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Managed timing of sulphur for blackcurrant gall mite control

Undertaken for SmithKline Beecham
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Authentication

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

Signed…………………………………………………………..
J. V. Cross

Dated………………………………………………………………

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Managed timing of sulphur for blackcurrant gall mite control

Summary

A replicated experiment was done at HRI-East Malling in 2000 to evaluate early season sprays of sulphur (10 kg of active ingredient in 500 litres water per hectare per spray) for the control of blackcurrant gall mite on the blackcurrant variety Ben Tirran, and to determine the effects of single sprays of sulphur on growth and yield. Results and conclusions of the experiment are as follows:

- A managed programme of two sprays of sulphur, timed according to the migration of the mite (one spray at the start and one at the peak of the migration) maintained numbers of migrating mites captured on sticky traps at very low levels throughout the migration period. It gave the best control of gall mite and the smallest end of season gall counts.

- A programme of two sprays of sulphur at the standard fixed timings (one at bud-burst and one at the first grape emerged growth stage of Ben Lomond, but while Ben Tirran was still dormant) maintained numbers of migrating mites captured to zero for the first half of the migration period, whereafter control broke down. The fixed spray timings were too early in relation to the migration period of the mite to maintain control throughout the migration period. It gave significantly poorer control than the managed programme.

- The sulphur sprays had approximately 3 weeks persistence during which they were highly effective, but after which their effectiveness declined.

- The accumulated temperature method of Cross and Ridout (in press) predicted the timing of first, 5% and the peak of the migration to within 4, 4 and 5 days of actual emergence. The method could be used by growers for better timing of gall mite sprays and would be superior to the fixed growth stage timing method used currently.

- Single sprays of sulphur to Ben Tirran when the bushes were dormant on 13 March, 31 March or 6 April or at the '3 leaves unfolded' growth stage (GS C3) on 5 May did not reduce yield or growth significantly compared to the untreated control.

- Further work is recommended to investigate the efficacy, persistence and the timing of sprays of sulphur for the control of gall mite. Further work is also needed to investigate the possible phytotoxic effects of sulphur applied at different timings to different commonly grown varieties of blackcurrant. This work shows that properly designed small plot experiments harvested by hand picking can be a cost effective and scientifically sound way of determining the phytotoxic effects of sprays on blackcurrants.

Introduction

In recent years in the UK, it has become common practice for blackcurrant growers to apply one or two early season sprays of micronised sulphur to blackcurrants to control blackcurrant gall mite. This practice is based on research in Denmark. The first spray is applied shortly after bud-burst and the second at the first grape emerged growth stage. Later sprays were considered to be phytotoxic and possibly to cause taint. Sprays are timed according to the growth stages of Ben Lomond. Cross & Ridout (in press) showed that the migration occurred at the same time on different varieties despite large differences in growth stage between early and late varieties.

The work reported here was done to investigate the efficacy of such early season treatment and to see whether control could be improved by timing the sprays in relation to the migration of the mites. Previous work for the SmithKline Beecham/ HDC blackcurrant fund by Cross & Easterbrook (1997) and for MAFF by Cross & Ridout (in press) had indicated that sprays at these early growth stages were likely to be too early to prevent the migration for the whole of the migration period which can last over 8 weeks. However, delaying the sprays posed the possible risk of phytotoxicity causing lower yield.

An experiment, funded by the the SmithKline Beecham/ HDC blackcurrant fund, done at HRI-East Malling in 2000 to investigate the efficacy, persistence and the timing of sprays of sulphur for the control of gall mite.

Methods and materials

Site: The experiment was done in an experimental blackcurrant plantation of the variety Ben Tirran in Kiln field, HRI-East Malling. It was planted with 2 year old plants supplied by Berryplants, Brooker Farm, Newchurch, Romney Marsh, Kent, on 13 May 1998 and consisted of 9 rows of 26 plants. The spacing between the rows was 3.0 m and the spacing between plants in the row was 1.5 m (plant density = 2222.2/ha). Shortly after planting, each bush was infested artificially with blackcurrant gall mite by tying a 10-15 cm length of shoot bearing one or more galls obtained from an adjacent highly infested plantation, to a central shoot in each bush. The gall mite established well and the bushes were infested moderately by the end of the season with several galls per bush. The infestation increased significantly in 1999 such that a high proportion of buds were galled by the end of the 1999 growing season.

Treatments: The experiment consisted of two parts as follows:

1) A comparison of the persistence and efficacy of a ‘Managed’ programme of sulphur sprays applied at the start of the migration (> a total of 1 mite emerging per gall) and when the number of mites exceeded 2% of the number on the untreated controls versus a ‘Fixed’ programme of two sprays at fixed growth stages (bud-break and first leaf unfolding).
2) The effects of single sprays at the same timings on the yield and growth of blackcurrants (cv Ben Lomond).

Thus there were three treatments in the first part of the experiment including a double replicated untreated control and five treatments in the second including the untreated control (Table 1).

Table 1. Treatments.

Treatment no. and name	Sulphur sprays			
	Number	Dates	Growth stage	
			Tirran	Lomond
		Persistence and efficacy of gall mite control		
1. Managed	Two	31 March, 5 May	A, C3	C3, F3
2. Fixed	Two	13 March, 6 April	A, A	B, E1
3. Control*	None	-		
		Effects on growth and yield		
4. First	One	13 March	A	B
5. Second	One	31 March	A	C3
6. Third	One	6 April	A	E1
7. Fourth	One	5 May	C3	F3
8. Control	None	-		

- Double replicated Key: A = dormant, B = bud-burst, C3 = 3 leaves unfolded, E1 =
- first grape emerged, F3 = full flower

Spray application: All sprays were of micronised sulphur applied with a hand lance at a dose of 10.0 kg a.i. in 500 l water per hectare. Ashlade Sulphur FL containing 720 g a.i. /l sulphur (dose = 13.9 l product per ha) was used for the first spray on 13 March 2000. Headland Sulphur containing 800 g a.i. /l (dose = 12.5 l product per ha) was used for the other sprays. A Cooper Pegler CP 15 knapsack sprayer fitted with a single Albuz 208 (Lilac, ATR series) ceramic hollow cone nozzle (‘high’ pressure setting, flow rate = 240 ml/min) was used for application of sprays. A pre-test showed that a spray volume of 500 l/ha allowing a spraying time of 56 s per bush, was sufficient to give complete spray cover of the surfaces of the bark and buds during the dormant period. This volume was used for all the spray applications. An anti-drift screen, consisting of four pieces of plastic board, each 1 m x 0.6 m, joined together at the edge into a long folding strip, was used to surround each bush at the time of spraying. This minimised inter-plot contamination by spray drift.

Experiment design: A randomised block experimental design was used with nine replicate plots of treatments 1,2 and 4-8. Treatment 3 was double replicated, there being two plots of treatment 3 in each block. Plots consisted of two adjacent bushes in the same row.

Assessments : For the efficacy part of the experiment, sticky traps were used to monitor the migration of the gall mites from two individual galls in each bush (= 4 traps per plot). The traps consisted of a circular plastic cap, 3.2 cm in diameter (the lids of plastic specimen containers) with a small square of double- sided Sellotape stuck to the underside. They were pinned through their centre to the end of a truncated shoot above a gall, at a distance of 5 cm above the gall. On the untreated controls (treatment 3), monitoring was started on 10 March and continued at 1-3 day intervals until the end of the migration. For the 'Fixed' and 'Managed' treatments, monitoring was started 3 days after the application of the first sulphur spray to that treatment and was continued at three days intervals until the migration had effectively ceased. At each date, the sticky caps were removed and replaced with fresh ones. The caps were taken to the laboratory shortly after removal from the bush and the mites adhering to the sticky tape on each were counted under a binocular microscope. The mites generally occurred in a narrow ring around the place of attachment of the shoot.

For the yield and growth part of the experiment, the all the fruit from each bush was picked by hand on July and weighed. The total length of the 2000 growing season extension growth was measured in November 2000.

Meteorological records: Full meteorological records are available from the Met Office station at HRI-East Malling nearby.

Statistical analysis: The number of mites emerging in the efficacy part of the experiment was very small and varied greatly from gall to gall. For this reason, analysis of variance of the data was inappropriate. The total number of mites caught per 36 galls (i.e. the treatment total) was calculated for each sampling date for each treatment. Results from the double replicated controls were averaged. The number emerging from the Fixed and Managed treatments were then expressed as a percentage of the number emerging from the untreated controls. These variates were plotted against time to assess the persistence and effectiveness of the treatments.

Results

Persistence of Fixed and Managed treatments

The first migrating mites were recorded on the untreated control plots on 3 March, when the buds of Ben Tirran were dormant and 10 days before bud break of Ben Lomond (Figure 1,Table 2). Numbers were small and variable throughout the rest of March but rose sharply to a first peak on 9 April. Numbers decreased greatly by 12 April but two subsequent peaks occurred on 30 April and 15 May with intervening periods of low numbers. The migration declined in late May and effectively ceased in early June. Much smaller total numbers of mites emerged per 36 galls from the Managed (total= 22) and Fixed (total = 147) treatments than from the untreated control (mean total = 992). The first spray applied for the Fixed treatment on 13 March maintained numbers of mites captured to zero for 24 days until the second spray was applied on 6 April. This second spray maintained numbers captured to zero for 21 days until 27 April when numbers rose sharply (Figure 2, Table 2). Although very small numbers of mites emerged from the Managed plots on 6-12 April, numbers emerging in April and May were much smaller. The two sprays on 31 March and 5 May at the start of the migration and when numbers started to rise 5 weeks later effectively maintained numbers captured to less than 10% of the control throughout the migration.

Figure 1

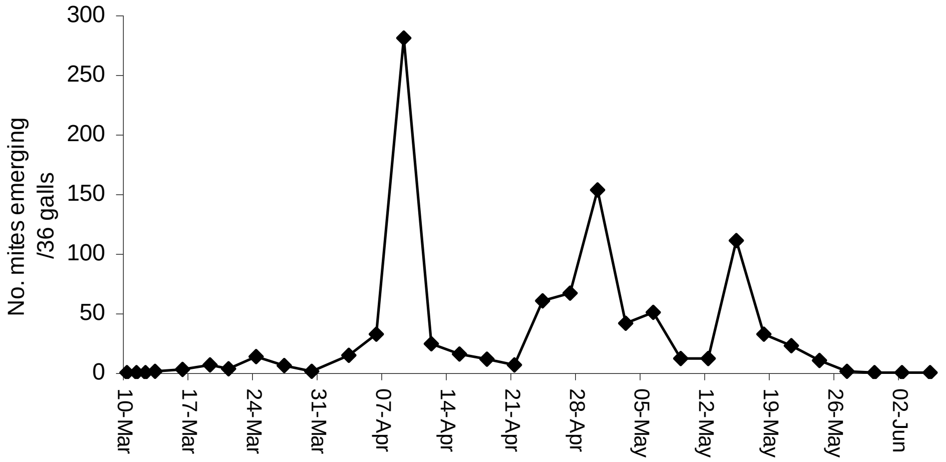

Figure 2

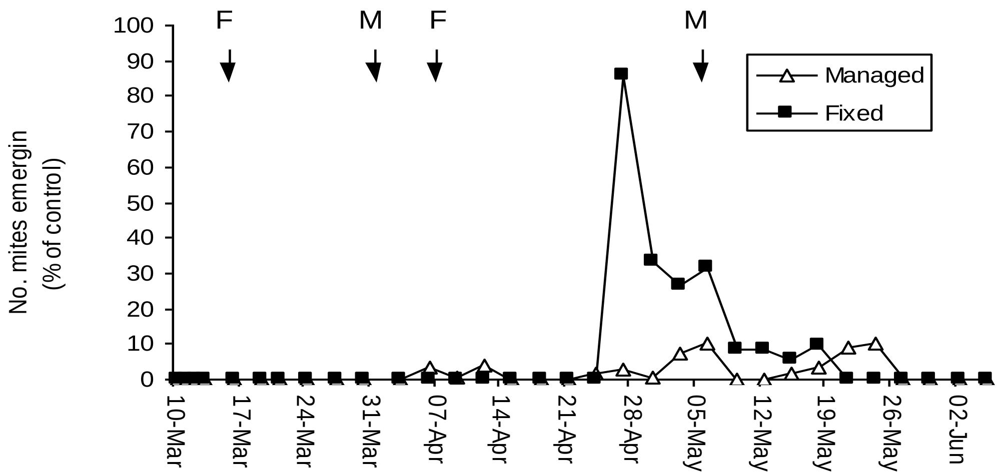

Figure 1. Numbers of mites captured per 36 galls on the untreated control plots.

Figure 2. Numbers of mites captured per 36 galls on the Managed and Fixed treatments as a percentage of the control. The dates of application for the Managed (M) and Fixed (F) treatments are marked with arrows.

Table 2. Number of gall mites caught per 36 galls from Untreated, Managed and Fixed treated plots and the number caught on the Managed and Fixed plots as a percentage of the untreated controls in 2000

Date (2000)	No. of mites caught/36 galls			% of Untreated	
	Untreated	Managed	Fixed	Managed	Fixed
10 Mar	0.0	-	-	-	-
11 Mar	0.0	-	-	-	-
12 Mar	0.0	-	-	-	-
13 Mar	1.3	-	-	-	-
16 Mar	2.5	-	0	-	0
19 Mar	6.5	-	0	-	0
21 Mar	3.5	-	0	-	0
24 Mar	13.6	-	0	-	0
27 Mar	6.0	-	0	-	0
30 Mar	1.2	-	0	-	0
3 Apr	14.3	0	0	0	0
6 Apr	32.0	1	0	3.1	0.0
9 Apr	280.6	2	0	0.7	0.0
12 Apr	24.0	1	0	4.2	0.0
15 Apr	15.5	0	0	0.0	0.0
18 Apr	11.5	0	0	0.0	0.0
21 Apr	6.5	0	0	0.0	0.0
24 Apr	60.0	1	0	1.7	0.0
27 Apr	66.5	2	57	3.0	85.7
30 Apr	153.5	1	51	0.7	33.2
3 May	41.5	3	11	7.2	26.5
6 May	50.5	5	16	9.9	31.7
9 May	12.0	0	1	0.0	8.3
12 May	12.0	0	1	0.0	8.3
15 May	111.0	2	6	1.8	5.4
18 May	32.0	1	3	3.1	9.4
21 May	22.7	2	0	8.8	0.0
24 May	10.0	1	0	10.0	0.0
27 May	1.0	0	0	0.0	0.0
30 May	0.0	0	1	0.0	0.0
2 Jun	0.0	0	0	0.0	0.0
5 Jun	0.0	0	0	0.0	0.0

The first peak in mite emergence co-incided with a period of higher daily maximum temperatures and low rainfall (Figure 3 overleaf). The smaller numbers in mid-April and early May appeared to coincide with periods of wetter, cooler weather. The migration effectively ceased at the end of May.

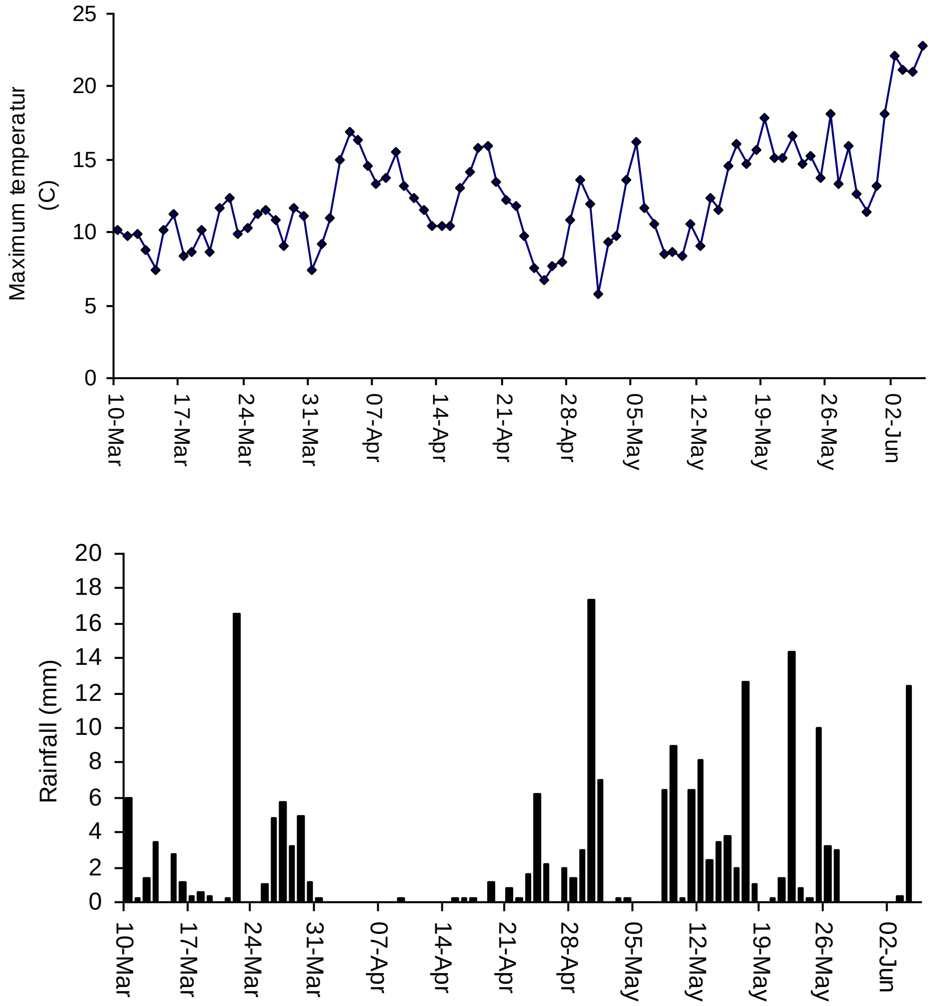

Figure 3. Daily maximum temperature (˚ C) and rainfall amounts (mm)

Prediction of the time of migration

The accumulated temperature model of Cross & Ridout (in press) was used to predict the dates of first, 5% and 50 % emergence and to compare the predictions with actual emergence dates. The model predicted dates in 2000 were Julian days 76, 98 and 120 (16 March, 7 April and 29 April) respectively. Actual first, 5% and 50% emergence occurred on Julian days 72, 93 and 115 respectively, 4, 4 and 5 days before those predicted.

Efficacy of Fixed and Managed treatments

Mean numbers of gall mite galls (big buds) per bush at the end of the season were reduced by all the sulphur treatments (Table 3). The Managed treatment gave the best control, reducing the mean number of galls per bush to 7.7 compared with 39.0 on the untreated control. The first spray of the Managed treatment was the most effective but the second spray on 5 May gave significant benefits. The Fixed treatment was only half as effective as the Managed treatment. The 31 March spray was the most effective of the single spray treatments but there was no significant difference in the efficacy of 13 March, 31 March and 6 April treatments.

Table 3. Mean number of gall mites per bush at the end of the season

Treatment: date (s) of sulphur spray application	Mean number of galls per bush at the end of the season	
	x	√x
13 March	20.0	4.26
31 March	16.5	3.77
6 April	23.1	4.64
5 May	27.0	4.93
Fixed treatment: 13 March + 6 April	15.2	3.73
Managed treatment: 31 March + 5 May	7.7	2.60
Untreated	39.0	5.93
SED (73 df) – comparisons with control	5.62	0.460
- other comparisons	6.49	0.531

Effects of single sprays on yield and growth

None of the single sulphur spray applications applied on 13 or 31 March or 6 April or 5 May reduced yield significantly compared to the untreated control. Differences in yield between single greater than 0.84 tonnes/ha would have been statistically significant. The mean yield of all the sulphur treated plots was 3.3 tonnes/ha.

Table 4. Mean total weight of year 2000 growing seasons extension growth and mean yield harvested by hand picking from blackcurrant bushes sprayed once to run-off with sulphur (10 kg a.i. /ha, 1000 l/ha) at different dates in spring 2000.

Date of application of sulphur	Growth stage	Total weight of extension growth/bush	Yield (t/ha)
13 March	A, dormant		3.18
31 March	A, dormant		3.17
6 April	A, dormant		3.42
5 May	C3, 3 leaves unfolded		3.36
Untreated	-		3.38
SED (32 df)	-		0.410

Discussion

The mean total number of mites captured per gall on the untreated control plots (27 mites per gall) was 10-60 fold smaller than had been recorded in previous years at HRI East Malling on Ben Tirran by Cross & Ridout (in press). This was probably because the weather was very wet and cool during much of the migration period in 2000. Some internal necrosis of the tissue of the galls occurred as had been observed on Ben Tirran in 1998 and 1999 by Cross & Ridout (in press). This necrosis appears to be caused by wet weather conditions and greatly reduces the total number of mites that emerge per gall.

The sulphur sprays appeared to have at least 21 days effective persistence in this experiment, which is comparable to the results of previous work done at East Malling in 1997 (Cross & Easterbrook, 1997). However, the two sulphur sprays applied for the Fixed treatment (timed according to the growth stage of Ben Lomond) were too early in relation to the migration of the gall mite to give a high degree of control for the whole of the migration period. The effectiveness of the second spray had declined well before the end of the migration allowing significant numbers of mites to be captured in the latter part of the migration. The effective persistence of sulphur is not great enough for the normal programme of two early sprays of sulphur (at bud break and at first grape visible of Ben Lomond) to give effective control of gall mite for the entire duration of the migration period. This work shows that the Managed approach is likely to be better. The first spray should be delayed until the start of the migration with subsequent sprays whenever emergence increases. However, direct observation of the emergence of mites by growers is likely to be impractical because the mites are too small to be easily visible. A more practical approach would be to use the accumulated temperature model of Cross & Ridout (in press) to predict the start of the migration when the fist spray should be applied. If the effective persistence of sulphur is about 3 weeks, in most years only two sulphur sprays would be needed using this strategy. The optimum timing for the second spray would be 2-3 weeks after the first, which in most years would coincide with the 50% emergence date.

However, this suitability of this approach depends on whether or not sulphur sprays are phytotoxic to the blackcurrant variety being grown. The single sulphur sprays applied up to the three leaves emerged growth stage in this experiment did not reduce yield or growth of Ben Tirran significantly. Further work is needed to investigate the possible phytotoxic effects of sprays of micronised sulphur to the range of commercially grown blackcurrant varieties. This work shows that small plot experiments can be cost effective for investigating

References

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