A (Table 4), where this pathogen caused severe damage in cvs. 'Dearest' and 'Blue Moon'. Anecdotal evidence has suggested that an increased occurrence of spring dieback is often preceded by a high incidence of this type of purple lesion in the autumn.

Cold storage dieback material

Three separate batches of cold-stored rose plants were assessed; two from commercial nurseries and one from HRI Efford. All samples were of cv. 'Sweet Dream' and showed very similar symptoms. These consisted of dark purple necrotic patches on the surfaces of the main stems and sometimes a similar coloured 'dieback' from the cut ends of stems. The lesions did not seem to have common origins (eg. petiole bases) and, in extreme cases, they merged until the stem was killed. Cutting through the surface of these lesions to expose the woody tissues beneath revealed a firm brick red coloured rot which penetrated deep into the stem. Leading edges of this discoloured area were surface sterilised and plated on the media outlined above, and *Pythium* spp. (a member of the Phycomycetes) were consistently isolated (Table 5). This *Pythium* was not identified to species, nor was its pathogenicity confirmed, although some mycelium of isolate number A123 did cause necrosis when inoculated into some detached young shoots of cv. 'Sweet Dream'. Other species of fungi were isolated from tissues in accession A122 (*Trichoderma* spp. and *Fusarium avenacum*), but these were considered unlikely to be pathogenic.

Table 4: Results of isolations from plants showing symptoms of 'spring dieback' or in observation trials for 'spring dieback'

Date	Accession No.	Nursery	No. Plants assessed	Symptoms	Varieties	Result
5/12/96	A204	A	15	Purple stem necrosis at petiole bases	'Dearest' 'Blue Moon' 'Gingernut'	*Botrytis Cinerea* isolated
6/12/96	A205	B	3	"	'Superstar'	No pathogens isolated
19/12/96	A206	C	10	Random isolations, some material with small purple patches on stems	'Stirling Silver' 'Tequila Sunrise'	Inconclusive *B. cinerea* isolated from TS & SS *Fusarium Culmorum* from SS
19/12/96	A207	A	5	Plants lifted for potting with small amount of dieback on main stems	'Dearest'	*B. cinerea* confirmed
10/2/97	A215	B	6	Purple stem necrosis at buds	'Superstar' 'Blue Moon'	*B. cinerea* isolated from only Blue Moon
28/2/97	A225	A	3	'Classic' spring dieback symptoms	'Gingernut'	Majority of plants 'clear' *F. avenaceum* isolated from 1 plant, but very unlikely to be pathogenic
26/3/97	A235	A	5	"	'Gingernut'	Nothing isolated
15/4/97	A254	C	3	Purple stem lesions	'Blue Moon'	Small no. of *B. cinerea* isolates, but inconclusive
27/6/97	A283a	B	17	'Classic' spring dieback symptoms	'Apricot Silk' 'Superstar' 'Piccadilly'	Nothing isolated
30/6/97	A276	A	8	'Classic' spring dieback symptoms	'Blue Moon'	Nothing isolated
3/7/97	A283b	C	4	"	'Stirling Silver'	Nothing isolated

Table 5: Results of isolations from samples of rose stems showing symptoms of 'cold storage dieback' from three nurseries

Accession No.	Date	No. Plants assessed	Symptoms	Varieties	Result
A116	20/2/96	5	Necrotic patches on stems plus small amount of 'dieback' from cut ends	'Sweet Dream'	*Pythium* sp. isolated (aggressiveness unknown)
A122	21/4/96	10	"	"	*Pythium* sp. *Trichodema* sp. *Fusarium avenacem* isolated (aggressiveness unknown)
A123	24/4/96	15	"	"	*Pythium* sp. isolated (aggressiveness unknown)

Discussion

Results from both the grower survey and isolations from affected plants indicate that spring dieback and cold storage dieback are not linked and are the result of action of different causal agents. In the case of spring dieback, the evidence suggests a physiological problem, whereas cold storage dieback appears to be the direct result of activities of a pathogen, most likely *Pythium* spp..

The spring dieback problem is very variety specific, affecting a number of commercially popular varieties such as 'Whisky Mac' and 'Blue Moon' It was interesting to note that 37% of the respondents to the questionnaire said that they avoided 'problem' varieties due to lost production, whereas 53% actually still grew problem varieties because of strong customer demand, var. 'Whisky Mac' being a particularly popular case in point. This indicates that work on trying to reduce the incidence of spring dieback in these varieties would be commercially worthwhile.

The fact that spring dieback is variety specific may partly explain why some 28% of the respondents to the questionnaire did not consider it to be a problem (i.e. they may not be growing the varieties which cause most trouble). However, the 72% of respondents who did attempt to quantify the disease problem unanimously suggested overall losses between 1 and 5%, indicating moderate losses of less susceptible varieties. Losses in 'problem' varieties apparently did vary from year to year, and, on average, fell between 10 and 50%. The question as to which were 'good' and which were 'bad' years was rather more subjective than the rest of the questionnaire, and this was borne out by the responses received, which on this point were contradictory in many cases. This is not unreasonable as climatic conditions can vary greatly from one region to another in the same season, and individual choices of varieties in a particular season could greatly affect the disease outcome. Ideally, a question such as this can only be accurately assessed after several seasons of closely-monitored and controlled plantings at several different sites.

From the survey, the main factors considered important in increasing the expression of 'spring dieback' were 'disease', drying of roots between lifting and potting, cold conditions after potting and the timing of potting. Most respondents referring to 'disease' meant the depleting effect of late-season foliar disease on the plants' reserves. *Botrytis cinerea* infections on stems could also fall into this reserve-depletion category when the amounts of infection were not sufficient to cause direct plant mortalities. Evidence for this type of involvement of *Botrytis cinerea* was seen on nurseries A and C. However, the absence of pathogens in isolations from a large amount of plant material showing full spring dieback symptoms indicated the possible physiological nature of this disease. This result is backed up by the earlier work of Thomas

(1980), who also carried out tests for viruses with no positive results. The anecdotal evidence strongly supports the supposition that spring dieback symptoms are the result of inhibited root establishment in the early spring, resulting from a number of possible causes, but most likely from a depletion of the plant's 'vigour'. This could be the result of direct physical damage: root drying or chilling injury, but could also be due to depletion of the plant's carbohydrate reserves, either by disease or agronomic practises such as over-hard pruning. These three factors require further investigation in order to assess their relative importance in the disease problem and possibly to help develop improvements in production to reduce its incidence.

As stated above, cold storage dieback appears to be unrelated to spring dieback in that it clearly appears to be the result of infection by *Pythium* sp.. The underlying causes of these infections are not known and neither is the pathogenicity of the *Pythium* sp. concerned. This problem could be the result of infections by an aggressive Phycomycete fungus under cold storage conditions, or may be the result of slight damage or adverse conditions in storage predisposing the plants to infection by a less aggressive opportunist. Cold storage conditions are known to predispose the tissues of other members of the *Rosacae* to infection by pathogens, for example the increased susceptibility of cold-stored strawberries to *Phytophthora cacterum* crown rot (Pettitt & Pegg, 1994). The cold storage of rose plants is still not a widespread practice in the industry and so the importance of cold storage dieback is hard to determine. Further isolation work and pathogenicity tests are required to confirm the role of *Pythium* sp. in this disease and more work is required on the disease biology before suitable control methods can be developed.

Recommendations for further work

Several areas were identified during this project where further work was needed to help with dealing with 'spring dieback' and 'cold storage dieback'. These were:

'Spring Dieback'

- to assess the impact of late season powdery mildew and rust epidemics on 'spring dieback';
- to assess the impact of autumnal defoliation and pruning treatments on 'spring dieback';
- to determine the importance of carbohydrate reserves and their depletion on the subsequent expression of 'spring dieback.

'Cold Storage Dieback'

- to identify the stage at which infection occurs in 'cold storage dieback' and to develop appropriate control measures.

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APPENDICES

APPENDIX I

Plate 1: Symptoms of 'Spring dieback' in var. 'Trumpeter': A, typical stunted foliage and negligible root development in affected plant; B, root development in mildly affected plant; and C, root development in healthy plant of same age.

A

B

C

APPENDIX II

Survey of 'Spring Dieback' in containerised roses

Tim Pettitt & Chris Burgess
HRI Efford

Introduction

Producers frequently experience problems with poor performance of roses in spring. This takes several forms, and it is blamed on a variety of causes.

Rose growers have requested the Hortiucltural Development Council to fund research which will give industry the means to reduce spring dieback.

The first stage of the research is a survey, where we aim to find out in more detail how spring dieback affects the rose growing industry. **We are seeking your assistance.** We would greatly appreciate it if you could fill in this questionnaire and return it in the pre-paid envelope.

Background

We suspect that a number of separate factors are involved in what has been lumped together under the general title of 'Spring Dieback'.

There are two groups of distinct symptoms that we are particularly interested in for the purposes of this survey. They are described below. The syndromes may be linked to one another.

Descriptions

A. 'Spring dieback' proper

- New emerging shoots fail to develop (eg. from new growth of potted roses in spring).
- Sometimes buds break and new leaves unfurl, but then fail to develop further.
- Buds that have formed may wither and die
- In other cases the bushes remain stunted and 'behind'. These bushes often have poor leaf size.
- Little or no new root is present when bushes are turned out of their pots,

B. 'Cold storage dieback'

- Problems with cold-stored material, particularly when bare root plants are held for an extended period.
- Stem blackening and/or development of purple blotches on stem (often extending back from cut ends).
- In severe cases the whole shoot blackens and plants can die.
- Cv. Sweet Dream is particularly prone to this problem
- When affected plants are potted up and unhealthy parts of shoots removed, subsequent development is usually normal.

HORTICULTURAL DEVELOPMENT COUNCIL

BRADBOURNE HOUSE STABLE BLOCK EAST MALLING KENT ME19 6DZ
TELEPHONE: (01732) 848383 FAX: (01732) 848498

Spring Dieback in Containerised Roses : Questionnaire

Name .....

Address of nursery .....

.....

.....

If you fill in your name and address, we can keep you up to date on the results of the survey.
If you prefer to remain anonymous, we will understand.

How many containerised **bush** roses do you produce annually? .....

How many containerised **standard** roses do you produce annually? .....

Please answer each question separately for the two symptom types using the spaces provided (descriptions of the symptoms are on page 1):

	Spring Dieback		**Cold Storage Dieback**	
			If you do not use cold storage please tick this box ☐ and ignore questions this column	
1. What proportion of losses would you associate with this problem as a year to year average?	Tick the box as appropriate		Tick the box as appropriate	
For all cultivars (containerised)	0%		0%	
	1 to 5%		1 to 5%	
	5 to 10%		5 to 10%	
	10 to 25%		10 to 25%	
	25 to 50%		25 to 50%	
	50 to 75%		50 to 75%	
	75 to 100%		75 to 100%	
On 'problem' cultivars	0%		0%	
	1 to 5%		1 to 5%	
	5 to 10%		5 to 10%	
	10 to 25%		10 to 25%	
	25 to 50%		25 to 50%	
	50 to 75%		50 to 75%	
	75 to 100%		75 to 100%	

If you have answered '0%' to all the above questions, you do not have problems with spring dieback. Thank you for your time. Please return this questionnaire in the envelope provided, as it is important for us to record the number of nurseries without a problem.

Otherwise, please continue.

	Spring Dieback	Cold Storage Dieback
2. Has the problem influenced your choice of cultivars?	Yes ❒ No ❒	Yes ❒ No ❒
3. If yes, please list which cultivars you have stopped growing because they had 'dieback' problems in containers.	....	....
4. Are there cultivars with dieback problems that you are still growing (eg. Because of high customer demand)?	Yes ❒ No ❒	Yes ❒ No ❒
5. If you answered yes to 4, please list the cultivars.	....	....
6. Does the problem vary significantly from year to year?	Yes ❒ No ❒	Yes ❒ No ❒
List any years which have been particularly problematic.	19 ❒❒ 19 ❒❒ 19 ❒❒ 19 ❒❒ 19 ❒❒ 19 ❒❒	19 ❒❒ 19 ❒❒ 19 ❒❒ 19 ❒❒ 19 ❒❒ 19 ❒❒
List any years which have been relatively trouble free.	19 ❒❒ 19 ❒❒ 19 ❒❒ 19 ❒❒ 19 ❒❒ 19 ❒❒	19 ❒❒ 19 ❒❒ 19 ❒❒ 19 ❒❒ 19 ❒❒ 19 ❒❒

	Spring Dieback		Cold Storage Dieback	
7. Are there any particular agronomic/cultural factors you suspect may influence the problem?	Tick the boxes as appropriate		Tick the boxes as appropriate	
	Defoliation		Defoliation	
	Nutrition		Nutrition	
	Disease		Disease	
	Production of large numbers of hips in the preceding season		Production of large numbers of hips in the preceding season	
	Cold storage		Time in storage	
			Storage temperature	
	Other (Please specify)		Other (Please specify)	
8. Do you have any comments or observations you wish to add which might help us in assessing this problem?	....		....	

Thank you for your time. Please return this form in the envelope provided.

All answers and information received will be treated as confidential.

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