Project title	Blackcurrants: Assessment of fungicides for the control of latent botrytis in fruit.
Project number:	SF12 (220)
Project leader:	John Atwood, ADAS UK Ltd
Report:	Final report, October 2009
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Key staff:	John Atwood, Project leader
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DISCLAIMER:

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

AUTHENTICATION

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

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GROWER SUMMARY

Headline

- Bayer UKA386 was the most effective treatment in reducing latent *Botrytis*. Signum and Bayer UKA386 were the most effective fungicides for the control of post harvest rots *Botrytis*, *Mucor* and *Penicillium*.

Background and expected deliverables

Botrytis is an important disease of blackcurrants causing flower run-off and contamination pre and post-harvest. Yield losses can range from 15 to 50% and latent *Botrytis* infection particularly in the cultivar Ben Hope is believed to have been responsible for severe processing problems for GSK. In most cases these problems were not apparent at the time of harvest. Latent *Botrytis* is an internal infection within the berry that has not yet caused a rot but may have the capability of doing so if conditions are favourable. Ben Hope is thought to be less susceptible to *Botrytis* induced flower run-off than Baldwin, making latent *Botrytis* a significant risk.

The last *Botrytis* fungicide screening on blackcurrants was carried out 5 years ago (Atwood 2004) (SF12, 195), but latent *Botrytis* infection was not specifically studied. Since that time, newer fungicides have become available with potential for *Botrytis* control. It is essential to have a range of fungicides available for *Botrytis* control with different modes of action to combat the development of resistance.

The objectives and deliverables of the project were to:

- Evaluate a range of new fungicides for *Botrytis* control, both latent and expressed, pre and post-harvest.
- Quantify the yield response from a range of fungicides used for *Botrytis* control.
- Evaluate any incidental control of leaf spot (*Drepanopeziza ribis*) and post-harvest *Mucor, Rhizopus* or *Peniciliium* resulting from the use of fungicides when used in a *Botrytis* control programme.

Summary of the project and main conclusions

A range of fungicides (Table 1) was applied either in a repeated three spray programme or as an alternating programme (Table 2) to a mature plantation of blackcurrants cv. Ben Hope.

Table 1. Product details

Product	Active ingredient(s)	Rate of use	Approval status
Bayer UKA386	Not disclosed	0.8 L/ha	Experimental
Bravo 500	Chlorothalonil (500 g/l)	3.0 L/ha	On-label approval
Serenade	Bacillus subtilis	10 L/ha	On-label approval
Signum	Boscalid (26.7% w/w) + pyraclostrobin (6.7% w/w)	1.5 kg/ha	SOLA
Stroby WG	kresoxim-methyl 50% w/w	0.2 kg/ha	On-label approval
Switch	cyprodinil 37.5 % + fludioxonil 25% w/w	1.0 kg/ha	On-label approval
Teldor	fenhexamid 50 % w/w	1.5 kg/ha	On-label approval

Table 2. Treatment programmes

Treatment No.	1st flower 16/4/09	Mid-end flower 26/4/09	1st set 10/5/09	100% set 21/5/09
1.	Nil	Nil	Nil	Nil
2.	Bayer UKA386	Bayer UKA386	Bayer UKA386	Nil
3.	Serenade	Serenade	Serenade	Nil
4.	Signum	Signum	Signum	Nil
5.	Stroby WG	Stroby WG	Stroby WG	Nil
6.	Switch	Switch	Switch	Nil
7.	Teldor	Teldor	Teldor	Nil
8	Bravo 500	Signum	Bravo 500	Nil
9.	Bravo 500	Signum	Bravo 500	Signum

Significant levels of latent *Botrytis* were found in samples of unripe berries when analysed in June (Fig. 1).

Most of the treatments tested significantly reduced latent *Botrytis* from 66.7% in the untreated control, but levels remained quite high at around 42-53%. Bayer UKA386 however stood out as the most effective treatment, substantially reducing latent *Botrytis* infection in the unripe fruit to around 16%. Signum was the most effective of the other treatments reducing levels to around 42%.

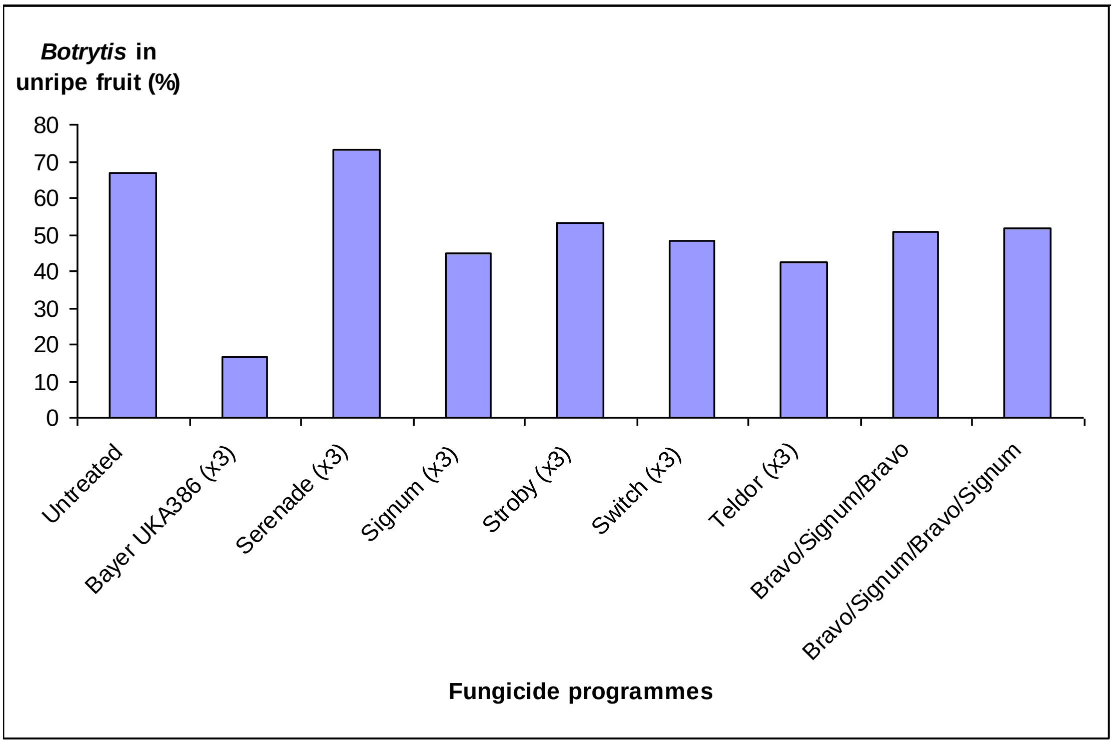

Figure 1. Percentage of unripe fruit with latent *Botrytis* infection

Levels of visible infection in the ripe fruit at harvest were lower but still rather higher than would be acceptable for a commercial crop (Fig. 2). Bayer UKA386 also appeared to give good control of *Botrytis* both in the fresh harvested fruit (Fig. 2) and in the incubated fruit although these results were only significant at the 7.5% probability level. Similarly Signum performed well and in addition gave some control of *Mucor*.

Bayer UKA386 and Signum treatments had the least rots from *Botrytis, Mucor* and *Penicilium* after incubation (Fig. 3). *Rhizopus* was not detected.

Of the other treatments Serenade was relatively ineffective, the only significant result being a small reduction in *Botrytis* infection in the bush. Stroby WG and Bravo 500 (when used as an alternating programme with Signum) were less effective than other treatments when comparing levels of *Botrytis* in the bush. A similar trend was apparent in the fruit *Botrytis* assessments but differences were not statistically significant.

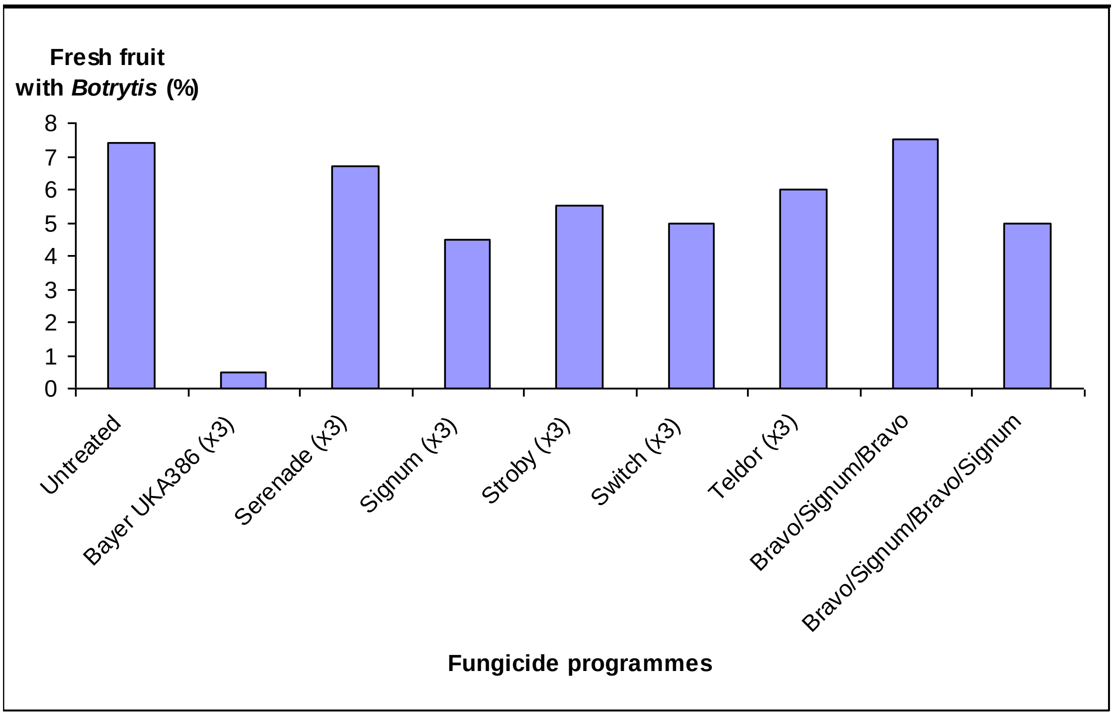

Figure 2. Percentage of fresh fruit with *Botrytis* infection

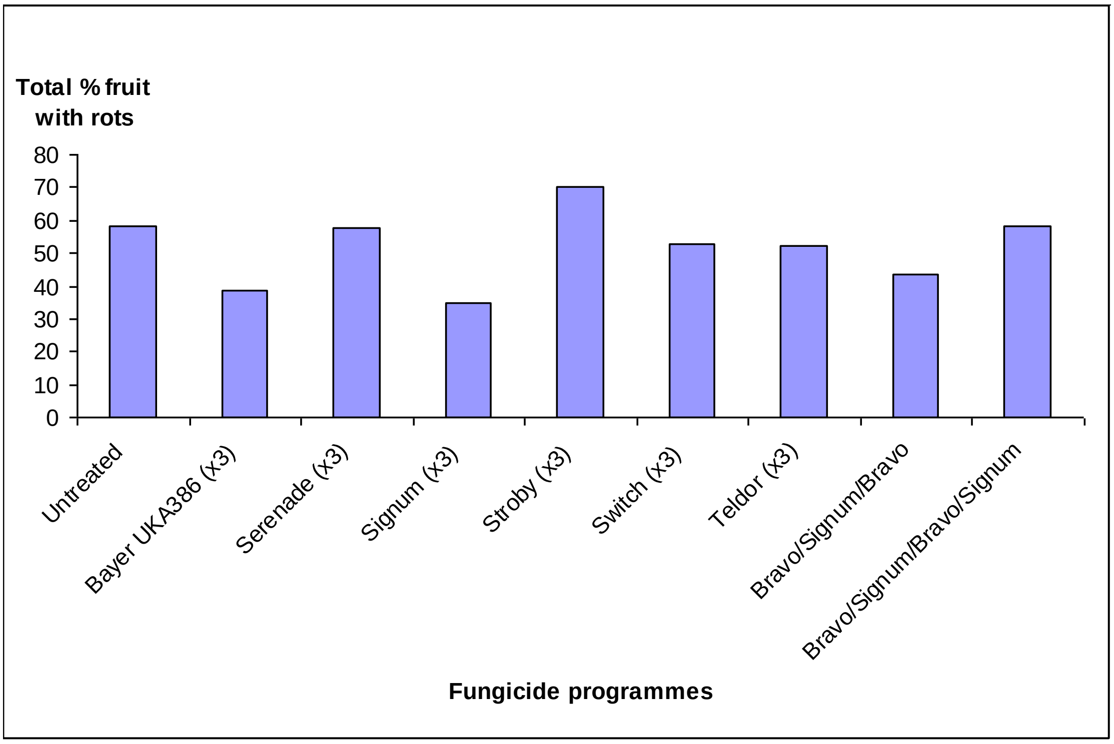

Figure 3. Total percentage of incubated fresh fruit with rots.

Apart from the Bravo/Signum programme only three fungicide applications were made and the spray interval between the second and third application may have been too long to achieve the best level of control. Bayer UKA386 and, to some extent, Signum performed well despite this, but the other fungicides would probably need to be applied more frequently to achieve a commercially acceptable level of control.

Bayer UKA386 is not yet available. Signum is the most effective currently available fungicide. This result confirms previous findings (Atwood 2004) (SF 12 project 194), but, to avoid the development of resistant *Botrytis*, Signum would need to be used in a programme with other fungicides. The next most effective fungicides are Switch or Teldor and either could be used in an alternating programme.

Bayer UKA386, Signum and Bravo 500 all gave excellent control of leaf spot; Switch and Stroby WG had moderate activity but Teldor, and Serenade had no effect

All treatments improved fruit set compared with the untreated. Although there were no significant differences in fruit set between the fungicides there was an indication that Signum had the most effect. All fungicide treatments except Serenade appeared to increase yields but differences were not statistically significant.

Financial benefits

It was not possible to demonstrate a significant yield response from the fungicide treatments but fruit quality is becoming more important than yield. Results indicate that Bayer UKA386 has the best potential to reduce latent *Botrytis* infection. Bayer UKA386 is not yet available so any financial benefits from this aspect of the research will not be realised until it is available with approval for use on Blackcurrants. Of the currently available products, Signum was the most effective fungicide for control of *Botrytis* and other rots in the fruit. The use of the best possible fungicide programme for *Botrytis* control avoids the risk of crop rejection by the processors at a potential cost of £6500/ha assuming a 10 t/ha crop at £650 / tonne.

Action points for growers

- When available and approved, Bayer UKA386 should be included in the fungicide programme for *Botrytis* and leaf spot control.
- Signum is the most effective currently available fungicide for *Botrytis* control and also offers excellent control of leaf spot.
- Teldor or Switch are suitable alternatives for use in a programme as an anti-resistance strategy.
- Bravo 500 and Stroby WG were less effective as *Botrytis* fungicides and should not be relied upon solely for *Botrytis* control during flowering and early fruit set when the risk of infection is greatest.

SCIENCE SECTION

Introduction

The two main diseases of blackcurrants are leaf spot (*Drapenopeziza ribis*) and grey mould (*Botrytis cinerea*). *Botrytis* is an important disease of blackcurrants causing flower run-off (Williamson *et al,* 1989), and contamination pre and post-harvest. Latent *Botrytis* is an internal infection within the berry that has not yet caused a rot but may have the capability of doing so if conditions are favourable. Yield losses can range from 15 to 50% and latent *Botrytis* infection, particularly in the cultivar Ben Hope, is believed to have caused severe processing problems for GSK. In most cases these problems were not apparent at the time of harvest. Ben Hope is thought to be less susceptible to *Botrytis* induced flower run-off than Baldwin (Xu & Berrie 2008) making latent *Botrytis* a significant risk. The last *Botrytis* fungicide screening experiment on blackcurrants was carried out 5 years ago (Atwood 2004) (SF12, 195). Since that time, newer fungicides have become available with potential for *Botrytis* control. It is essential to have a range of fungicides available for *Botrytis* control with different modes of action to combat the development of resistance.

The objectives of the project were to:

- Evaluate a range of new fungicides for *Botrytis* control, both latent and expressed pre and post-harvest.
- Quantify the yield response from a range of fungicides used for *Botrytis* control.
- Evaluate any incidental control of leaf spot and post harvest *Mucor, Rhizopus* or *Penicillium* resulting from the use of fungicides when used in a *Botrytis* control programme.

Materials and Methods

Site and crop details

The experiment was carried out at Gorgate Ltd., Hall Farm, Gressenhall, Dereham, Norfolk NR19 2QF on a blackcurrant plantation of cv. Ben Hope. The plantation was planted in spring 1999, with bushes spaced at 3 m x 0.3 m.

Prior to the start of the experiment, the following treatments were applied: 19/3/09 Solfa 10 kg/ha (acaricide / fungicide Sulphur 80% w/w), 1/4/09 Solfa 10 kg/ha.
During the course of the experiment the following insecticide was applied: 11/6/09 Aphox (pirimicarb 50% w/w) 280 g/ha. No fungicides were applied apart from the experimental treatments.

The soil type was a sandy clay loam, P index 3, K index 3, Mg index 2. The following nutrients were applied with a compound fertiliser on 29/3/09: P_2O_5 40 kg/ha, K_2O 60 kg/ha, Mg 50 kg/ha.

Experimental design and analysis

The experiment was arranged in randomised blocks with 4 replicates of each treatment and eight replicates of the untreated plots. Plot size was 10 m length of row. Results were analysed by analysis of variance.

Treatments

Experimental treatments consisted of either a three or four-spray programme (Table 3), applied at the start of flowering (F1-F2)*, mid-end flower (F2-F3), first fruit set (I1) and 100% fruit set (I3). Where three sprays were used, these were applied at the first three timings omitting the 100% fruit set spray. Product details are shown in Table 4.

All sprays were applied in water volumes equivalent to 1000 l/ha. Applications were made by ADAS staff using a gas pressurized knapsack sprayer with a 1.5m boom.

*See glossary p18 for growth stage codes.

Table 3. Treatment programmes

Treatment No.	1st flower 16/4/09	Mid-end flower 26/4/09	1st set 10/5/09	100% set 21/5/09
1.	Nil	Nil	Nil	Nil
2.	Bayer UKA386	Bayer UKA386	Bayer UKA386	Nil
3.	Serenade	Serenade	Serenade	Nil
4.	Signum	Signum	Signum	Nil
5.	Stroby WG	Stroby WG	Stroby WG	Nil
6.	Switch	Switch	Switch	Nil
7.	Teldor	Teldor	Teldor	Nil
8	Bravo 500	Signum	Bravo 500	Nil
9.	Bravo 500	Signum	Bravo 500	Signum

Note: Two sets of untreated plots were combined for treatment 1.

Table 4. Product details

Product	Active ingredient(s)	Rate of use	Approval status
Bayer UKA386	Not disclosed	0.8 L/ha	Experimental
Bravo 500	chlorothalonil (500 g/l)	3.0 L/ha	On-label approval
Serenade	*Bacillus subtilis*	10 L/ha	On-label approval
Signum	boscalid (26.7% w/w) + pyraclostrobin (6.7% w/w)	1.5 kg/ha	SOLA
Stroby WG	kresoxim-methyl 50% w/w	0.2 kg/ha	On-label approval
Switch	cyprodinil 37.5 % + fludioxonil 25% w/w	1.0 kg/ha	On-label approval
Teldor	fenhexamid 50 % w/w	1.5 kg/ha	On-label approval

Assessments

Phytotoxicity was assessed following each spray application. Assessments were made on 27 April, 10, 21 and 29 May 2009.

Pre-harvest *Botrytis* in the bush was assessed by taking 30 shoots at random from 10 bushes in the middle 6 m of plot row and recording the total number of sporulating infection points along 0.5 m of shoot, measured back from the start of the current season's growth. Assessments were made on 29 May, 29 June and 20 July 2009. Results were expressed as infections per 0.5 m of shoot.

Fruit set was assessed on 30 June 2009 by taking 10 randomly selected flower trusses from the middle 6 m of each plot and recording the number of set berries, and the number of dropped flower stalks.

Leaf spot was assessed on 30 June, 23 July and 20 August using the standard key of Clarke and Corke (1955), which takes into account both the level of leaf infection and defoliation. Five bushes were assessed in each plot and a mean percentage infection calculated for the plot.

Pre-harvest latent *Botrytis* in the unripe fruit was assessed on samples collected on 9 June 2009. Thirty fully swollen unripe fruit were picked from the centre 6m of each plot. Fruit was taken from each of the bushes, picked to include fruit from a range of heights and both row faces. Latent *Botrytis* infection was assessed by surface sterilizing the fruit, placing on paraquat agar and incubating at ambient temperature (20 deg C) for seven days, then recording the percentage fruit with sporulating *Botrytis* infection.

Plot yields were recorded following machine harvest of individual plots on 27 July 2009.

Fruit *Botrytis* at harvest was assessed by taking a machine harvested 0.2kg fruit sample from the middle of each plot during the harvesting operation, subsampling 100 fruit at random and recording the percentage fruit with sporulating *Botrytis* infection.

Post-harvest *Botrytis, Mucor* and *Penicillium* were assessed by taking 50 fruits from the harvested sample and incubating at ambient temperature (20 deg C) for seven days, then recording the % fruit with sporulating *Botrytis, Mucor* or *Penicillium* infection.

Results and discussion

Bushes were examined 7 – 14 days after each spray application but there was no sign of phytotoxicity symptoms from any of the treatments.

The trial plantation was chosen because the bushes were large and very leafy. *Botrytis* levels in the bushes were quite high in the untreated plots. The first disease assessments were made in late June, by which time *Botrytis* sporulation was apparent on dead flowers and the dead ends of strigs throughout the trial. *Botrytis* levels steadily increased as the season progressed (Table 5). The most effective treatment for the control of *Botrytis* infection in the bush was Bayer UKA386, which gave around 90% control and was significantly better than most of the other treatments. The next best treatment was Signum when applied in a three-spray programme (treatment 4) followed by Switch and Teldor (treatments 6 and 7).

Table 5: Blackcurrant *Botrytis* infection per 0.5m shoot

Treatment	**Product / Programme**	**Assessment date**		
		29/5/09	**29/6/09**	**20/7/09**
1	Untreated	1.31	2.24	2.40
2	Bayer UKA386 (x3)	0.15	0.12	0.34
3	Serenade (x3)	0.81	1.72	1.85
4	Signum (x3)	0.21	0.60	0.62
5	Stroby (x3)	0.62	0.92	1.15
6	Switch (x3)	0.27	0.41	0.62
7	Teldor (x3)	0.27	0.79	0.62
8	Bravo/Signum/Bravo	0.75	1.14	1.26
9	Bravo/Signum/Bravo/Signum	0.58	1.07	0.92
	f value	<0.001	<0.001	<0.001
	df	28	28	28
	s.e.d[1]	0.135	0.257	0.212
	s.e.d[2]	0.155	0.297	0.245

[1] Comparing untreated with spray treatments

[2] Comparing spray treatments

Where Signum was alternated with Bravo (treatments 8 and 9), control was poorer compared with Signum alone. Although there was an indication that the additional Signum applied at fruit set (treatment 9) improved control, the difference was not significant. Serenade and Stroby WG also performed poorly compared with the other treatments, although they were significantly better than the control.

An assessment of latent *Botrytis* was made by incubating surface sterilized unripe fruit on paraquat agar. The high level of latent *Botrytis* was noteworthy, with the untreated plots containing 66.7% of berries infected (Table 6). All treatments apart from Serenade significantly reduced the level of latent *Botrytis* infection, but the only treatment to reduce levels substantially was Bayer UKA386. Of the other treatments, Teldor and Signum were the next most effective but differences between treatments, apart from Bayer UKA386, were not statistically significant.

Table 6: Percentage of latent *Botrytis* in unripe fruit

Treatment	Product / Programme	Percentage of berries with Botrytis
1	Untreated	66.7
2	Bayer UKA386 (x3)	16.7
3	Serenade (x3)	73.3
4	Signum (x3)	45.0
5	Stroby (x3)	53.3
6	Switch (x3)	48.3
7	Teldor (x3)	42.5
8	Bravo/Signum/Bravo	50.8
9	Bravo/Signum/Bravo/Signum	51.7
	f value	<0.001
	df	28
	s.e.d[1]	6.48
	s.e.d[2]	7.49

[1] Comparing untreated with spray treatments

[2] Comparing spray treatments

By harvest, 7.4% of the fruit in the untreated plots had visible *Botrytis* fruit rot. There were no significant differences between the treatments in the individual disease assessments at the 5% level of probability (Table 7). However there were clear visual indications that Bayer UKA386 had reduced *Botrytis* infection at harvest to 0.5%. This result was significant at a 7.5% level of probability. This was the only treatment to give a commercially acceptable result.

The other treatments were less effective, with *Botrytis* infection levels ranging from 4.5% to 7.5%. These results were not significantly different from the control, although there was an indication that the Signum programme was the next most effective, reducing infection levels down to 4.5%.

Table 7: Analysis of fruit rots post-harvest

Treatment	Product /Programme	Fresh	Incubated			
		% Botrytis	% Botrytis	% Mucor	% Penicillium	% Total fruit rots
1	Untreated	7.4	15.3	23.7	26.9	51.8
2	Bayer UKA386 (x3)	0.5	3.0	17.7	20.6	38.8
3	Serenade (x3)	6.7	13.3	22.4	30.1	57.7
4	Signum (x3)	4.5	6.5	13.1	19.2	34.7
5	Stroby (x3)	5.5	15.0	40.0	21.5	70.0
6	Switch (x3)	5.0	11.8	26.5	18.3	53.0
7	Teldor (x3)	6.0	8.5	26.0	24.5	52.5
8	Bravo/Signum/Bravo	7.5	13.8	18.9	13.7	43.3
9	Bravo/Signum/Bravo/Signum	5.0	10.0	37.2	15.5	58.2
	f value	0.075	0.065	0.057	0.202	0.018
	df	28	28	28	28	28
	s.e.d[1]	ns[3]	ns[3]	ns[3]	ns[3]	8.16
	s.e.d[2]	ns[3]	ns[3]	ns[3]	ns[3]	9.42

[1] Comparing untreated with spray treatments

[2] Comparing spray treatments

[3] ns = not significant at the 5% level of probability

When the fruit was incubated, further infection became apparent with the levels of *Botrytis* increasing to 15.3% in the untreated control. Although differences were not significant at the 5% level, there was an indication that Bayer UKA386 gave the best reduction of *Botrytis* with the next best treatment being Signum. These differences were significant at the 6.5% level of probability.

The other fruit rots *Mucor* and *Penicillium* were even more prevalent and were less well controlled by the fungicides. Results for *Mucor* were not strongly significant, although there was an indication that Signum gave some control, reducing infection from 23.7% to 13.1%. No *Rhizopus* was detected.

Taking all the diseases into account, the only two treatments to give a statistically significant reduction in fruit rots compared with the control were Signum and Bayer UKA386. Signum gave the best result, although still with 34.7% of the fruit with one or more infections, and Bayer UKA386 resulted in 38.8% of fruit infected. The other treatments were much less effective for both latent and expressed *Botrytis* and would not have given a commercially acceptable result for fruit quality.

Most of these treatments are used commercially for *Botrytis* control but there are a number of factors that could account for the relatively poor results from them in this experiment:

- The site had a history of *Botrytis* problems with large leafy bushes.
- The spray interval between the second and third treatment application was 14 days because of difficult weather conditions. This was longer than ideal and could have led to infection occurring between spray treatments if there was insufficient persistence or “kick-back”.
- All but one of the treatment programmes were three-spray programmes whereas commercial programmes cover a longer period typically with five or more treatments.
- Where a four-spray programme was used (treatment 9) performance was not outstanding because one of the components, Bravo, was much less effective compared with Signum.

All treatments except Serenade increased fruit set (Table 8). The products with the greatest effect in increasing fruit set were Signum and Switch.

Table 8: Percentage fruit set.

Treatment	Product / Programme		Percentage fruit set
1	Untreated		33.1
2	Bayer UKA386 (x3)		42.6
3	Serenade (x3)		35.3
4	Signum (x3)		50.3
5	Stroby (x3)		41.8
6	Switch (x3)		48.4
7	Teldor (x3)		42.0
8	Bravo/Signum/Bravo		44.4
9	Bravo/Signum/Bravo/Signum		44.0
		f value	0.002
		df	28
		s.e.d[1]	3.78
		s.e.d[2]	4.37

[1] Comparing untreated with spray treatments

[2] Comparing spray treatments

Although all of the treatments except Serenade appeared to increase yield (Table 9), the differences were not statistically significant.

Table 9: Fruit harvest yield

Treatment	Product / Programme		Yield (kg / 10m row)
1	Untreated		20.4
2	Bayer UKA386 (x3)		24.9
3	Serenade (x3)		19.3
4	Signum (x3)		23.2
5	Stroby (x3)		24.7
6	Switch (x3)		21.3
7	Teldor (x3)		22.1
8	Bravo/Signum/Bravo		25.2
9	Bravo/Signum/Bravo/Signum		24.7
		f value	0.194
		df	28
		s.e.d	ns[1]

[1] ns=not significant at the 5% level of probability

Bayer UKA386, Signum and Bravo 500 gave excellent control of leaf spot, Switch and Stroby WG were partially effective and Teldor and Serenade had no effect (Table 10).

Table 10: Percentage leaf area infected with blackcurrant leaf spot

Treatment	Product / Programme	Assessment date		
		30/6/09	**23/7/09**	**20/8/09**
1	Untreated	0.15	1.18	46.6
2	Bayer UKA386 (x3)	0	0	0.2
3	Serenade (x3)	0.30	1.10	45.0
4	Signum (x3)	0	0.10	0.5
5	Stroby (x3)	0.05	0.35	10.9
6	Switch (x3)	0.	0.10	4.5
7	Teldor (x3)	0.20	1.40	46.2
8	Bravo/Signum/Bravo	0	0	0.5
9	Bravo/Signum/Bravo/Signum	0.05	0	0.3
	f value	0.037	<0.001	<0.001
	df	28	28	28
	s.e.d[1]	0.087	0.149	5.24
	s.e.d[2]	0.100	0.172	6.06
	l.s.d[1]	0.178	0.304	10.74
	l.s.d[2]	0.206	0.351	12.40

[1] Comparing untreated with spray treatments

[2] Comparing spray treatments

Conclusions

A high level (66.7%) of latent *Botrytis* was found in untreated unripe fruit. Most of the treatments tested significantly reduced latent *Botrytis* but levels remained around 42% to 53% infected. Bayer UKA386 however stood out as the most effective treatment, substantially reducing infection in the unripe fruit to 16.7%. Signum was the most effective of the other treatments, reducing levels to 42.5%.

Levels of expressed infection in the ripe fruit were lower but still rather higher than would be acceptable for a commercial crop. Bayer UKA386 again gave the best control of *Botrytis,* both in the fresh harvested fruit and in the incubated fruit. Similarly Signum performed well and in addition gave some control of *Mucor* and *Penicillium*.

Of the other treatments Serenade was relatively ineffective, the only significant result being a small reduction in *Botrytis* infection in the bush. Stroby WG and Bravo 500 (when used as an alternating programme with Signum) were less effective than other treatments when comparing levels of *Botrytis* in the bush. A similar trend was apparent in the fruit *Botrytis* assessments but differences were not statistically significant.

Apart from the Bravo/Signum programme, only three fungicide applications were made and the spray interval between the second and third application was probably too long to achieve the best level of control. Bayer UKA386 and to some extent Signum performed well despite this, but the other fungicides would probably need to be applied more frequently to achieve a commercially acceptable level of control.

Bayer UKA386 is not yet available. Signum is the most effective currently available fungicide confirming previous results (Atwood 2004), but for an anti resistance strategy would need to be used in a programme with other fungicides. The next most effective fungicides are Switch or Teldor and either could be used in an alternating programme. Switch has the benefit of giving good control of leaf spot, as does Signum, Bayer UKA386 and Bravo 500.

All treatments significantly improved fruit set compared with the untreated. Although there were no significant differences in fruit set between the fungicides, there was an indication that Signum had greatest effect. All fungicide treatments except Serenade appeared to increase yields, but differences were not statistically significant.

Technology transfer

No technology transfer activities were undertaken during this project.

Glossary

Table 11. Growth stage codes

A	Dormant, no green showing
B1	Burst, tips of buds showing green
B2	Burst, folded leaves as long as the bud scales
C1	First leaves fan open
C3	Three leaves open
D	Grape stage, flower buds visible as a compact dome
E1	Grape stage, first bud separated
E2	Grape stage, all buds separated
F1	1st Flowers open
F2	50% flowers open
F3	100% flowers open
I1	1st fruit set
I2	50% fruit set
I3	100% fruit set

References

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APPENDIX

Appendix 1. Plot layout

NORTH

9	1	5	2
10	20	30	40
1	5	8	9
9	19	29	39
7	8	1	1
8	18	28	38
5	4	2	8
7	17	27	37
3	9	7	7
6	16	26	36
2	2	1	5
5	15	25	35
8	3	4	3
4	14	24	34
6	1	3	1
3	13	23	33
4	7	6	6
2	12	22	32
1	6	9	4
1	11	21	31
I	II	II	IV

HEADLAND

Appendix 2. Spray details

	16/4/09	**26/4/09**	**10/5/09**	**21/5/09**
General weather	Sunny Dry Warm	Sunny Dry Cool	Sunny Dry Warm	Sunny Dry Warm
Temperature	13^{o}C	13 ^{o}C	16-22 ^{o}C	18 ^{o}C
Wind direction	Easterly	Easterly	S Westerly	S Westerly
Wind speed	1.2 km/hr	1.2 km/hr	1.4 km/hr	1.4 km/hr
Weather in previous 24hr	Showery, warm	Dry Cool	Dry warm	Showery Moderate
Weather post application	Showery, Warm	Light shower Warm	Showery Warm	Dry then Showery
Drift	None	None	None	None

