Project Title: Raspberry: Epidemiology and fungicide control of cane blight (*Leptosphaeria coniothyrium*)

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Raspberry: Epidemiology and fungicide control of cane blight (*Leptosphaeria coniothyrium*)

Headline

The fungicide products Folicur and Signum offer viable alternatives to carbendazim products for controlling cane blight. More than two applications of a preventative fungicide may be necessary to maintain control through the autumn months.

Background and expected deliverables

Cane blight, caused by the fungus *Leptosphaeria coniothyrium*, can result in significant losses in raspberries and other cane fruit, particularly in seasons following wet harvests. The fungus overwinters on old cane debris, and spores produced in spring and summer during rain infect the base of the primocanes at wound sites. Infection is particularly prevalent in wet weather. The disease develops over the winter and, once the cane is girdled, the fruiting cane wilts and dies the following summer, usually just as fruiting begins. No new studies have been conducted on cane blight since the initial work on epidemiology, fungicides and disease management was done at the Scottish Crop Research Institute in the 1970s. These studies showed that weather, variety and cane maturity were important factors in determining the severity of cane blight damage. For the last ten years cane blight has been of little importance in plantations due to changes in cultural practices, the use of less susceptible varieties and the availability of effective fungicides.

During 2003, a higher incidence of cane blight occurred in England and Wales, particularly in the variety Glen Ample. Yield loss occurred in open field and those that had been protected in 2003 and the previous year, both during harvest, or from pre-flowering until the end of harvest. Where cane blight has occurred in other cultivars, it has usually been associated with obvious damage to canes. The problems observed in Glen Ample have been more difficult to explain as there has not been obvious damage on canes for the fungus to enter. Changes in raspberry production methods, including production under polytunnels and different methods of spawn control (including use of paraquat which could damage young spawn or even encourage the cane blight fungus to sporulate on cane stubs) may be responsible for the reappearance of the disease. In addition, seasonal weather conditions have changed. With the extension of warmer conditions into October and milder winters, the period for fungal activity has been extended and such conditions may delay cane maturity, thus extending the period of cane susceptibility to the disease. Of the available fungicies, the MBC fungicide carbendazim is currently the only active ingredient known to effectively control this disease and, as a consequence, a SOLA for post-harvest use of carbendazim products on cane fruit crops was issued in 2003. The restriction of usage of this fungicide to the post harvest period is not ideal as far as effective control is concerned. Consumers, along with all the primary markets for horticultural crops, are not keen to receive produce that has been treated with any of the MBC fungicides. The availability and usage of carbendazim on cane fruit crops has therefore to be considered to

have a very limited future. Alternative fungicides such as diclofluanid or thiram have been shown in earlier trials to be ineffective against this pathogen. There are now many new fungicides available, some of which may be effective against this disease and can be used to replace carbendazim. This project therefore aims to:

- Re-examine the epidemiology of this fungus in the light of changes in variety, weather conditions and cultural practices.

- Evaluate new fungicide products to replace carbendazim.

A better understanding of cane blight in relation to the new varieties, growing practices and seasonal weather should enable the development of an integrated system for disease control to optimise fungicide use.

Summary of project and main conclusions

A survey of Glen Ample plantations on twenty one sites across England and Scotland showed that cane blight was present in all 21 sites visited. Disease incidence varied from 1% to 29% of canes infected. The highest incidence was found in plantations in South-East England. Most cane blight lesions were located at the base of the cane, but a proportion were also present in the top third of the cane, at least 1.5-2.0 metres above ground level. A higher incidence of cane blight occurred in older plantations, in those that had been covered by polytunnels and in plantations with a significant incidence of spur blight.

In five plantations in England and Scotland canes were artificially wounded between July and early October, Observations on cane blight development showed that most infection occurred in July/August, but that infection with cane blight was still occurring in early October. Most infection occurred in wounds made at the base of the cane, but a low percentage of wounds made at points around 1.5-2.0m above the ground also became infected with cane blight. Weather suitable for cane blight infection occurred in most months and especially in September and October. Variation in weather conditions did not account for differences in infection of wounds between the five sites.

In 2004, in a replicated trial in an open field Glen Ample plantation in Berkshire, nine different fungicide products (Table A) were compared for their effectiveness at controlling cane blight in comparison to an untreated control. Treatments were applied post-harvest at the end of picking in July and repeated two weeks later. Fungicide efficacy was assessed the following June as percentage dead or dying fruiting canes. The percentage of canes with cane blight lesions was recorded on the fruiting canes after harvest in September. None of the treatments tested gave complete control of cane blight, although it was not possible to distinguish between cane death due to cane blight and that due to wet feet or Phytophthora root rot which were also present in the plantation. Bavistin (carbendazim) was

the most consistently effective product. Folicur (tebuconazole) and Signum (pyraclostrobin + boscalid) were also effective.

These fungicides were further evaluated in 2005 in a second trial at a new site in Kent, also on the variety Glen Ample. Ten different fungicide products were evaluated (Table A), including experimental compounds and compared to an untreated control, following the same method as used in 2004. As before none of the products evaluated gave complete control of cane blight. Folicur, Signum and Delsene 50 Flo (carbendazim) were the most effective of the products evaluated, confirming the results of the previous trial.

In both years, two fungicide treatments were applied post harvest in August for the trial. From the observations made on cane blight development it is likely that two sprays were insufficient to cover the potential infection period for cane blight. Further treatments may be required in September and also ideally in July during harvest, although this latter timing is probably not feasible. This probably accounts for the failure of the fungicide treatments applied to give complete control of the disease.

Financial benefits of the project

Soft fruit growers are constantly under pressure to minimise pesticide inputs and to avoid the use of products that are linked to health scares. The active ingredient carbendazim is a product which frequently features in the press linked to health scares. This project will provide the industry with information on epidemiology of the disease under the current growing systems used and the efficacy of alternative fungicides from which an integrated approach to disease control could be developed. Failure to control cane blight effectively can result in total crop loss.

The identification of alternative fungicides to carbendazim that offer some control of cane blight will allow growers to continue to reduce the financial losses incurred by cane blight infection.

Table A. **Effect of fungicide treatments applied in 2004 or 2005 on dead/dying raspberry canes assessed in June 2005 or 2006 and incidence of cane blight lesions in the plantation assessed post-harvest in September**

Product	Active ingredient	Rate product /ha	Mean % dead or dying canes in June		% canes with sporing lesions assessed post harvest in September	
			2005	2006	2005	2006
Untreated	-	-	35.0	49.2	22.9	6.8
Bavistin or Delsene 50 Flo	carbendazim	1.1 L	**14.0**	34.2	**6.6**	1.8
Folicur	tebuconazole	1.0 L	**12.6**	27.3	10.3	**0.5**
Amistar	azoxystrobin	1.0 L	19.0	34.8	10.4	2.3
Elvaron Multi	tolylfluanid	3.4 kg	36.8	48.5	15.0	4.8
Talat	tolylfluanid + fenhexamid	3.0 kg	28.0	-	16.1	-
Signum	boscalid + pyraclostrobin	1.8 kg	**10.1**	**23.2**	12.7	**0.9**
Frupica	mepanipyram	0.8 kg	17.6	-	24.5	-
Switch	Cyprodonil+ fludioxonil	1.0 kg	19.7	43.4	20.6	3.1
Scala	pyrimethanil	2.0 L	19.2	42.9	13.3	4.2

UKA374	experimental	0.4 kg	-	35.7	-	4.1
UKA379A	experimental	1.44 kg	-	32.4	-	6.5
EX02002b	experimental	0.9 L	-	40.5	-	4.3

Action points for growers

- Folicur has an off-label approval for use on raspberries (0897/2005) and could be used as an effective alternative to carbendazim products for cane blight control

- Treatments should be applied post harvest in August and repeated in September to ensure adequate protection from cane blight infection.

Science Section

Introduction

Cane blight, caused by the fungus *Leptosphaeria coniothyrium*, can result in significant losses in raspberries and other cane fruit, particularly in seasons following wet harvests. The fungus overwinters on old cane debris and spores produced in spring and summer during rain infect the base of the young cane through wounds, which can be due to a variety of causes, including frost, mechanical injury or insect feeding, e.g. by cane midge larvae. The disease develops over the winter and, once the cane is girdled, the fruiting cane wilts and dies the following summer, usually just as fruiting begins. No new studies have been conducted on cane blight since the initial work on epidemiology, fungicides and disease management was done in Scotland at SCRI in 1970s and 1980s. These studies showed that weather, variety and cane maturity were important factors in determining the severity of cane blight damage. In Scotland, the incidence of cane blight was greatest in plantations that were machine harvested due to damage to the primocanes by the picking machinery (Williamson & Hargreaves, 1978). In other plantations the cane blight fungus gained entry through wounds on the primocanes caused by old cane stubs, strimmer damage during cane thinning and through damage caused by cane midge larvae feeding and frost. Seemuller *et al.* (1988) showed that, in studies in Germany, the cane blight fungus could invade healthy undamaged cane, but the invasion progressed very slowly and was enhanced by weakening of the canes by defoliation. Cane blight is present in the USA, but appears to be much less damaging, even in machine harvested crops. Reasons for the difference are not clear. Other studies abroad on cane blight have been very limited and not added much to the earlier studies at SCRI.

For the last ten years, cane blight has been of little importance in plantations mainly because of the widespread planting of varieties such as Leo that are less susceptible, the use of organophosphate insecticides to control cane midge and the availability of effective fungicides. During 2003, considerable numbers of fruiting canes were either severely debilitated or died as the result of cane blight infection in many summer fruiting raspberry plantations in England and Wales, most notably those of the cultivar Glen Ample. Cane and as a consequence yield loss due to this disease was observed not only in open field but also plantations which had been protected in the current and previous year by Spanish tunnels during harvest, or from pre flowering until the end of harvest. Where cane blight has occurred in other cultivars, it has usually been associated with obvious damage to canes. The problems observed in Glen Ample have been more difficult to explain as there has not been obvious damage on canes for the fungus to enter. Changes in raspberry production methods, including production under polytunnels and different methods of spawn control, including use of paraquat which could damage young spawn or even encourage the cane blight fungus to sporulate on cane stubs, may be responsible for the reappearance of the disease. In addition, seasonal weather conditions have changed. With, the extension of warmer conditions into October and milder winters, the period for fungal activity has been extended and such conditions may delay cane maturity extending the period of cane susceptibility to the disease. Carbendazim is currently the only known product to effectively

control this disease and, as a consequence, a SOLA for its post-harvest use on cane fruit crops was issued last year. The restriction of usage of this fungicide to the post harvest period is not ideal for effective control. Consumers along with all the primary markets for horticultural crops are not keen to receive products that have been treated with any of the benzimidazole fungicides. The availability and usage of carbendazim on raspberries and other cane blight susceptible cane fruit crops has therefore to be considered to have a very limited future. Alternative products such as diclofluanid or thiram were shown in earlier trials to be ineffective against this pathogen. There are now many new fungicide products available, some of which may be effective against this disease and can be used to replace carbendazim.

Overall objective:

To investigate the biology, epidemiology and control of cane blight on raspberries to generate information that can be used to develop an integrated management system to optimise disease control and minimise fungicide inputs.

Specific objectives:

1. To study the factors affecting cane blight development in commercial summer fruiting raspberry plantations

2. To evaluate fungicides for control as alternatives to carbendazim

3. To develop an integrated approach to control of cane blight

Materials and Methods

In year 2, the evaluation of fungicides for control of cane blight was repeated. In addition, a survey of Raspberry plantations of Glen Ample was conducted together with monitoring of cane blight development in five plantations to obtain data on cane blight infection and factors affecting this.

Cane blight survey

A survey of raspberry plantations of Glen Ample was conducted to ascertain the extent and severity of the problem. Five plantations, selected at random, were visited in July/August 2005 in each of South East, East and South West/West Midlands of England and Scotland. (up to 20 in total). In each plantation 15 fruiting canes, growing adjacent to each other in a short length of crop row were examined for the presence of cane blight. This was repeated at 10 further locations in the plantation giving a total of 150 fruiting canes assessed at each site. Any suspect canes were cut out at ground level and sent to East Malling Research (EMR) for confirmation of cane blight. In addition a sample of old cane stubs or other cane debris from the alleyway was collected and also sent to EMR for

examination. Presence of midge blight and any sign of cane midge feeding were also recorded. Information was also collected for each plantation on age, training system, whether covered or not and timing, method of primocane control and spray programme in 2004 and 2005.

In the laboratory for each sample the cane was divided into top, middle and bottom and each section examined for cane blight lesions and sporulation.

Cane blight monitoring

Summary of monitoring in 2004

Preliminary observations at one site (Crockford Bridge Farm, Addlestone, Surrey) on cane blight development in canes artificially wounded between July and early October, showed that most infection occurred in July/August, but that infection with cane blight was still occurring in early October (Table 6 and Fig 1). Most infection occurred in wounds made at the base of the cane, but a low percentage of wounds made at points around 1.5-2.0m above the ground also became infected with cane blight, which is difficult to explain on the basis of existing knowledge on cane blight epidemiology. From this study preliminary data was obtained and a protocol was established which was followed in 2005 when the monitoring was extended to raspberry plantations in several parts of the UK.

Monitoring in 2005

In 2005, five plantations of Glen Ample, where cane blight had previously been a problem were chosen for the study. Selected sites and locations are shown in Table 1. All the raspberry plantations in the study received a standard programme for pest and disease control, including three sprays of carbendazim for cane blight control applied at 10-14 day intervals from early August. Old fruiting canes were pruned out and pulverised in the first week of August.

The plantations were visited fortnightly from early July until early October 2005. At each visit 30 primocanes were tagged and their rind damaged at heights of 0.3 (Zone 1) and 0.6m (zone 2) above the ground up to zone 5, depending on cane height. The canes were selected at random, across the rows and were at least 1 m away, from the next one to be sampled, two new rows being used as a source of sample canes for each visit to the site. One month after wounding the canes were cut at ground level, their tips and leaves removed and then sent to East Malling Research so that the artificial lesions could be examined in the laboratory for cane blight infection. Meteorological data (daily maximum and minimum temperatures (^{o}C) and rainfall (mm)) was obtained from local meteorological stations.

In the laboratory canes were assessed for cane blight infection by scraping off the rind and checking for lesion development associated with the damaged areas. Confirmation of cane blight was by damp incubation of canes under UV light to encourage sporulation of the suspect cane blight lesions. Any cane blight present usually sporulated within 14 days and was confirmed by microscopic examination.

Table 1. Location of crops of raspberry cv. Glen Ample and dates canes wounded in cane blight monitoring study (2005)

Site	Location	Dates canes wounded
1	Cropthorne Fruit Cropthorne, Worcestershire	11/7, 25/7, 8/8, 25/8, 5/9, 22/9, 3/10
2	Thompson Blairgowrie, Perthshire	9/7, 23/7, 3/8, 16/8, 5/9, 21/9
3	Sunclose Farm Milton, Cambridge Cambridgeshire	12/7, 26/7, 10/8, 21/8, 6/9, 22/9
4	Cherry Orchard Nursery Langley Buckinghamshire	3/8, 23/8, 9/9, 21/9, 12/10
5	Belks Farm Otham, Maidstone, Kent	10/7, 25/7, 8/8, 30/8, 12/9, 26/9, 10/10

Evaluation of fungicides for control of cane blight

Summary of results of year 1 (2004)

In a replicated trial in an open field raspberry plantation of cv. Glen Ample, nine different fungicide products (Annual Report for 2004, Table 12) were compared for their effectiveness in controlling cane blight in comparison to an untreated control. Treatments were applied post-harvest at the end of picking in July and repeated two weeks later. Fungicide efficacy was assessed the following June as percentage dead or dying fruiting canes. The percentage of canes with cane blight lesions was recorded on the fruiting canes after harvest in September. None of the treatments tested gave complete control of cane blight, although it was not possible to distinguish between cane death due to cane blight and that due to wet feet or Phytophthora root rot which were also present in the plantation. Bavistin (carbendazim) was the most consistently effective product. Folicur (tebuconazole) and Signum (pyraclostrobin + boscalid) were also effective. These fungicides were further evaluated in 2005.

Fungicide evaluation - 2005

Method

Site details

The site was located at Decoy Farm, Decoy Hill Road, High Halstow, Rochester, Kent in a mature covered (French tunnels) field plantation of cv. Glen Ample due to be grubbed in 2006. Cane blight was known to be an extensive problem in the plantation.

Experimental design

Each plot was 6.5m in length with 2m between plots in the same row and separated from plots in adjacent rows by 2m. Each treatment was replicated four times in a randomised block design. Blocks 1 and 2 were in one French tunnel and 3 and 4 in the adjacent tunnel.

Products

The products listed in Table 2 were evaluated in year 2 at the recommended dose. An untreated control was included.

Treatment application

Treatments were applied at 1000 L/ha using a CP15 knapsack sprayer. Sprays were directed to the entire height of the primocane. Treatments were applied on two occasions – immediately post-harvest on 9 August with a second spray two weeks later on 23 August. All plots were treated routinely for control of pests and other diseases as needed.

Table 2. Fungicide treatments evaluated in year two (2005) for control of *L coniothyrium* in raspberry

Product	Active ingredient	Rate product /ha
Untreated	-	-
Delsene 50 Flo	carbendazim	1.1 L
Folicur	tebuconazole	1.0 L
Amistar	azoxystrobin	1.0 L
Elvaron Multi	tolylfluanid	3.4 kg
UKA374	experimental	0.4 kg
Signum	boscalid + pyraclostrobin	1.8 kg
UKA379a	experimental	1.44 kg
Switch	cyprodonil+fludioxonil	1.0 kg
Scala	pyrimethanil	2.0 L
EX02002b	experimental	0.9 L

Assessments

In June 2006, the plots were assessed visually for signs of cane blight by recording the number of dead or dying canes on all the canes in each plot. Any sporing cane blight lesions were also recorded. As soon as harvest was complete in early August 2006, all the canes in each plot were cut off at ground level and taken back to the laboratory for assessment for cane blight. For assessment each cane was divided into three zones – bottom, middle and top. The canes were assessed visually for presence or absence of cane blight lesions and pycnidia of *Leptosphaeria coniothyrium* (Williamson & Hargreaves, 1981). Presence of pycnidia of *L. coniothyrium* was confirmed using a x10 hand lens.

Statistical analysis

The data were analysed using a generalised linear model with logit link function and estimated dispersion. This takes into account the total number of canes as well as the number showing the characteristic of interest for the analysis.

Results and Discussion

Cane blight survey

A total of 21 plantations of Glen Ample were surveyed in July and August 2005. The plantations were located in the main raspberry production areas of the UK, including two sites in Scotland. Full details of the sites are given in the appendix.

Cane blight incidence

Cane blight was present in all the plantations visited varying from <1% of canes affected to 29% (Table 3). The highest incidence was in plantations in south east England. Most lesions were present in the bottom two thirds of the cane and associated with obvious damage to canes, especially where lesions were present at base of the cane. A proportion of the lesions were present in the top third of the cane, at least 1.5-2.0m above the ground. These lesions were located around nodes on the canes with no obvious signs of damage.

Only a few samples of old cane debris provided as part of the survey to check for the sexual state of *L. coniothyrium* were examined. The debris was colonised by many secondary fungi and it was not possible to readily identify fruiting bodies (perithecia) of the sexual state without considerable extra effort.

Possible factors affecting cane blight incidence

The results of the questionnaire completed for each plantation as part of the survey are given in the appendix. The most significant items are summarised in Table 4. There was no obvious clear effect on cane blight incidence of the presence of old cane stubs or

pulverised prunings left in the plantation compared to removal of prunings and disposal by burning. This is surprising as cane stubs are thought to be the main source of inoculum for cane blight so their elimination would be thought to have some effect on disease. The incidence of cane blight was greater in older plantations as expected, but there was still a significant incidence in plantations less than five years in age and even in those recently planted. The latter could result from inoculum from adjacent older plantations or even possibly from infected planting material.

The incidence of cane blight was lower in well managed plantations (Table 4).
Plantations which were covered by polythene tunnels during flowering and fruiting had almost double the cane blight incidence compared to open field plantations. The opposite would have been expected since cane blight is spread by rain splash so any reduction in rain by cover would be expected to result in a reduction in disease incidence. This will be discussed further later. The incidence of cane blight was also greater in plantations with a significant level of spur blight present, particularly for lesions located in the top third of the cane. Since many of these lesions were present around nodes on the cane at the same location as spur blight lesions (Fig. 2) it is possible that spur blight lesions provide entry points for cane blight, which has been reported in studies in USA.

Figure 2. Cane blight lesion on Glen Ample associated with node

Effect of weather on cane blight incidence

This is shown in Table 5 and 5A. Weather data for 2004 for each survey site is taken from the nearest Meteorological station. Potential cane blight infection days are shown based on rainfall >1mm and a maximum temperature of 14°C or >. These criteria are based on experience only. From the weather data available and cane blight infection incidence for the corresponding 21 sites (it would be possible to develop more exact criteria, but this was not included in the project) are shown for June-October, based on the considered main period for infection of spawn. Suitable infection days occurred in most months and especially in August-October for most sites and did not offer an explanation for differences in cane blight incidence. This is more clearly shown in Table 5A where the cane blight incidence for the sample sites is arranged in order of severity in relation to the total number of potential infection days in the period June to October and the number of potential infection days in July and August. The latter two months are those in which most cane blight infection occurred as identified by the cane blight monitoring study. Table 5A shows that there is no obvious relationship between weather and cane blight infection based on these criteria. Sites with the highest cane blight incidence are often those with the lowest number of potential infection days. Most of the covered sites had poly tunnels up only for June and July so there was plenty of opportunity for infection in August – October. One possible explanation for the higher incidence of cane blight in covered crops may be that protection leads to spawn that has a softer epidermis and is slower to mature leading to increased risk of infection.

Conclusions from Survey

- All plantations of Glen Ample visited in the survey were infected with cane blight varying in incidence from < 1% - 29% of canes infected
- The highest incidence was in plantations in South-East England
- Most cane blight lesions were located at the base of the cane, but a proportion were also present in the top third of the cane, at least 1.5-2.0 metres above ground level
- A higher incidence of cane blight occurred in older plantations, in those that had been covered by polytunnels and in plantations with a significant incidence of spur blight

Table 3. Cane blight survey of raspberry plantations cv. Glen Ample in UK in 2005. Data shown is total number of canes with cane blight-like lesions (% of total canes examined in brackets) and number of those that were sporing and confirmed as cane blight. Also position of lesion (or sporing lesion) on cane is given. Total number of canes examined at each site was 150 (15 canes at each of 10 positions in the plantation)

Sample number/ date	Source/ sampler	Total number Of canes		Lesion position Total number of canes					
		Lesions (% of total canes examined)	Sporing lesions	Bottom third		Mid third		Top third	
				Lesion	Sporing	Lesion	Sporing	Lesion	Sporing
4 April	Crockford J Allen	13 (8.7)	13	2	2	9	9	2	2
R106/05 10 Aug	Lower Hope Farm C Nicholson	6 (4.0)	6	3	3	2	2	1	1
R107/05 10 Aug	Fishers Castle Farm C Nicholson	18 (12.0)	18	9	9	8	8	1	1
R111/05 15 Aug	Rectory Farm J Allen	27 (18.0)	11	22	6	2	2	5	3
R94/05 10 Jul	Peterley Manor Farm J Allen	27 (18.0)	6	25	5	1	1	1	0
R101/05 22 Jul	Decoy Farm S Raffle	35 (23.3)	23	33	21	0	0	2	2
R98/05 28 Jul	Claremont Farm C Creed	11 (7.3)	11	6	6	3	3	2	2

R92/05 12 Jul	Thompson Blairgowrie R Irving	1 (multiple lesions) (0.7)	1	1	1	1	1	1	1
R102/05 25 Jul	Roughway Farm S Raffle	22 (14.7)	22	8	8	9	9	5	5
R97/05 5 Aug	Cherry Orchard Nsy J Allen	13 (8.7)	13	10	10	3	3	0	0
R99/05 29 Jul	Napley Farm C Creed	12 (8.0)	10	9	9	3	3	0	0

Table 3 - continued

Sample number/ date	Source/ sampler	Total number of canes		Lesion position Total number of canes					
		Lesions (% of total canes examined)	Sporing lesions	Bottom third		Mid third		Top third	
				Lesions	Sporing	Lesions	Sporing	Lesion only	Sporing
R79/05 5 Jul	Barn Farm J Attwood	1 (0.7)	1	0	0	1	1	0	0
R118/05 28 Aug	Farrow Ulceby R Irving	2 (1.3)	2	1	1	1	1	0	0
R120/05 27 Aug	Sykes York R Irving	1 (0.7)	1	0	0	1	1	0	0

R121/05 17 Aug	David Leslie Fruits R Irving	7 (4.7)	7	1	1	6	6	1	1
R95/05 13 Jul	Belks Farm S Raffle	44 (29.3)	40	26	22	8	8	10	10
R84/05 6 Jul	Cammas Farm J Attwood	24 (16.0)	18	10	4	9	9	5	5
R85/05 6 Jul	Parkside Farm J Attwood	11 (7.3)	11	2	2	6	6	3	3
R93/05 12 Jul	Wiveton Hall J Attwood	13 (8.7)	12	1	0	5	5	7	7
R78/05 4 Jul	A G Meale & Son J Attwood	14 (9.3)	13	1	0	10	10	3	3
R110/05 16 Aug	Netherton Fruit Farm C Nicholson	2 (1.3)	2	2	2	0	0	0	0
R113/05 18 Aug	Garson Farm J Allen	6 (4.0)	2	2	2	4	0	0	0

Table 4. **Summary of survey samples, cane blight incidence and factors from grower questionnaire that could influence the incidence of cane blight**

Sample	Total no. canes with lesions	Total canes with lesions in top third	Plantation age		Management standard of plantation			Covered		Cane stubs present		Pruning disposal		Obvious damage to spawn		Obvious spur blight in plantation	
			5 or >	< 5	Good	average	poor	Yes	No	Yes	No	pulverised	Removed and burnt	Yes	No	Yes	No
R106	6	1	+		+			+		+		+			+		+
R107	18	1	+				+		+	+			+		+	+	
R111	27	5		+		+			+		+	+			+	+	
R94	27	1		+	+				+		+	+		+		+	
R101	35	2	+				+	+			+		+		+	+	
R98	11	2		+	+				+	+			+		+		+
R92	1	1		+	+			+		+		+			+		+
R102	22	5	+			+			+		+	+			+	+	
R97	13	0	+		+			+			+		+	+			+
R99	12	0		+	+				+	+			+		+		+
R79	1	0	+		+				+		+				+		+
R118	2	0		+		+			+	+			+		+		+
R120	1	0		+			+		+	+			+		+	+	
R121	7	1					+		+	+		+			+	+	
R95	44	10	+			+		+		+		+			+	+	
R84	24	5	+		+			+		+			+		+	+	
R85	11	3	+		+				+	+			+		+	+	

R93	13	7	+		+				+	+			+		+	+	
R78	14	3	+			+			+	+			+		+	+	
R110	2	0	+			+			+		+		+		+		+
R113	6	0	+		+				+	+		+		+		+	
Mean no. canes with lesions			**16.1**	**11.6**	**11.4**	**18.5**	**15.3**	**20.5**	**11.6**	**12.1**	**18.1**	**17.5**	**13.0**	**15.3**	**13.9**	**19.2**	**6.0**
Mean no. canes with lesions in top third			**2.8**	**1.3**	**1.8**	**3.8**	**1.0**	**3.2**	**1.9**	**2.4**	**1.9**	**3.0**	**1.9**	**0.3**	**2.6**	**3.3**	**0.5**

Table 5. Summary of survey samples, cane blight incidence and likely infection days (Max temperature 14°C or > and rain >1mm)

Sample	Total number of canes with lesions	Month	No. days when max temperature 14°C or > and rainfall >1mm	Crop cover (+) or open field (−)
R106	6	June	8	+
		July	7	+
		August	12	−
		September	10	−
		October	16	−
R107	18	June	9	−
		July	11	−
		August	16	−
		September	13	−
		October	10	−
R111	27	June	3	−
		July	8	−
		August	15	−
		September	9	−
		October	16	−
R94	27	June	4	−
		July	9	−
		August	15	−
		September	6	−
		October	14	−
R101	35	June	6	−
		July	7	−
		August	12	−
		September	7	−
		October	12	−
R98	11	June	12	−
		July	13	−
		August	18	−
		September	13	−
		October	17	−
R92	1	June	17	+
		July	5	+
		August	16	−
		September	11	−
		October	17	−
R102	22	June	7	−
		July	9	−

Sample	Total number of canes with lesions	Month	No. days when max temperature 14°C or > and rainfall >1mm	Crop cover (+) or open field (−)
		August	14	−
		September	8	−
		October	14	−
R97	13	June	6	−
		July	8	+
		August	16	−
		September	8	−
		October	13	−
R99	12	June	9	−
		July	11	−
		August	16	−
		September	13	−
		October	10	−

Sample	Total number of canes with lesions	Month	No. days when max temperature 14°C or > and rainfall >1mm	Crop cover (+) or open field (−)
R79	1	June	7	−
		July	12	−
		August	18	−
		September	8	−
		October	15	−
R118	2	June		−
		July		−
		August		−
		September		−
		October		−
R120	1	June	10	−
		July	16	−
		August	17	−
		September	7	−
		October	12	−
R121	7	June	15	−
		July	8	+
		August	17	+
		September	13	−
		October	14	−
R95	44	June	7	+
		July	9	+
		August	14	+
		September	8	−
		October	14	−
R84	24	June	7	+
		July	12	+
		August	18	+
		September	8	−
		October	15	−
R85	11	June	9	−
		July	9	−
		August	18	−
		September	10	−
		October	15	−
R93	13	June	14	−
		July	16	−
		August	17	−
		September	10	−
		October	12	−

Sample	Total number of canes with lesions	Month	No. days when max temperature 14°C or > and rainfall >1mm	Crop cover (+) or open field (−)
R78	14	June	12	−
		July	11	−
		August	18	−
		September	11	−
		October	15	−
R110	2	June	7	−
		July	7	−
		August	19	−
		September	13	−
		October	21	−
R113	6	June	6	−
		July	8	−
		August	16	−
		September	8	−
		October	13	−

Table 5A. Summary of Table 5 showing cane blight incidence (in order of severity) in relation to total number of likely infection days (Max temperature 14°C or > and rain >1mm) in period June–October (cane blight infection period) and in period of peak infection July and August (based on results from monitoring study)

Sample	Total number of canes with lesions	Total number of likely infection days June to October	Total number of likely infection days in July and August
R92	1	66	21
R120	1	62	33
R79	1	60	30
R110	2	67	26
R113	6	51	24
R106	6	53	19
R121	7	67	25
R85	11	61	27
R98	11	73	31
R99	12	59	27
R97	13	51	24
R93	13	69	33
R78	14	67	29
R107	18	59	27
R102	22	52	23
R84	24	60	30
R111	27	51	23
R94	27	48	24
R101	35	44	19
R95	44	52	23

Cane blight monitoring

The results of the artificial wounding of canes in five plantations of Glen Ample in various parts of the UK, including Scotland, are shown in Tables 7-11. Up to four artificial wounds were made on the young canes on five or six timings between July and October. The number of wounds made on the canes at each visit varied depending on cane height and timing of spawn control. Four of the sites were covered by polytunnels from either May or June to after harvest in July or August, the fifth site at Cropthorne being entirely open field. At most of the covered sites the covers were removed soon after the first wounds were made so for the period of the study all crops were uncovered. Weather data for 2005 for each monitoring site is taken from the nearest meteorological station. Potential cane blight infection days, based on rainfall >1mm and a maximum temperature of 14°C or > (these criteria are based on experience only), are shown for the seven days prior to wounding and for the period from wounding to cane collection. Suitable infection days occurred in most months and especially in September and October for most sites. There were fewer potential infection days in July for most sites when rainfall was limiting. Conditions in September/October were less favourable at the site at Blairgowrie in Scotland when temperature was limiting.

Natural infection by the cane blight fungus at the base of the canes was recorded in the samples from all sites and was in general higher than that resulting from artificial wounding, but it was not possible to identify the timing of infection. The lowest incidence of infection of the artificial wounds was in the sites at Blairgowrie in Perthshire and at Belks Farm in Kent. Reasons for the lower infection are not clear as favourable weather conditions were recorded at both sites and were similar to those at the other sites. The differences are also not really accounted for by variation in inoculum levels as at both sites old cane is pulverised leaving old debris in the alleyway, whereas at two of the other sites where cane blight infection was higher, the practice is to remove old cane from the plantation and burn it (see Table 2 in appendix). At all sites the greatest incidence of cane blight infection was in wounds made nearer the cane base in zones 1 or 2. Nevertheless infection was recorded in wounds made up to 2 metres above ground level. At almost all sites the highest incidence of cane blight was recorded in wounds made in July or early August despite the weather in general being less favourable (lower rainfall) at this time. Investigations by Seemuller *et al.* (1988) showed that infection of canes by the cane blight fungus was dependent on weather conditions and cane susceptibility. In the late summer/autumn the outer rind thickens as the new canes mature resulting in reduced susceptibility to cane blight. At the same time as temperatures fall conditions become less favourable for the fungus. Observations suggest that canes produced under protection may remain immature for longer increasing the period the canes are susceptible to infection. However, the data here do not clearly support this theory as at most sites, whether covered or not, the greatest infection of wounds was recorded in wounds made in July and August.

A low incidence of cane blight infection occurred in wounds made at around 2 metres height. Most of the cane blight inoculum is present on the old cane stubs and other cane

debris at ground level and, since the fungal spores (conidia) are spread by rain splash, it is difficult to explain the infection at heights of 2 metres. It is possible that if pulverising the old fruiting cane, which is usually carried out soon after the old cane has been cut out in August, is done during rain then spores may be splashed higher up the canes. Such infection may also result from ascospores which are forcibly ejected from perithecia (sexual fruiting bodies) and therefore could infect at higher points on the cane. The sexual state of the cane blight fungus is produced in old cane blight lesions on cane stubs or on pulverised prunings. Ascospores are usually produced in spring (Williamson, 1997). Limited observations on spore traps at East Malling located near old raspberry cane debris infected with cane blight, indicated the presence of spores similar to ascospores of *L coniothyrium* in May. Further studies would be needed to establish the period in which ascospores release occurs.

Conclusions

- Monitoring of cane blight development in artificially wounded developing spawn in five plantations showed that most cane blight infected wounds occurred in the base of the cane as expected. However, a significant number of wounds became infected at heights of 1.5-2.0 metres above the ground and are difficult to explain on the basis of existing knowledge on cane blight epidemiology

- The greatest proportion of wounds were infected in late July/early August, but infection of wounds was still occurring at the last wounding in October

Table 6 . Cane blight monitoring 2004 - Time of wounding, date collected and % wound areas infected with cane blight

Site: Crockford Bridge Farm, Addlestone, Surrey

Date canes wounded	Date canes collected	Base natural infection	Mean % wounds infected					Mean % of wounds infected	Rain mm during 7 days before wounding	Rain mm between wounding and collection	Date carbendazim applied post-harvest
			Zone 1	Zone 2	Zone 3	Zone 4	Zone 5				
13 Jul	23 Jul	-	10.7	14.3	0	3.6	3.6	6.4	29.7	0.6	
23 Jul	5 Aug	73.3	53.3	60.0	50.0	3.3	-	41.7	0.6	8.8	
5 Aug	3 Sep	-	69.7	39.4	30.3	12.1	9.1	32.1	5.4	61.6	10 Aug
19 Aug	17 Sep	3.4	34.5	34.5	20.7	3.4	-	23.3	48.8	22.8	1 Sep
16 Sep	26 Oct	5.7	42.9	0	42.9	0	-	21.5	1.4	100.2	
2 Oct	26 Oct	11.1	22.2	7.4	3.7	7.4	-	10.2	5.8	89.6	7 Oct
	Mean % infected	**15.8**	**38.9**	**25.9**	**24.6**	**5.0**	**2.1**				

Zones 1-5 are at approximately 0.3m intervals up the cane with zone 1 the lowest wound site at 0.3m above the cane base
Rainfall data are from RHS Wisley

Fig. 1 % wounds made at different zones on raspberry cane (Glen Ample) that became infected with cane blight in 2004

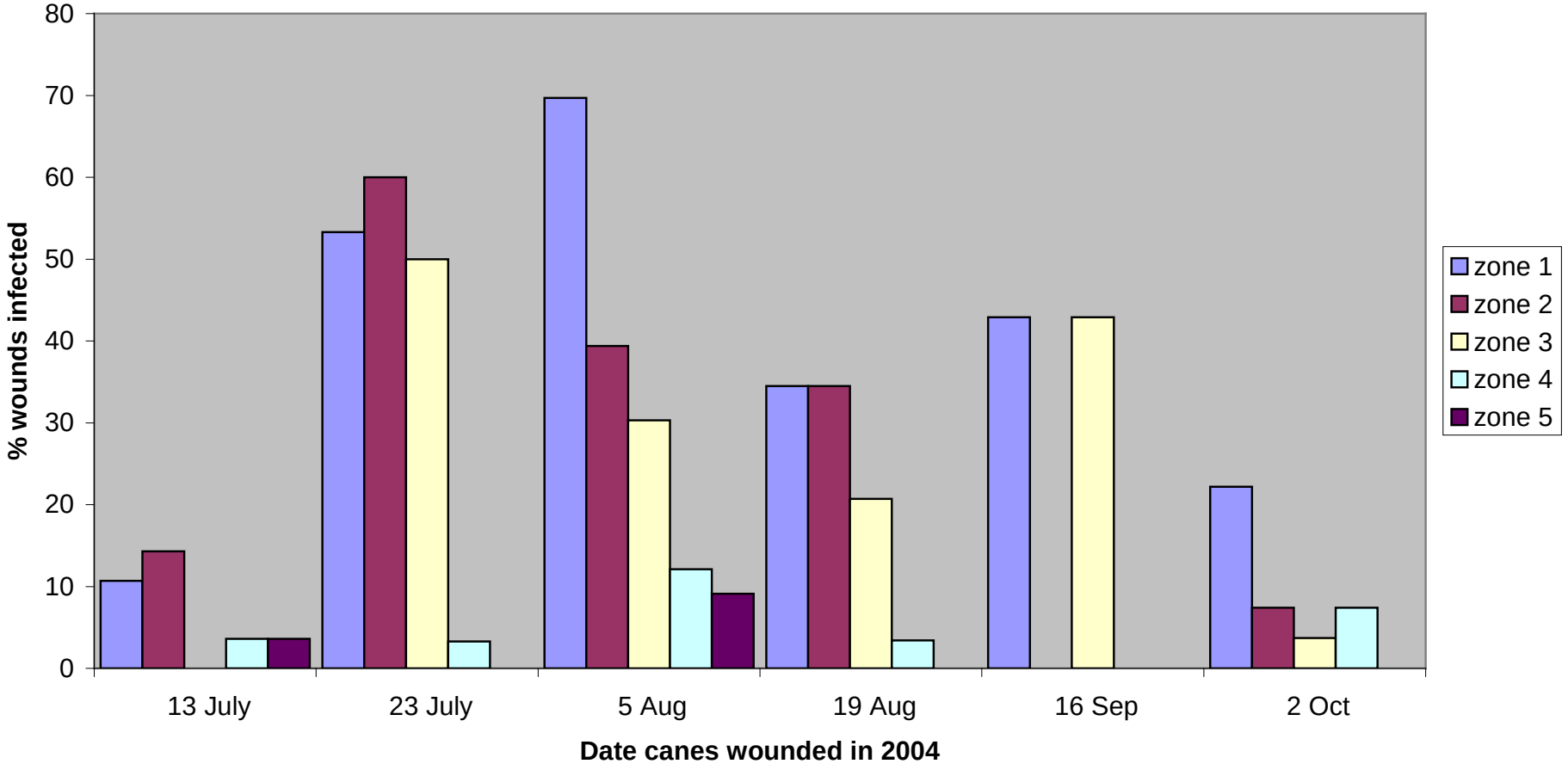

Table 7. **Cane blight monitoring 2005 - Time of wounding, date collected and % wound areas infected with cane blight**

Site: **Cropthorne Fruit, Cropthorne, Worcs (open field)**

Date canes wounded	Date canes collected	Base natural infection	Mean % wounds infected					Mean % infected	No. days when max. temperature = 14°C or > and rain > 1mm in 7 days pre- wounding	No. days when max. temperature = 14°C or > and rain > 1mm between wounding and cane collection
			Zone 1	Zone 2	Zone 3	Zone 4	Zone 5			
11 July	8 August	34.5	27.6	-	-	-	-	27.6	2	9
25 July	25 August	10.0	30.0	36.7	-	-	-	33.4	2	16
8 August	5 September	3.3	20.0	30.0	-	-	-	25.0	4	14
25 August	22 September	13.3	26.7	16.7	-	-	-	21.7	4	12
5 September	3 October	6.7	3.3	6.7	-	-	-	5.0	0	16
22 September	20 October	10.3	3.4	3.4	-	-	-	3.4	3	13
3 October	31 October	0	0	0	-	-	-	0	5	14
Mean % infected			**15.9**	**15.6**	-	-	-			

Zones 1-5 are at approximately 0.3m intervals up the cane with zone 1 the lowest wound site at 0.3m above the cane base
Weather data from Pershore, Worcs

Table 8. **Cane blight monitoring 2005 – Time of wounding, date collected and % wound areas infected with cane blight**

Site: **Thompson, Blairgowrie, Perthshire (covered May – August)**

Date canes wounded	Date canes collected	Base natural infection	Mean % wounds infected					Mean % infected	No. days when max. temperature = 14°C or > and rain > 1mm in 7 days pre-wounding	No. days when max. temperature = 14°C or > and rain > 1mm between wounding and cane collection
			Zone 1	Zone 2	Zone 3	Zone 4	Zone 5			
9 July	3 August	10.0	10.0	6.7	–	–	–	8.3	2	4
23 July	18 August	36.7	13.3	16.7	6.7	3.3	–	10.0	1	9
3 August	5 September	6.7	3.3	0	6.7	0	–	2.5	1	17
16 August	21 September	0	0	0	0	0	–	0	3	18
5 September	5 October	3.3	0	0	0	0	–	0	2	12
21 September	19 October	6.7	3.3	0	3.3	0	–	1.7	2	9
Mean % infected			**5.0**	**3.9**	**2.2**	**0.7**	–			

Zones 1–5 are at approximately 0.3m intervals up the cane with zone 1 the lowest wound site at 0.3m above the cane base
Weather data from Leuchars

Table 9. **Cane blight monitoring 2005 - Time of wounding, date collected and % wound areas infected with cane blight**

Site: **Sunclose Farm, Milton, Cambridge (covered May - July/August)**

Date canes wounded	Date canes collected	Base natural infection	Mean % wounds infected					Mean % infected	No. days when max. temperature = 14°C or > and rain > 1mm in 7 days pre wounding	No. days when max. temperature = 14°C or > and rain > 1mm between wounding and cane collection
			Zone 1	Zone 2	Zone 3	Zone 4	Zone 5			
12 July	10 August	58.6	51.7	-	-	-	-	51.7	2	7
26 July	23 August	33.3	63.3	16.7	-	-	-	40.0	2	9
10 August	6 September	34.5	75.9	75.9	-	-	-	75.9	1	9
21 August	21 September	22.2	18.5	18.5	-	-	-	18.5	2	10
6 September	7 October	20.0	3.3	0	3.3	0	-	1.7	2	12
22 September	21 October	13.3	6.7	0	0	6.7	-	3.3	1	13
Mean % infected			**36.7**	**22.2**	**1.7**	**3.4**	-			

Zones 1-5 are at approximately 0.3m intervals up the cane with zone 1 the lowest wound site at 0.3m above the cane base

weather data from Cambridge

Table 10. **Cane blight monitoring 2005 - Time of wounding, date collected and % wound areas infected with cane blight**

Site: **Cherry Orchard Nursery, Langley, Bucks (covered June - July/August)**

Date canes wounded	Date canes collected	Base natural infection	Mean % wounds infected					Mean % infected	No. days when max temperature = 14°C or > and rain > 1mm in 7 days pre wounding	No. days when max temperature = 14°C or > and rain > 1mm between wounding and cane collection
			Zone 1	Zone 2	Zone 3	Zone 4	Zone 5			
3 August	6 September	36.7	20.0	6.7	-	-	-	13.3	2	7
23 August	21 September	2.9	17.1	11.4	11.4	-	-	13.3	3	5
9 September	12 October	54.8	32.3	19.4	9.7	-	-	21.1	2	10
21 September	31 October	21.9	3.1	0	0	0	-	0.8	1	19
12 October	22 December	9.4	3.1	0	0	0	-	0.8	2	19
Mean % infected			**15.1**	**7.5**	**5.3**	**0**	-			

Zones 1-5 are at approximately 0.3m intervals up the cane with zone 1 the lowest wound site at 0.3m above the cane base
Weather data from Heathrow

Table 11. Cane blight monitoring 2005 - Time of wounding, date collected and % wound areas infected with cane blight

Site: Belks Farm, Otham, Kent (covered June - July/August)

Date canes wounded	Date canes harvested	Base natural infection	Mean % wounds infected					Mean % infected	No. days when max temperature = 14°C or > and rain > 1mm in 7 days pre wounding	No. days when max temperature = 14°C or > and rain > 1mm between wounding and cane collection
			Zone 1	Zone 2	Zone 3	Zone 4	Zone 5			
10 July	10 August	0	0	0	0	-	-	0	2	6
25 July	26 August	32.0	4.0	0	-	-	-	2.0	2	11
8 August	12 September	9.1	4.5	0	-	-	-	2.3	1	9
30 August	26 September	15.4	3.8	0	-	-	-	1.9	3	6
12 September	10 October	7.7	7.7	3.8	-	-	-	5.8	2	8
26 September	26 October	0	13.3	0	-	-	-	6.7	2	15
10 October	14 November	0	0	0	-	-	-	0	0	18
Mean % infected			**4.8**	**0.5**	**0**	-	-			

Zones 1-5 are at approximately 0.3m intervals up the cane with zone 1 the lowest wound site at 0.3m above the cane base

Weather data from East Malling

Evaluation of fungicides

The interpretation of the results was complicated by cane death due to rabbit damage that occurred during spring 2006. The greatest amount of rabbit damage was in the plots at the southern end of the trial that was nearest the nature reserve. Rabbit damage in raspberry plantations was a common problem in 2006, primarily due to the late spring (*pers comm*. Scott Raffle). Rabbits had not been a problem at this site in previous years. Use of a covariate (presence or absence of rabbit damage) in the analyses was investigated in an attempt to overcome the problem. For percentage of canes dead/dying and percentage of canes with sporing lesions, the covariate was statistically significant (positive, indicating increased death/lesions with rabbit damage) and so was included in the analyses and the means presented (Tables 14 and 15) are those adjusted for the covariate. Weather data for the trial site from the nearest Meteorological Site (Shoeburyness) are shown in Table 13. Conditions favouring infection were recorded in all months from June to September

The data for percentage dead or dying canes and for canes with sporing lesions assessed in June are presented in Table 14. Numbers of dead or dying canes were significantly reduced ($p=0.032$), compared to the untreated control, in plots treated with Signum (pyraclostrobin + boscalid). Other fungicide treatments, apart from Elvaron Multi, also reduced the number of dead or dying canes, but these differences were not significant. The greatest percentage of canes with sporing lesions was recorded in untreated plots. Lowest numbers of canes with sporing lesions were recorded in plots treated with Folicur or Signum and these were significantly lower than in untreated plots.

The data for percentage of canes with sporing cane blight lesions, assessed on harvested canes after harvest, is presented in Table 15. Most of the sporing lesions were located at the base of the cane as expected, but a percentage was present in the middle of the cane and the top zone – more than 2 metres above the ground. Only Scala ($p=0.023$) and Delsene 50 Flo ($p=0.052$) significantly reduced the number of sporing lesions compared to the untreated control. Numbers of canes with sporing lesions was also reduced by treatment with Folicur compared to the untreated control, but not significantly so. There was no effect of treatment on percentage canes with sporing lesions in the different height section of cane.

None of the treatments evaluated gave complete control of cane blight. The fungicide products identified as most effective in the first trial in 2004 were also the most effective in this trial. Elvaron Multi and Switch did not appear to be effective in controlling cane blight. This is surprising as Switch is used in Germany for cane blight control. It is possible that the two post harvest treatments applied in the trial were insufficient to give complete control. It was not possible to investigate treatment timing in this project, but evidence from the cane blight monitoring study indicates that conditions may remain suitable for infection in September and October and that July was also a peak time for cane blight infection. Treatments were only applied in August immediately post harvest so there may

have been further infection occurring after this that additional treatments would have prevented. Additional treatments may also be required in July ideally. However this is likely to coincide with harvest and is probably not feasible. Poor fungicide timing most likely accounts for the failure of fungicide treatments applied to give complete control of the disease. The raspberry crop in which the trial was conducted was covered by polytunnels from May until the end of harvest. The survey results suggested that the incidence of cane blight in covered crops was higher than in open field plantations. A possible explanation for this is that covering the crop may delay the maturing of the new cane prolonging the period of susceptibility to infection by cane blight.

Conclusions for fungicide evaluation

- None of the treatments tested gave complete control of cane blight indicating that two sprays applied post harvest in August may not be adequate for effective control
- Delsene 50 Flo (carbendazim), Folicur (tebuconazole) and Signum (pyraclostrobin + boscalid) were the most consistently effective products
- Most of the other fungicides reduced cane death compared to the untreated, but differences were not significant
- Elvaron Multi and Switch appeared to be the least effective of the products tested

Table 12. **Effect of fungicide treatments applied in 2004 on dead / dying raspberry canes assessed in June 2005 and incidence of cane blight lesions at various cane heights in the plantation assessed post harvest in September. Data presented are angular transformation of the original. The back transformed percentage figures are given in parentheses**

Product	Active ingredient	Mean % dead or dying canes		% canes with basal lesions (zone1)		% canes with sporing lesions (zone 1)		% canes with sporing lesions (zone 2)	
Untreated	-	36.3	(35.0)	41.6	(44.1)	28.6	(22.9)	15.5	(7.2)
Bavistin	carbendazim	22.0	(14.0)	27.9	(21.8)	14.9	(6.6)	12.4	(4.6)
Folicur	tebuconazole	20.8	(12.6)	30.9	(26.4)	18.8	(10.3)	7.8	(1.8)
Amistar	azoxystrobin	25.8	(19.0)	28.0	(22.0)	18.8	(10.4)	17.3	(8.8)
Elvaron Multi	tolylfluanid	37.4	(36.8)	42.2	(45.1)	22.8	(15.0)	16.8	(8.3)
Talat	tolylfluanid + fenhexamid	32.0	(28.0)	30.0	(24.9)	23.6	(16.1)	21.8	(13.8)
Signum	boscalid + pyraclostrobin	18.6	(10.1)	33.5	(30.4)	20.8	(12.7)	13.2	(5.2)
Frupica	mepanipyram	24.8	(17.6)	49.3	(57.5)	29.7	(24.5)	18.1	(9.6)
Switch	cyprodonil+fludioxonil	26.4	(19.7)	38.8	(39.3)	27.0	(20.6)	18.8	(10.4)
Scala	pyrimethanil	26.0	(19.2)	32.8	(29.3)	21.4	(13.3)	13.9	(5.8)
Treatment F prob		**0.031**		**0.086**		**0.244**		**0.695**	
LSD		**11.7**		**14.8**		**11.6**		**13.8**	
df		**26**		**27**		**27**		**26**	

Table 13. **Potential cane blight infection days at Decoy Farm in 2005 during the fungicide trial period**

Month	No. days when max. temperature = 14°C or > and rain > 1mm
June	3
July	8
August	8
September	8
October	13

Table 14. **Effect of fungicide treatments applied in 2005 on dead/dying raspberry canes and canes with sporing cane blight lesions assessed in June 2006. Data shown is the predicted % means together with the individual approximate standard errors. Figures in bold and underlined are significantly different from untreated control**

Product	Active ingredient	Mean % dead or dying canes		% canes with sporing lesions	
		Predicted % mean	Approx-imate standard error	Predicted % mean	Approx-imate standard error
Untreated	-	49.2	8.43	6.8	2.0
Delsene 50 Flo	carbendazim	34.2	8.84	1.8	1.2
Folicur	tebuconazole	27.3	8.15	**0.5**	0.6
Amistar	azoxystrobin	34.8	8.01	2.3	1.2
Elvaron Multi	tolylfluanid	48.5	8.33	4.8	1.74
UKA374		35.7	7.69	4.1	1.49
Signum	boscalid + pyraclostrobin	**23.2**	6.96	**0.9**	0.76
UKA379A	mepanipyram	32.4	7.40	6.5	1.98
Switch	cyprodonil+fludioxonil	43.4	8.14	3.1	1.36
Scala	pyrimethanil	42.9	9.23	4.2	1.71
EX02002b	experimental	40.5	8.50	4.3	1.66
F prob		**0.463**		**0.057**	
df		**29**		**30**	

Table 15. **Effect of fungicide treatments applied in 2005 on numbers of canes with sporing cane blight lesions and incidence of cane blight lesions at various cane heights in the plantation assessed on harvested canes post harvest in September 2006. Data shown are the predicted % means together with the individual approximate standard errors. Figures in bold and underlined are significantly different from untreated control**

Product	Active ingredient	Number of canes with sporing lesions as % of total		% of sporing canes with lesions in different positions		
		Predicted % mean	Approx-imate standard error	Bottom	Middle	Top
Untreated	-	63.4	5.51	100	15.3	1.18
Delsene 50 Flo	carbendazim	**43.7**	7.70	100	3.7	0
Folicur	tebuconazole	47.2	7.68	100	0	1.89
Amistar	azoxystrobin	60.5	6.90	98.4	22.7	3.47
Elvaron Multi	tolylfluanid	60.7	5.01	98.9	17.7	1.54
UKA374		59.3	4.68	95.2	14.8	0
Signum	boscalid + pyraclostrobin	56.0	6.25	100	8.5	6.2
UKA379A	mepanipyram	63.4	5.00	96.2	21.2	1.07
Switch	cyprodonil+fludioxonil	68.6	5.15	96.2	13.8	3.01
Scala	pyrimethanil	**42.8**	5.72	96.6	8.3	0
EX02002b	experimental	54.9	5.18	100	17.7	0
F prob		**0.103**		**0.172**	**0.439**	**0.079**

df		**16**	**16**	**16**	**16**

Future work

- A study to determine the period of ascospore release in relation to high cane lesions to identify whether treatments should be applied in spring
- A spray timing trial to determine the most effective fungicide programme
- Obtain off label approval for use of Signum on raspberry so that it could be included in a programme with Folicur and or carbendazim for cane blight control

Technology transfer

Preliminary results from the project were presented at the Soft Fruit Conference in November 2005 and reported in *HDC News*.

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APPENDIX

Appendix 1. Details of sites used in cane blight survey in 2005

Sample number	Sample date in 2005	Sampler	Farm
-	4 April	J Allen	Crockford Bridge Farm, Addlestone, Surrey
R78/05	4 July	J Attwood	A G Meale & Son, Wayford Farm, Stalham, Norwich, Norfolk, NR12 9LJ
R79/05	5 July	J Attwood	Williamson, Barn Farm, Bradfield, Manningtree, Essex
R84/05	6 July	J Attwood	Cammas Hall Farm, Hatfield Broad Oak, Bishops Stortford, CM22 7HT
R85/05	6 July	J Attwood	Parkside Farm, Hadley Road, Enfield, Middlesex, EN2 8LA
R92/05	12 July	R Irving	Peter Thompson, Blairgowrie, (Spenders Field, Ample 2000-2001)
R93/05	12 July	J Attwood	Wiveton Hall, Cley next-to-sea, Holt, Norfolk
R94/05	10 July	J Allen	R Brill, Peterley Manor Farm, Peterley Road, Prestwood, Bucks, HP16 0HH
R95/05	13 July	S Raffle	Chambers, Belks Farm, (No 29 protected)
R97/05	5 August	J Allen	Ted Franks, Cherry Orchard Nursery, Trenches Lane, Langley, Bucks
R98/05	28 July	C Creed	Pimbley, Claremont Farm, Bebington, Wirral, L63 4JB
R99/05	29 July	C Creed	John Roberts, Napley Farm, Norton in Hales, Market Drayton, Shropshire, TF9 4DP
R101/05	22 July	S Raffle	Myatt, Decoy Farm, Decoy Hill Road, High Halstow, Rochester, ME3 8SR (Bungalow Ample)
R102/05	25 July	S Raffle	Cannon, Roughway Farm, Plaxtol, Tonbridge, TN11 9SN
R106/05	10 August	C Nicholson	Lower Hope Farm, Ullingswick, Hereford
R107/05	10 August	C Nicholson	David Stanley, Fishers Castle Farm, Harvington, Kidderminster
R110/05	16 August	C Nicholson	Tim Colston, Netherton Fruit Farm, Newton Abbot, Devon
R111/05	15 August	J Allen	Hon, R Stanley, Rectory Farm, Stanton St. John, Oxford

R113/05	18 August	J Allen	Thompson Bros, Garson Farm, Winterdawn Road, West End, Esher, Surrey
R118/05	28 August	R Irving	Farrow, Ulceby, N Lincs
R120/05	27 August	R Irving	Sykes, York
R121/05	17 August	R Irving	David Leslie Fruits

Appendix 2. Summary of questionnaire on management and treatments at raspberry cane blight survey sites

Respondee	**Lower Hope R106/05**	**Fishers Castle R107/05**	**Rectory Farm R111/05**	**Peterley Manor Farm R94/05**	**Decoy Farm R101/05**	**Claremont Farm R98/05**
County	**Hereford**	**Worcs**	**Oxon**	**Bucks**	**Kent**	**Cheshire**
Questions						
Age of plantation or planting date	Spring 2000	7 or 8 years	1998	1999	8 years	2002
Row spacing (m)	3	3	3	3	2.4m leg rows, 1.8m inside rows	3
Plantation produces for	Supermarket	PYO and farm shop	Farm shop and supermarket	PYO	Supermarket	PYO and farm shop
Harvesting - hand	Yes	Yes	Yes	Yes	Yes	Yes
Harvesting - machine						
Sheltered from prevailing wind?	Yes	Yes	Yes	Yes	Slightly	No
Worst winds in	Spring	Spring	All year	Spring, summer & autumn		
Shelter provided by	Topography	Tall hedge, topography	Windbreaks + buildings	Windbreaks	Topography	
Is plantation covered this year	Yes	No	No	No	Yes	No

(2006)?						
If covered, by what?	Spanish				French Tunnels	
Crop rows per tunnel	2				2	
					1.8m between rows, 2.4m between leg rows	

Appendix 2 - continued

Respondee	Lower Hope R106/05	Fishers Castle R107/05	Rectory Farm R111/05	Peterley Manor Farm R94/05	Decoy Farm R101/05	Claremont Farm R98/05
Distance - outside row to gutter (m)	1.5				1.2m	
When covered in 2005?	Just before/at pink fruit				1 week of April	
Covered in 2004?	Yes	No		No	Yes	
When covered in 2004?	As above				1 week of April	
When uncovered post harvest in 2004?	Mid-August				late July (2 weeks after harvest)	
Stool or continuous row?	Stool	Stool	Cont. row	Cont. row	Cont. row	Cont. row
Description of crop support system	Single post & wire	2 wires on tee at chest height	ADAS trellis	ADAS trellis	Scottish Trellis	Vertical Scottish
Height of support posts (m)						

Fixed and mobile wire heights (cm)	75		2 fixed at 1.8 and 1.5m, 4 mobile hts. at 0.45, 0.75, 1.2 and 1.5m	Top fixed wire at 1.74m, mid fixed wire at 0.86m, 3 mobile wire positions at 0.49, 0.95 and 1.43m	Top fixed wire at 1.5m, 2 pairs of strings clipped together every 7-10cm used to support floricane	2 wires at 0.4m, 1 wire at 1.5m.
How are fruiting canes secured?	Between fixed and plastic wires at shoulder height	Running string onto 2 wires at chest height		Laced to top or mid fixed wires	Laced to top wire	Tied in with short lengths of string

Appendix 2 - continued

Respondee	**Lower Hope R106/05**	**Fishers Castle R107/05**	**Rectory Farm R111/05**	**Peterley Manor Farm R94/05**	**Decoy Farm R101/05**	**Claremont Farm R98/05**
Fruiting canes tied in per m of row	8	8	6	6 - 8	7-8	10
Primocanes per m of row	15 - 20	25	20	6 - 8	9-12	20
Raised bed (RB) or on the flat (F)?	RB	RB	RB	F	F	F
Width of top of raised bed (cm)	70	76	90			
Height of raised bed (cm)	20	15	20			
Alleys bare soil				Yes	Yes	Yes
grass	Yes		Yes			
tumble down		Yes	Yes			
Crop rows bare soil			Yes	Yes	Yes	Yes

	polymulch	Yes	Yes (black)				
Spent cane	pulverised *in situ*	Yes		Yes	Yes		
	removed and burnt		Yes			Yes	Yes
Much crop debris in alleyways?		Yes	No	No	Some	No	No
Type of debris in alleyways?		Sticks <30cm			Short to medium lengths of old floricane in alleys + some in crop row		
Primocanes supported?		Yes	Yes	Yes	Yes	No	Yes
Method of p/c support and heights		2 strings – hip height and top wire height	String each side at 76cm	Mobile wire 0.45m above ground	Pair of mobile wires at 0.95m	Post-harvest supports temporarily with string 1.2m off the ground	Bale string at 1.0m either side
primocane?		Yes	Yes	No	No		No

Appendix 2 - continued

Respondee	Lower Hope R106/05	Fishers Castle R107/05	Rectory Farm R111/05	Peterley Manor Farm R94/05	Decoy Farm R101/05	Claremont Farm R98/05
If so, type of damage	Abrasion 5 – 10cm	Abrasion one side 7.5 cm			In the past this has been a problem, canes rub on strings when tunnel cladding removed	

Cane stubs in row?	Yes	Yes	No	Some - moderate number	Some	Yes
Average length of stubs (cm)	10	10		7 - 10	10-12 cm in height	8 - 10
Any damage to primocanes from strimmers, mowers, other machinery?	No	No	No	Yes	None	No
Type of damage?				Strimmer/ mower		
How did it occur?				Reducing width of primocane in crop row		
How well is plantation managed?	Very well	OK for PYO	Average	Well managed in the main	Adequate - poorly	Well managed

Appendix 2 - continued

Respondee	**Lower Hope R106/05**	**Fishers Castle R107/05**	**Rectory Farm R111/05**	**Peterley Manor Farm R94/05**	**Decoy Farm R101/05**	**Claremont Farm R98/05**

If not managed well, why?			P/c not properly thinned of supported		Poor primocane management, little cane support post harvest, cane rind damaged by strings. Not secured to wire until late autumn	
If Cane Blight present, how much fruiting cane has been killed of severely debilitated by this disease (%)?	Very low	Most fruiting cane has lost buds	10-15%	5% - in patches, not overall	25%	5 - 8%
Height above ground of Cane Blight lesions on fruiting canes?		Up to 1m	0.3m	Mainly towards base of canes	Mainly 10-30cm above the ground	0 - 0.5m
Are Cane Blight lesions surrounded by lesions of Spur Blight or Botrytis?	No	No	Some	Some, but not all	In some cases	No
Cane Blight lesions associated with physical damage?	No	No	Yes. Frost splitting and *Botrytis* infection	Yes. Some associated with mechanical damage to bottom 20cm of canes	Not all, history of cane midge lesions and also severe rabbit damage to canes in autumn and winter	No

Appendix 2 - continued

Respondee	Lower Hope R106/05	Fishers Castle R107/05	Rectory Farm R111/05	Peterley Manor Farm R94/05	Decoy Farm R101/05	Claremont Farm R98/05
Rasp Cane Midge damage on p/c?	No	No	No	No	No	No
If present, at what height (mm)?						
Frost damage on p/c?	No	Not sure	Yes	No	Insignificant	No
Vine weevil damage?	No	No	Yes	No	No	No
Fruiting laterals on whole length of fruiting canes?	Yes	No	No	No. Poor or mod. bud break on bottom 30% of canes	Yes in the main, but not all canes produced laterals down whole length	Yes
If not - where are laterals on canes?		Only above 1m	At top or scattered down length	Mainly in top two thirds of cane		
If not - are the moribund bud nodes surrounded by Spur Blight or Botrytis?		Above 1m	Yes but some buds dead and clear of disease	Yes - where bud break is poor	Slight infection by spur blight	

Appendix 2 - continued

Respondee	Thompson Blairgowrie R92/05	Roughway Farm R102/05	Cherry Orchard Nursery R97/05	Napley Farm R99/05	Barn Farm R79/05	Farrow, Ulceby R118/05
County	**Perthshire**	**Kent**	**Bucks**	**Shropshire**	**Essex**	**North Lincs**
Questions						
Age of plantation or planting date	3-4 years	1999	1999	2004	5 years	2 - 3 years
Row spacing (m)	2.15	2.4	2.3	3	3	3.2
Plantation produces for	Supermarket	Supermarket	Supermarket	PYO & farm shop	Supermarket and processing	PYO and farm shop
Harvesting – hand	Yes	Yes	Yes	Yes	Yes	Yes
Harvesting – machine					Yes	
Sheltered from prevailing wind?	Yes	Yes	Yes	Yes	Yes	No
Worst winds in	Autumn		Spring, summer and autumn	Spring, summer and autumn		Spring
Shelter provided by	Topography, natural and artificial windbreaks	Topography	Hedges	Mature trees	Planted windbreaks	Topography, hedges, trees
Is plantation covered this year (2006)?	Yes	No	Yes	No	No	No
If covered, by what?	Spanish tunnels		Spanish tunnels			
Crop rows per tunnel	3		3			

Row spacing in tunnels (m)	2.15					
Appendix 2 - continued						
(m)	2.15					
Respondee	**Thompson Blairgowrie R92/05**	**Roughway Farm R102/05**	**Cherry Orchard Nursery R97/05**	**Napley Farm R99/05**	**Barn Farm R79/05**	**Farrow, Ulceby R118/05**
When covered in 2005?	May (start of flowering)		Late June/July			
Covered in 2004?	Yes	No	Yes			No
When covered in 2004?	As per 2005					
When uncovered post harvest in 2004?	Late August		Late August			
Stool or continuous row?	Stool	Cont. row	Cont. row	Cont. row	Cont. row	Cont. row
Description of crop support system	Single top wire tied, double low wire	Scottish system	Adas Trellis	Scottish vertical	Scottish vertical trellis	Standard single wire and post. No mobile wires
Height of support posts (m)						
Fixed and mobile wire heights (cm)		1 fixed wire at 1.7m and 1 at 1.1m	1 top wire at 1.8m, 2 sets of mobile wires	Wires at 0.7 and 1.6m, no mobile wires		

How are fruiting canes secured?		2 pairs of parallel strings – at 1.7m and 1.1m. Canes laced to top wire	Clipped to fixed wires	Baler twine	Laced to top wire	
Fruiting canes tied in per m of row	10	8	8 – 10	8	6	8 – 9
Primocanes per m of row	10 – 15	15 – 16	12 – 15	8	8	10
Raised bed (RB) or on the flat (F)?	F	RB	RB	F	F	RB
Width of top of raised bed (cm)		50	30			100
Height of raised bed (cm)		30	30 – 38			10
Alleys bare soil	Yes	Yes		Yes		
tumbledown			Yes		Yes	Yes

Appendix 2 - continued

Respondee	**Thompson Blairgowrie R92/05**	**Roughway Farm R102/05**	**Cherry Orchard Nursery R97/05**	**Napley Farm R99/05**	**Barn Farm R79/05**	**Farrow, Ulceby R118/05**
Crop rows bare soil	Yes	Yes	Yes	Yes	Yes	
polymulch						Yes
Spent cane pulverised *in situ*	Yes	Yes				
removed and burnt			Yes	Yes		Yes
Much crop debris in alleyways?	No	No	No	No	No	No

Type of debris in alleyways?		Last year's pulverised prunings				
Primocanes supported?	No	Yes	Yes	Yes	Yes	No
Method of p/c support and heights		2 pairs of parallel strings - at 1.7m and 1.1m. P/c not tucked in well	2 sets of mobile wires - 3 positions	Baler twine at 1m	2 intermediate wires either side of canes	
Have supports damaged primocane?		Yes	No	No	No	No
If so, type of damage		Abrasion by strings			Some damage to fruiting canes	
Cane stubs in row?	Yes	A few	No	Yes	No	Yes
Average length of stubs (cm)	<5	4 - 5		10		10
	No	No	Some	No	No	No

Appendix 2 - continued

Respondee	**Thompson Blairgowrie R92/05**	**Roughway Farm R102/05**	**Cherry Orchard Nursery R97/05**	**Napley Farm R99/05**	**Barn Farm R79/05**	**Farrow, Ulceby R118/05**

Type of damage?		Significant damage from use of Croptex Steel	Foliar tears, tips of some primocanes snapped			
How did it occur?		Spray drift and splashes. Botrytis on some damaged canes	Pickers			
How well is plantation managed?	Very well	Adequate	Very well	Good	Well managed	Well for PYO
If not managed well, why?		Primocanes not tucked in - flop across alleyway				No sprays used
If Cane Blight present, how much fruiting cane has been killed of severely debilitated by this disease (%)?	None seen	35%	None	2 - 5%	5%	None present
Height above ground of Cane Blight lesions on fruiting canes?		Variable - to top of canopy		0 - 100mm	0.75m	
Are Cane Blight lesions surrounded by lesions of Spur Blight or Botrytis?		In many cases	Not always	No	Yes	
Cane Blight lesions associated with physical damage?		Only in some cases. In others, seem to be overlying Spur Blight	Natural cane splitting	No	Yes - wire damage	

Appendix 2 - continued

Respondee	Thompson Blairgowrie R92/05	Roughway Farm R102/05	Cherry Orchard Nursery R97/05	Napley Farm R99/05	Barn Farm R79/05	Farrow, Ulceby R118/05
Rasp Cane Midge damage on p/c?	No	No	No	No	No	No
If present, at what height (mm)?						
Frost damage on p/c?	No	Yes		No	No	No
Vine weevil damage?	Low level	No	Yes	No	No	No
Fruiting laterals on whole length of fruiting canes?	No	Yes - in most cases	No	Yes	Yes	No
If not - where are laterals on canes?	Top 50 - 70% of cane length		Top & bottom. Low numbers in middle			Top half
If not - are the moribund bud nodes surrounded by Spur Blight or Botrytis?	Some at a low level. Quite clean	Significanr infection by Spur Blight	Mainly Botrytis			Some Spur Blight

Appendix 2 - continued

Respondee	Sykes York R120/05	David Leslie Fruits R121/05	Belks Farm R95/05	Cammas Farm R84/05	Parkside Farm R85/05
County	**Yorks**	**Perthshire**	**Kent**	**Essex**	**Middx**
Questions					
Age of plantation	3 years		5 years	5 years	7 years
Row spacing (m)	2.5	3	2.4	3.6	3.6
Plantation produces for	PYO and farm shop	Supermarket	Supermarket	PYO and farm shop sales	PYO
Harvesting hand	Yes	Yes	Yes	Yes	Yes
machine					
Sheltered from prevailing wind?	No	Yes	Yes	Yes	No
Worst winds in		Spring and autumn		Spring	Spring
Shelter provided by	Topography		Natural hedges and woodland	Planted tree windbreaks	Hedge
Is plantation covered this year?	No	No	Yes	Yes	No
If covered, by what?			Spanish tunnels	Spanish tunnels	
Crop rows per tunnel			3	2	
Row spacing in tunnels (m)			2.4m between rows, 2.4m between leg rows	3.65m	
Distance - outside row to gutter (m)			1.2m	1.8	
When covered in 2005?			Early June (prior to harvest)	Late March	

Covered in 2004?		Yes	Yes	Yes	
Appendix 2 - continued		At picking (July)	Early June (prior to harvest)	Late march	
Respondee	**Sykes York R120/05**	**David Leslie Fruits R121/05**	**Belks Farm R95/05**	**Cammas Farm R84/05**	**Parkside Farm R85/05**
When uncovered post-harvest in 2004?		August	late July (approx 2 weeks after harvest)	Mid-August	
Stool or continuous row?	Cont row	Stool	Stool originally now continuous row	Stool	Continuous row
Description of crop support system	Top single wire, double lower wires (not mobile)	Top single wire, double lower wires (not mobile)	Scottish System, two fixed wires	Scottish vertical wall	Scottish vertical wall
Height of support posts (m)					1.65
Fixed and mobile wire heights (cm)			Top fixed wire at 1.5m, lower fixed wire at 1m above ground + 2 pairs of strings at 1.5 & 1m above ground	Top fixed wire at 1.8m, also fixed intermediate and single pair of mobile wires	Top fixed wire at 1.65m, intermediate fixed wire at 1m, 1 pair of mobile wires
How are fruiting canes secured?	Sandwiched between lower wires		Laced to top wire	Laced to top wire	Laced to top wire
Fruiting canes tied in per m of row	10	8 - 10	7	6	6

Primocanes per m of row	15	10 – 12	12	15	10
Raised bed (RB) or on the flat (F)?	RB	RB	RB	RB	F
Width of top of raised bed (cm)	30	75	50	60	
Height of raised bed (cm)	10	10	30	10	
Alleys bare soil			Yes	Yes	
grass	Yes	Yes			
tumble down					Yes
Crop rows bare soil	Yes		Yes		Yes
		Yes		Yes	
Spent cane pulverised *in situ*		Yes	Yes		

Appendix 2 - continued

Respondee	Sykes York R120/05	David Leslie Fruits R121/05	Belks Farm R95/05	Cammas Farm R84/05	Parkside Farm R85/05
Spent cane removed and burnt	Yes			Yes	Yes
Much crop debris in alleyways?	No	Yes	Yes	None	None
Type of debris in alleyways?		Pulverised fruiting cane and grass	Pulverised fruiting cane		
Primocanes supported?	No	No	Yes	Yes	Yes
Method of p/c support and heights			2 pairs of strings at 1.5 and 1m above ground. Primocane held by them against floricane	A single pair of mobile wires	A single pair of mobile wires

Have supports damaged primocane?		No	Yes	Yes	No
If so, type of damage			Strings cut into rind of primocane, especially when tunnel first removed and they rock in the wind	Slight rubbing on wires and each other	
Cane stubs in row?	Yes	Yes	Yes	Yes	Yes
Average length of stubs (cm)	10 - 15	15	10 – 15	10	5
Any damage to primocanes from strimmers, mowers, other machinery?	No	No	No	No	No

Appendix 2 - continued

Respondee	Sykes York R120/05	David Leslie Fruits R121/05	Belks Farm R95/05	Cammas Farm R84/05	Parkside Farm R85/05
How did it occur?					
How well is plantation managed?	Casual PYO style	Managed lightly	Adequately	Well	Well
If not managed well, why?	Primocanes flop into alleyways	*Phytophthora* becoming severe. Neglect of weeds and tying in	Primocane support inadequate		
If Cane Blight present, how much fruiting cane has been killed of severely debilitated by this	None seen	None seen	15%	10%	2%

disease (%)?					
Height above ground of Cane Blight lesions on fruiting canes?			From soil level to top of canes	Up to 1m	Up to 0.75m above the ground
Are Cane Blight lesions surrounded by lesions of Spur Blight or Botrytis?	Low level of Spur Blight		Yes, most spur blight	Yes	Yes
Cane Blight lesions associated with physical damage?			Only in a few cases, most associated with spur blight lesions	Wire rubbing damage	Wire rubbing damage
Rasp Cane Midge damage on p/c?	No	No	No	No	No
If present, at what height (mm)?					
Frost damage on p/c?			Insignificant	Yes	No
Vine weevil damage?	No	Yes (low level)	Yes but insignificant	No	No

Appendix 2 - continued

Respondee	**Sykes York R120/05**	**David Leslie Fruits R121/05**	**Belks Farm R95/05**	**Cammas Farm R84/05**	**Parkside Farm R85/05**
Fruiting laterals on whole length of fruiting canes?	No	No	Yes, most but not all canes	No	Yes
If not - where are laterals on canes?	Top 70%	Top 50%		Top 30%	

If not – are the moribund bud nodes surrounded by Spur Blight or Botrytis?	Low level of Spur Blight	Lots of Spur Blight, some Cane Botrytis	Where buds not broken significant amount of spur blight present	Lots of spur blight and some *Botrytis* lesions around moribund buds	A few moribund buds surrounded by spur blight

Appendix 2 – continued

Respondee	A G Meale & Son R78/05	Netherton Fruit Farm R101.05	Garson Farm R113/05	Cropthorne Fruit	Sunclose Farm
County	**Norfolk**	**Devon**	**Surrey**	**Worcs**	**Cambridge**
Questions					
Age of plantation	6 years	5 years	8 years	7 years	5 years
Row spacing (m)	3.0	3.6	3	2.4	2.8
Plantation produces for	PYO and farm shop sales	PYO and farm shop sales	PYO	Supermarket	Supermarket
Harvesting hand	Yes	Yes	Yes	Yes	Yes
machine					
Sheltered from prevailing wind?	Yes	Some protection	Yes	Yes	Yes
Worst winds in		Spring	Spring, summer and autumn	Spring	Spring
Shelter provided by	Planted windbreaks, artificial windbreaks and buildings	Willow windbreaks plus topography of field i.e. slope	Windbreaks – birch /alder	Alder windbreak and hedge	Willow windbreaks
Is plantation covered this year?	No	No	No	No	Yes
If covered, by what?					Spanish tunnels
Crop rows per tunnel					3
Row spacing in tunnels (m)					2.8
Distance – outside row to gutter					1.4

(m)					
When covered in 2005?					May
Appendix 2 - continued				No	Yes
When covered in 2004?					May
Respondee	**A G Meale & Son R78/05**	**Netherton Fruit Farm R101.05**	**Garson Farm R113/05**	**Cropthorne Fruit**	**Sunclose Farm**
When uncovered post harvest in 2004?					August
Stool or continuous row?	Continuous row	Continuous row	Continuous row	Stool	Continuous row
Description of crop support system	Scottish vertical Wall	Double wire trellis	Scottish vertical Wall	Post and 2 wires – middle and top	Scottish vertical Wall
Height of support posts (m)	1.3m				1.8
Fixed and mobile wire heights (cm)	Fixed wire at 1.3m. Plus a single pair of mobile wires set at 0.75m above the ground	T-piece at 1.5m above the ground. Second set of wires at 0.9m above the ground	1 fixed wire at 1.4m, T-piece at 1.7m above ground. 1 pair mobile wires at 0.35, 0.7, 1.0 or 1.35m		Two fixed wires one at 1.8m and a lower one at 1m
How are fruiting canes secured?	Tops of canes looped over and secured with main part of canes to top wire, laced	Laced to top wires	As above	Continuous string and knots	A single pair of mobile wires
Fruiting canes tied in per m of row	6	8-10	8	9 - 10	5-7

Primocanes per m of row	30	25-30	6 - 8		7-8
Raised bed (RB) or on the flat(F)?	F		F	RB	RB
Width of top of raised bed (cm)				80	60
Height of raised bed (cm)				20	20
Alleys bare soil					Yes
grass	Yes		Yes		
tumble down		Yes		Yes	
(	Yes	Yes	Yes		

Appendix 2 - continued

Respondee	**A G Meale & Son R78/05**	**Netherton Fruit Farm R101.05**	**Garson Farm R113/05**	**Cropthorne Fruit**	**Sunclose Farm**
Crop rows polymulch				Yes	Yes
Spent cane pulverised *in situ*			Yes		Yes
removed and burnt	Yes	Yes		Yes	
Much crop debris in alleyways?	None	Some	Yes	No	Yes
Type of debris in alleyways?		Wilted just cut out primocane	Small pieces of cane		Old pulverised floricane
Primocanes supported?	Yes	No	Yes	Yes	Yes
Method of p/c support and heights	2 sets of mobile wires both at 0.75m above the ground, not clipped together		Mobile wires at 0.95m above ground, not clipped together	String and clips at 1.0m	Strings plus mobile support wires

Have supports damaged primocane?	Yes	Yes	Yes	Yes	Yes
If so, type of damage	Rubbing on rind of primocane	Rubbing on top and intermediate wires of trellis where the canes touch them	Some wire rubbing at 0.95m. Not severe	Some rubbing – 50mm long lesions	Some rubbing on each other and strings used for their support and fruiting laterals at harvest
Cane stubs in row?	Yes	No	Yes	Yes	Yes
Average length of stubs (cm)	8		Up to 10cm	5	5-15
Any damage to primocanes from machinery?	No	No	Yes	No	Yes

Appendix 2 - continued

Respondee	**A G Meale & Son R78/05**	**Netherton Fruit Farm R101.05**	**Garson Farm R113/05**	**Cropthorne Fruit**	**Sunclose Farm**
Type of damage?			By secateurs or by rubbing on old cane stubs		By secateurs or by rubbing on old canes
How did it occur?			As above		As above
How well is plantation managed?	Moderate	Moderate	Generally good. Very clean and tidy	Last year of plantation	Fairly well

If not managed well, why?	Too many primocanes in rows/m			As above	Primocane support especially during and post harvest when tunnels removed not adequate
If Cane Blight present, how much fruiting cane has been killed of severely debilitated by this disease (%)?	15%	Not seen	10% infection but few canes killed	< 1%	15%
Height above ground of Cane Blight lesions on fruiting canes?	0.75-1.3m		0.5 - 1.0m	Ground level	From ground level to 1m
Are Cane Blight lesions surrounded by lesions of Spur Blight or Botrytis?	Yes		Yes - Spur Blight	No	Yes
Cane Blight lesions associated with physical damage?	Wire rubbing on floricane		No	No	Yes
Rasp Cane Midge damage on p/c?	No		No	No	Yes
If present, at what height (mm)?					15 - 20
Frost damage on p/c?	May have been	No	No	No	No
	No	No	Yes	No	No
Respondee	**A G Meale & Son R78/05**	**Netherton Fruit Farm R101.05**	**Garson Farm R113/05**	**Cropthorne Fruit**	**Sunclose Farm**

Appendix 2 - continued

Fruiting laterals on whole length of fruiting canes?	No	No	Yes - most of cane	No	No
If not - where are laterals on canes?	Top 40cm of floricane	Top 50% of floricane	Top/middle	Top half only	Middle-top of floricane
If not - are the moribund bud nodes surrounded by Spur Blight or Botrytis?	Yes spur blight and botrytis found around moribund buds		Spur Blight	Some	Spur blight and some botrytis