Project title:	Strawberry: Comparison of five non-pesticide mildew control products on strawberry
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The results and conclusions in this report are based on an investigation conducted over one year. The conditions under which the experiment was carried out and the results obtained have been reported with detail and 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.

CONTENTS

GROWER SUMMARY

Headline

Commercial control of powdery mildew can be achieved using the combination of potassium bicarbonate and sulphur and offers the opportunity of minimising the risk of detectable pesticide residues occurring in harvested fruit.

Background and expected deliverables

Powdery mildew is an important disease of strawberry causing significant yield losses each year. Current production systems provide conditions that are conducive to infection and development of the disease. Chemical control close to harvest using fungicides is limited to the product Nimrod (bupirimate) with a one day harvest interval or perhaps the use of Amistar (azoxystrobin), Systhane (myclobutanil), Kindred (myptyldinocap) and Topas (penconazole) at times when picking frequencies allow three day harvest intervals in between picks. Given such limitations, new methods for mildew control, especially during fruiting, are an important priority. The industry is seeking to develop residue free production strategies which will reduce the reliance made upon conventional fungicides.

A number of products recently released onto the market could be used as alternatives. These include biological control agents, natural plant derivatives and foliar feeds. Some of these products have received approval as crop protection products for use in strawberries. This project aimed to examine the effect of a combination of five such products.

Summary of the project and main conclusions

The five products tested are listed in the table below. The products which have not currently received approval as crop protection products have been assigned HDC chemical codes.

Table 1. Products tested during the experiment together with their approval status. Note that the formulation of sulphur used was Kumulus DF as there is no limit to the number of applications that can be made in strawberries.

Trade name	Active ingredient	Number of permitted applications	Rate of application	Approval status
Potassium bicarbonate	Potassium bicarbonate	60kg per Ha	10g/L (max application rate is 20g/L)	Approved as commodity substance
sulphur	80% w/w sulphur	-	2g/L	Approved
Serenade ASO	*Bacillus subtilis*	20 per crop	25ml/L	Approved
HDC F7	Plant extract from R*eynoutria sacchaliensis* L.	-	10ml/L	Not approved
HDC F8	Plant extract and foliar feed	-	5ml/L	Not approved

Commercial experience of using these products suggests that their efficacy when used on their own will not be sufficient to offer commercially acceptable levels of control and so the products were applied in combinations of two or three products as shown below.

Table 2. Combinations of products applied

Treatment	Product combinations
1	Potassium bicarbonate + Serenade ASO
2	Potassium bicarbonate + HDC F7
3	Potassium bicarbonate + sulphur
4	HDC F8 + HDC F7
5	HDC F8 + sulphur
6	HDC F7 + sulphur
7	Serenade ASO + sulphur
8	Serenade ASO + sulphur + HDC F7
9	Control

Products were applied weekly using a motorized knapsack sprayer to a 60-day crop of 'Sonata' planted in early July. Assessments of mildew were then conducted weekly just prior to making the product applications.

There were significant effects of the product combinations on severity of mildew and the data provides useful practical guidelines to strawberry growers on the control of mildew. Of the combinations tested, only those containing potassium bicarbonate, sulphur and Serenade ASO are approved plant protection products and only these three products provided a useful level of control. Results from a combination of these products are summarised in Figure 1 (below).

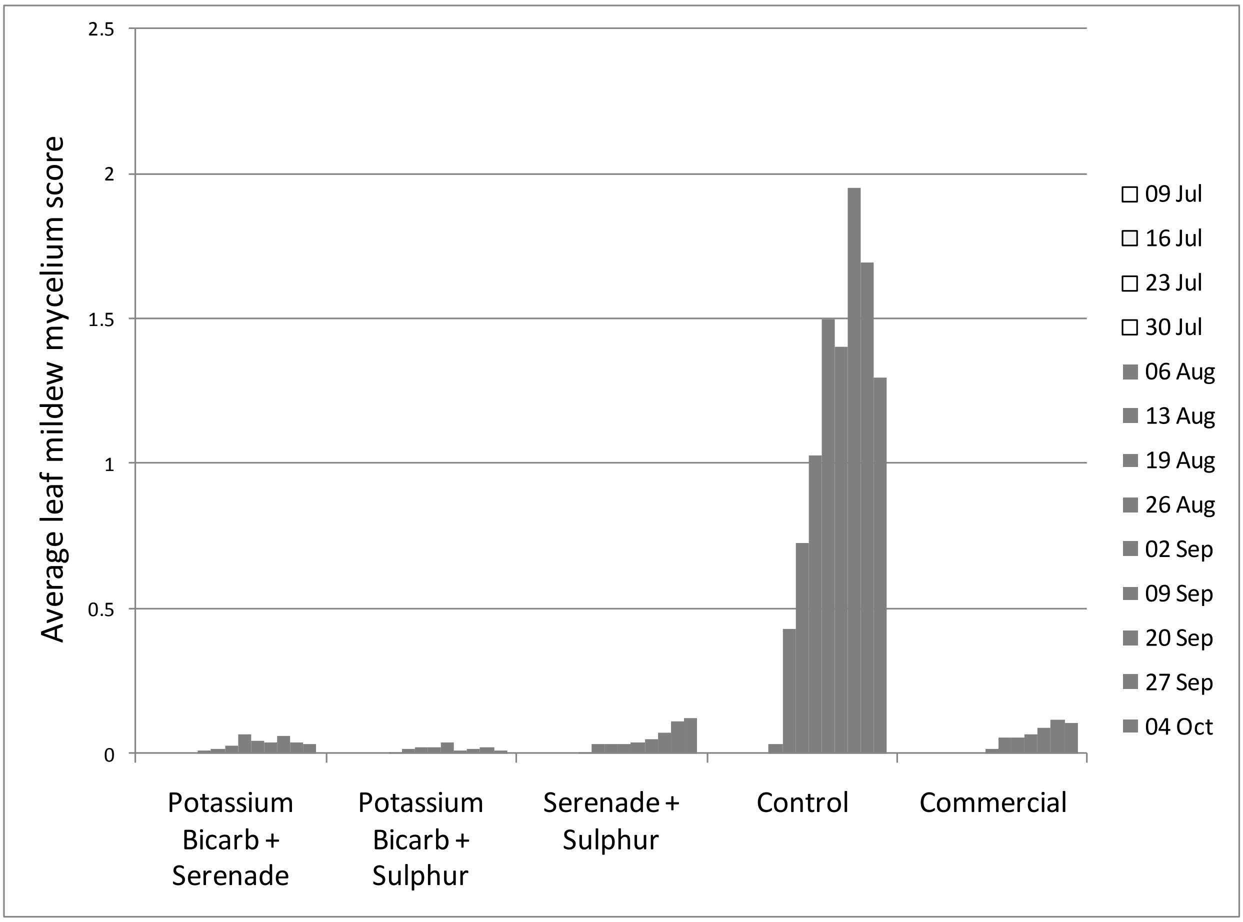

Figure 1. Effect of three combinations on mildew in strawberry. The open symbols represent the period during which sprinklers were used. Only those treatments which consist of approved plant protection products are shown here. Assessments were also made in the commercial tunnel next to the experimental tunnel.

Sprinklers were used during the first four weeks following planting from 9th July to 3rd August. Whilst the use of sprinklers is primarily aimed at reducing transpiration rates and cooling plants to improve establishment and yield, their use also prevented development of the symptoms of mildew. As soon as the sprinklers were switched off, leaf cupping, mildew mycelium and purple blotching was seen. Sprinklers can only be used until the start of flowering and so control after this period must be through applications made to the crop.

All combinations significantly reduced the severity of mildew to a level that was consistent with commercial best practice. Potassium bicarbonate, in particular when combined with sulphur, was the most effective combination and caused significantly lower levels of mildew than most other treatments. However, repeated use of sulphur is known to have a phytotoxic effect on strawberry, whilst potassium bicarbonate can give rise to some leaf scorch if overused, particularly in hot conditions. Therefore great care should be taken when using these products either singly or in combination over a period of time, with their effects monitored closely during management of the spray programme.

Conclusions

- Sprinklers prevented the development of mildew symptoms throughout their period of use.
- Potassium bicarbonate + sulphur was the most effective combination tested and caused the lowest severity of mildew in the experiment described here.
- Weekly applications of control products are necessary as the rate at which mildew severity increased in the control treatment was significant.
- Potassium bicarbonate is the only product which is able to eradicate powdery mildew.
- Be aware of the potential long term damage that can be caused by repeated use of sulphur in strawberry and the risk of leaf scorch occurring in certain conditions where potassium bicarbonate is employed. Great care should be taken when using these products either singly or in combination over a period of time, with their effects monitored closely during management of the spray programme.

Financial benefits

The recording of yield was not part of the experimental protocol and so comparisons of the financial benefits of the product combinations tested are not possible. However, control of mildew is essential and the products tested here will form a useful part of any powdery mildew control programme. Potassium bicarbonate in particular offers a relatively inexpensive method of control.

Action points for growers

- Make use of sprinklers until first open flower to aid plant establishment but also to prevent the development of mildew symptoms.

- Use combinations of potassium bicarbonate, sulphur and Serenade ASO as part of mildew control strategies.

- Be aware of the potential long term damage that can be caused by repeated use of sulphur in strawberry and the risk of leaf scorch occurring in certain conditions where potassium bicarbonate is employed. Great care should be taken when using these products either singly or in combination over a period of time, with their effects monitored closely during management of the spray programme. Consider using reduced rates should problems appear.

- Apply combinations weekly. Be careful not to miss a week's application as mildew severity can increase significantly during this time.

- As an eradicant, combinations containing Potassium bicarbonate can be used to eradicate mildew but take care to reduce and avoid the risk of scorch occurring.

SCIENCE SECTION

Introduction

Powdery mildew, caused by *Podosphaera aphanis,* it occurs in most areas of the world where strawberries are grown (Strand, 2008). *P. aphanis* is an important disease of strawberry partly because it is so widespread but also because it infects leaves, flowers and fruit and current production systems tend to provide optimal conditions for its development.

The disease overwinters in growing leaves and so may be present in both established fields and new plantings of cold stored bare-root runners and tray plants. There are three main symptoms of the disease in strawberry. Cupping of leaves appears first although this can also be a result of plant stress. White mycelia develop and purple blotches can be seen on the leaf surfaces. White mycelia do develop on fruit and runners as well. Yield reductions result from the loss of photosynthetic potential and through direct effects on flowers and fruit development.

Mildew mycelium develops quickest on the plants' youngest leaves and the older, mature leaves are hardly affected by mildew at all if inoculation does not take place early during leaf development (Okayama *et al*., 1995). For this reason, mildew was assessed in the experiment described here on the four newest expanded leaves from each plant.

The optimal temperatures for conidial germination and conidial germ tube length range between 15 and 25 °C with relative humidities higher than 75%, but less than 98% (Amselam *et al*., 2006). Leaf wetness prevents the symptoms of mildew from developing, overhead irrigation being found to inhibit the development of the disease (Carew and Battey, 2002). However, because dry conditions and high humidities are common in tunnels, and because a number of commercial varieties are susceptible, the disease remains a serious problem of UK strawberry production. Xiao *et al*. (2001), working in Florida, compared mildew epidemiology between tunnel grown and out-door strawberry crops in California and whilst they found similar levels in both situations, this was because the conditions in both situations favoured disease development. In the UK the use of tunnels during summer can provide near optimal conditions for development of the disease.

The control of powdery mildew in strawberry is limited by the harvest intervals of currently available conventional fungicides once fruiting begins. Options are limited to Nimrod with a one day harvest interval and perhaps Amistar, Systhane, Kindred and Topas at times when picking frequencies allow for a three day harvest interval in between picks. This makes the development of new methods for mildew control. especially during fruiting. an important priority. Also driving the need for a solution to mildew is the aim of the strawberry industry to develop residue free production strategies. This will eliminate the use of the few pesticides available to growers for powdery mildew.

For a number of reasons therefore, a replacement strategy for mildew control is necessary. However, there have been a number of products released onto the market in recent years which may be able to be used as part of a mildew control strategy. These include biological control agents, natural plant derivatives and foliar feeds. Some of these products have received approval as crop protection products for use in strawberries. This project aims to examine the effect of a combination of 5 products on mildew in strawberry.

Materials and methods

The experiment was conducted using a 60-day crop of c.v. 'Sonata' planted in July because experience suggests there would be high mildew pressure at this time of year and so effects of treatments would be clearer. Treatments were applied from planting giving the best possible potential for control particularly where treatments consisted of only protectants.

Five products were selected for inclusion in the experiment (Table 2) and applied in eight combinations (Table 3). Two of the products are not approved crop protection products for strawberry and so in this report, HDC new product codes have been assigned to these products.

Table 2. Products tested during the experiment together with their approval status.

Trade name	Active ingredient	Number of permitted applications	Rate of application	Approval status
Potassium bicarbonate	Potassium bicarbonate	60kg per Ha	10g/L (max application rate is 20g/L)	Approved as commodity substance
sulphur	80% w/w sulphur	-	2g/L	Approved
Serenade ASO	*Bacillus subtilis*	20 per crop	25ml/L	Approved
HDC F7	Plant extract from R*eynoutria sacchaliensis* L.	-	10ml/L	Not approved
HDC F8	Plant extract and foliar feed	-	5ml/L	Not approved

Commercial experience of using products such as these suggests that when they are applied singly, the level of control achieved is not sufficient and additional control measures are necessary. Therefore in this project, the effect of applying these products in the combinations shown below was tested and compared with a control which received no control applications.

Table 3. Combinations of products applied.

Treatment	Product combinations
1	Potassium bicarbonate + Serenade ASO
2	Potassium bicarbonate + HDC F7
3	Potassium bicarbonate + sulphur
4	HDC F8 + HDC F7
5	HDC F8 + sulphur
6	HDC F7 + sulphur
7	Serenade ASO + sulphur
8	Serenade ASO + sulphur + HDC F7
9	Control

Treatments were applied to a waiting-bed '60 day' crop of 'Sonata' at Sandbanks Farm, Faversham which was grown in 4-row table tops in a Spanish tunnel and was planted in early July. The plants were planted into 1m strawberry bags containing peat at a density of 10 plants per metre row. Fertigation was through drippers as per the farm's normal practice. For the first four weeks following planting, sprinklers were used by the farm to aid plant establishment. Sprinklers were applied based on accumulation of light between 8am and 5pm.

The nine treatments were applied in a completely randomized block design with five blocks per treatment. Each treatment replicate consisted of seven 1m strawberry bags, all of which were sprayed weekly as outlined below. Of these, the outer four bags were guard bags with three bags in the centre being assessed (Figure 2). This was to minimise the effect of spray drift and contamination of mildew from one treatment to the next.

GUARD	GUARD				GUARD	GUARD

Figure 2. Arrangement of strawberry bags in each treatment replicate. Whilst all seven bags were sprayed, only the centre three bags were assessed. This was repeated in all five blocks giving a total of 150 plants and 600 leaves assessed in each treatment.

Applications were made through an air assisted knapsack sprayer at a rate of 500L water per Ha. Applications began immediately following planting and continued weekly thereafter until 4th October.

Just prior to each application, mildew severity was scored weekly. Mildew was scored on 4 leaves per plant giving a total of 600 leaves assessed per treatment. Because mildew mycelium develops quickest on the plants' youngest leaves and the older, mature leaves are hardly affected by mildew at all if inoculation had not taken place earlier during leaf development, mildew was assessed here on the four newest expanded leaves from each plant. The severity of mildew mycelium infection was scored on a 0 to 5 scale (Table 4).

Table 4. The scoring system used to determine severity of mildew mycelium infection.

0	No mildew mycelium present	3	<25% leaf coverage in mildew mycelium
1	<1cm diameter mildew mycelium	4	<50% leaf coverage in mildew mycelium
2	<2cm diameter mildew mycelium	5	<Complete leaf coverage in mildew mycelium

In addition, leaf cupping was recorded as present or absent on each assessed leaf. Leaf cupping was defined for the purposes of uniform assessment as being when the leaf margins were perpendicular to the leaf orientation. Purple blotching was also recorded as being present or absent at these times. From these data, the percentage mildew infection was calculated. Each week photographs of each treatment were taken to demonstrate the effects seen. Photographs from two assessment dates are shown in Appendices 1 and 2. A final assessment of leaf number per plant was recorded at the end of the experiment to determine whether any treatment had had a phytotoxic effect on plant growth.

Statistical analysis was conducted to determine significance of differences between treatments using Statsgraphics Plus. Where appropriate, angular transformations were conducted to account for non-normality of data. ANOVA and LSDs were then used to determine statistical significance of results.

Results

No symptoms of mildew were seen for the first four weeks of the trial, whether that be mildew mycelium, leaf cupping or blotching. This period of four weeks coincided with the period during which sprinklers were used by the farm. Following this every parameter measured showed mildew severity increasing to varying degrees.

Figure 2 shows the average mildew score for each treatment from the first assessment on 9th July onwards. Following the initial four week period, mildew severity in the control treatment increased rapidly for the following seven weeks, increasing to an average maximum score of 1.9. In comparison with the control, all other treatments caused a significant reduction ($P<0.001$) in the severity of mildew. Whilst mildew severity did increase over the course of the experiment in all eight treatments, the maximum average mildew score in any of these treatments was 0.3 in the HDC F7 + HDC F8 treatment compared to 1.9 in the control. The treatment which caused the lowest average mildew score was potassium bicarbonate + sulphur in which case the maximum mildew score never increased above 0.035. This was significantly lower than the HDC F7 + HDC F8 treatment ($P<0.01$).

Every treatment therefore was effective at reducing mildew severity when compared to the control ($P<0.001$). Of the eight treatments, potassium bicarbonate + sulphur was most effective with the lowest average mildew score and HDC F7+ HDC F8 was the least effective ($P<0.01$).

At the end of the assessment period, the average mildew score decreased in each treatment presumably in response to declining temperatures. In the three treatments containing potassium bicarbonate, however, average mildew score also decreased twice during the assessments whereas in all other treatments which did not contain potassium bicarbonate average mildew score just increased throughout the experimental period and only at the end of the experiment did mildew severity decrease. That potassium bicarbonate is an eradicant means that the treatments containing it were able to reduce the level of mildew during the trial. This tended to coincide with weeks where temperatures were lower than preceding weeks.

The effect of treatment on the percentage of leaves with mildew mycelium followed the same pattern as average mildew score (Figure 4). All treatment combinations significantly reduced mildew ($P<0.001$). In the control treatment, mildew severity increased until 11 weeks after planting and then decreased. Potassium bicarbonate + sulphur was shown to be the most effective treatment again, with HDC F7 + HDC F8 being the least effective and the difference between these two treatments was significant ($P<0.05$).

Leaf cupping can be used by growers as a warning that mildew infection is occurring before mildew mycelium is visible. However, it can also be a response to heat or drought stress. In this experiment, the first sign of leaf cupping occurred five weeks after the start of applications (Figure 5). This was the week after the sprinklers had been switched off and the same time that mildew mycelium had become visible in the treatments. However, the rate of increase in leaf cupping was much greater than the increase in mildew mycelium. This was particularly the case in the control treatment. Within 2 weeks, leaf cupping neared 100% in the control treatments whereas the maximum mycelium score was not reached until 5 weeks after this. Following this leaf cupping then decreased. This was different to the increase mildew mycelium score which occurred over a period of 7 weeks. Whilst this confirms that leaf cupping does generally occur before mildew mycelium develops, the fact that cupping appeared at the same time as mildew mycelium limits its use to predict the start of mycelium development because by the time leaf cupping was seen, the mildew mycelium had already started to develop.

The percentage of leaves with purple blotching is shown in Figure 6. In the control treatment, leaf blotching again began to appear the week following sprinklers being switched off. Following this, the percentage of blotching increased for two weeks before decreasing until the end of the experiment. This was interesting as blotching is usually considered to appear following mildew mycelium infection. In the other treatments, leaf blotching occurred at much reduced levels and so it is clear that whilst the blotching was connected with mildew, the timing of appearance was not consistent with it appearing after mildew infection.

At the end of the experiment, leaf number for each plant was counted to test whether any of the treatment combinations had caused a phytotoxic effect (Figure 7). Leaf number can only be used as a guide to the potential toxicity and further work is needed to assess the effect of the treatments on yield. However, clear effects were seen and indicate significant phytotoxic effects. Potassium bicarbonate + sulphur caused the fewest leaves to be produced by the plants. The control, (HDC F7 + sulphur), (Serenade ASO + sulphur) and (Serenade ASO + sulphur + HDC F7) treatments all caused the most leaves to be produced by the plants. It is clear therefore that potassium bicarbonate does cause phytotoxicity as seen by the lower number of leaves produced. However, there are indications that sulphur also causes a slight phytotoxic effect. For example, potassium bicarbonate + HDC F7 produced more leaves than potassium bicarbonate + sulphur indicating that sulphur may have caused this reduction. In other treatments though, the addition of sulphur did not cause a significant reduction in leaf number. Perhaps it is only when combined with potassium bicarbonate that sulphur does cause a phytotoxic effect.

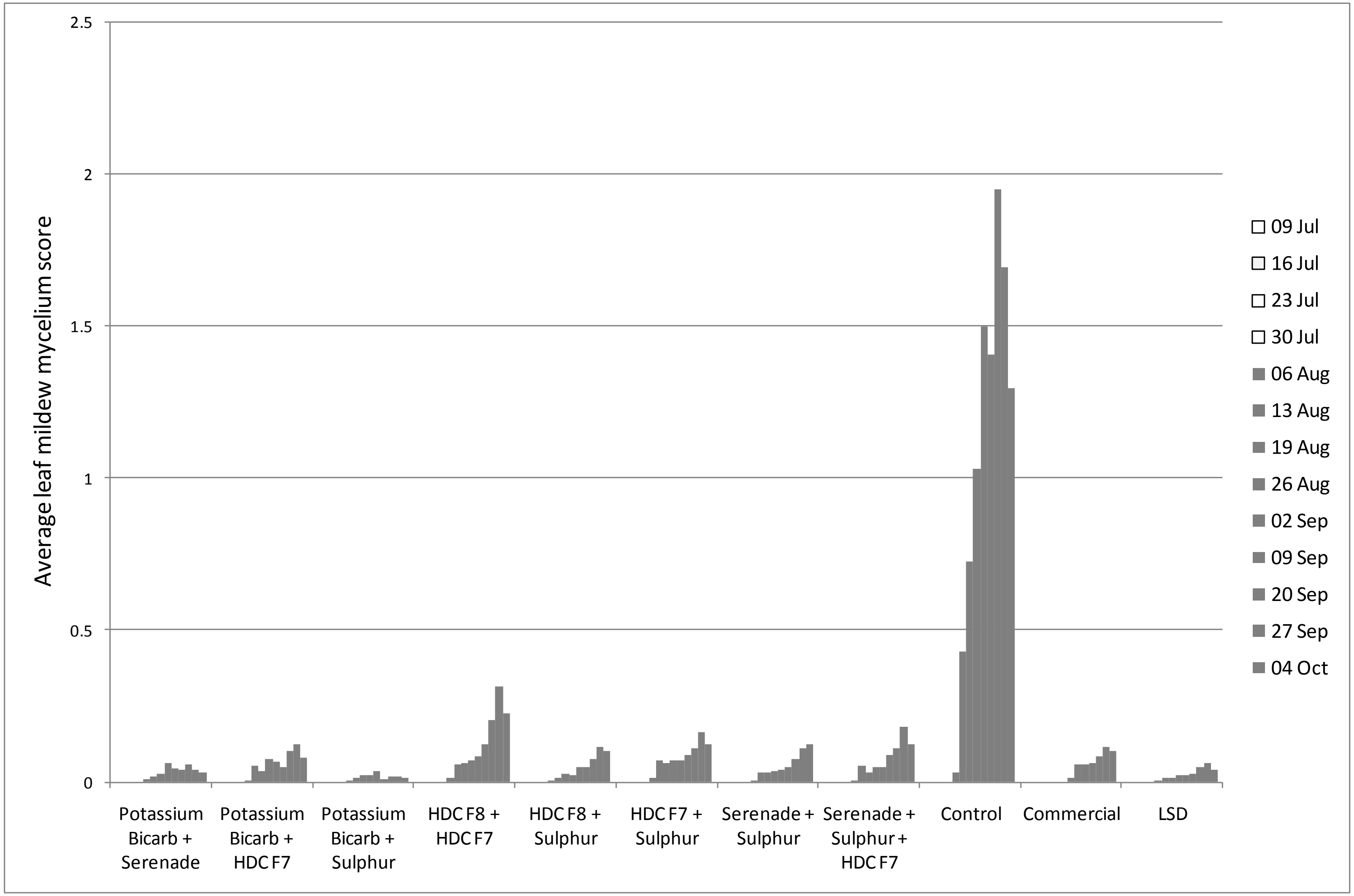

Figure 3. Effect of treatment on the average mildew mycelium score. 600 leaves were assessed per treatment and the presence of mildew mycelium was score 0 (min) to 5 (max). During the first four weeks following planting no mildew mycelium was present in any of the treatments (shown by open symbols). LSDs are shown.

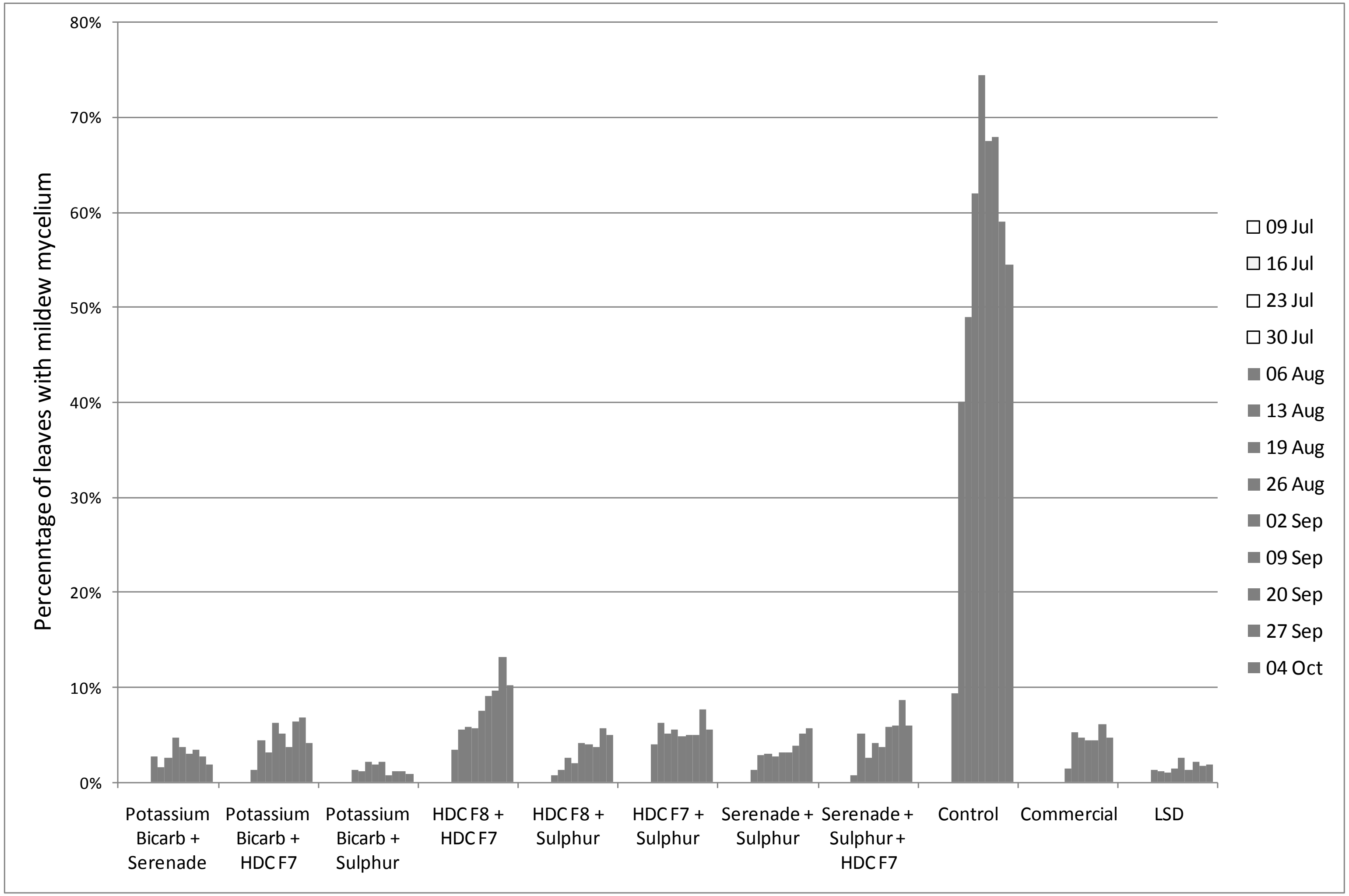

Figure 4. Effect of treatment on the percentage of leaves showing mildew mycelium. 600 leaves were assessed per treatment and during the first four weeks following planting no signs of mildew were present in any of the treatments (shown by open symbols). LSDs are shown.

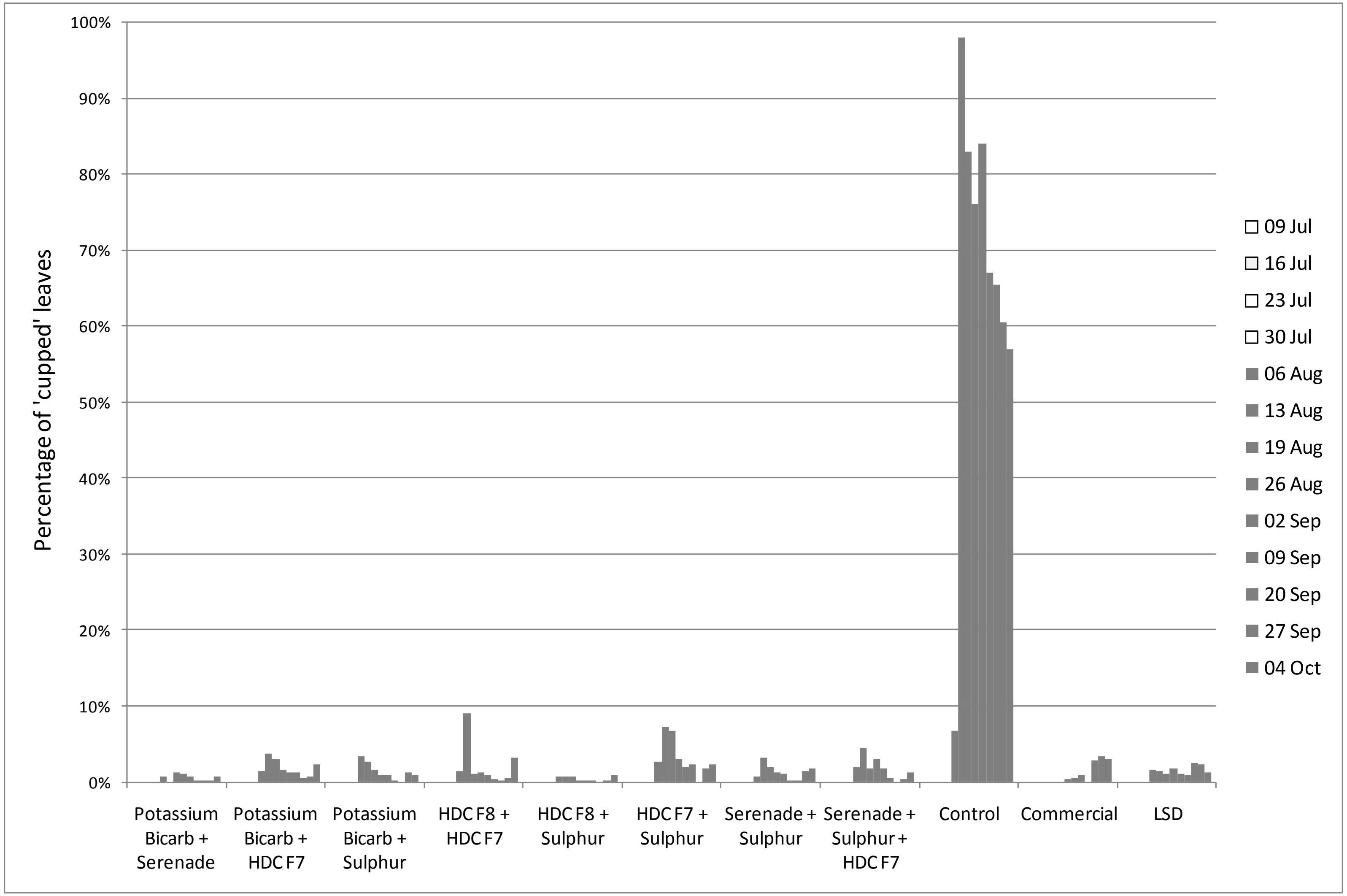

Figure 5. Effect of treatment on the percentage of leaves showing cupping. 600 leaves were assessed per treatment and during the first four weeks following planting no signs of mildew were present in any of the treatments (shown by open symbols). LSDs are shown.

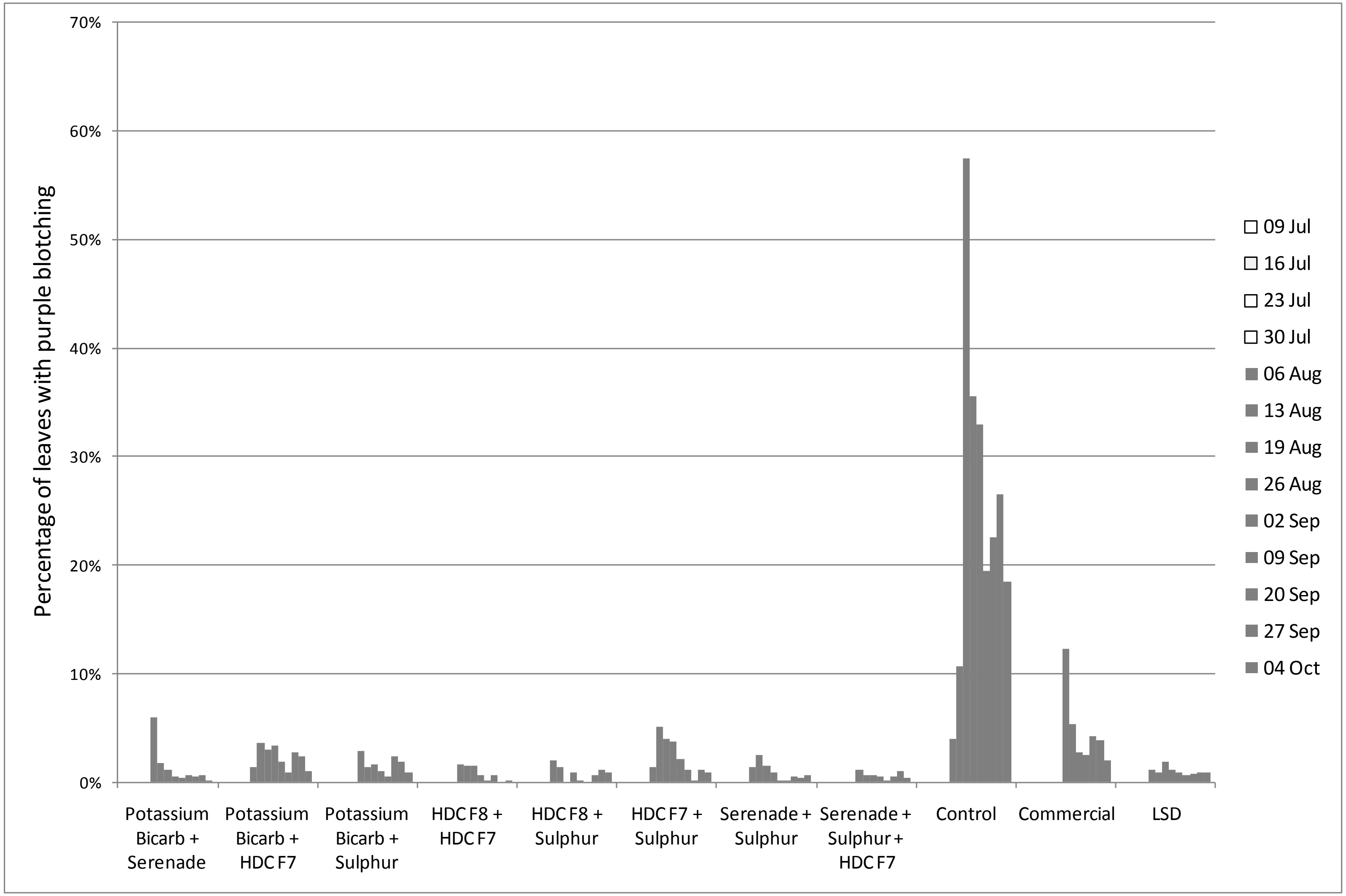

Figure 6. Effect of treatment on the percentage of leaves showing purple blotching. 600 leaves were assessed per treatment and during the first four weeks following planting no signs of mildew were present in any of the treatments (shown by open symbols). LSDs are shown.

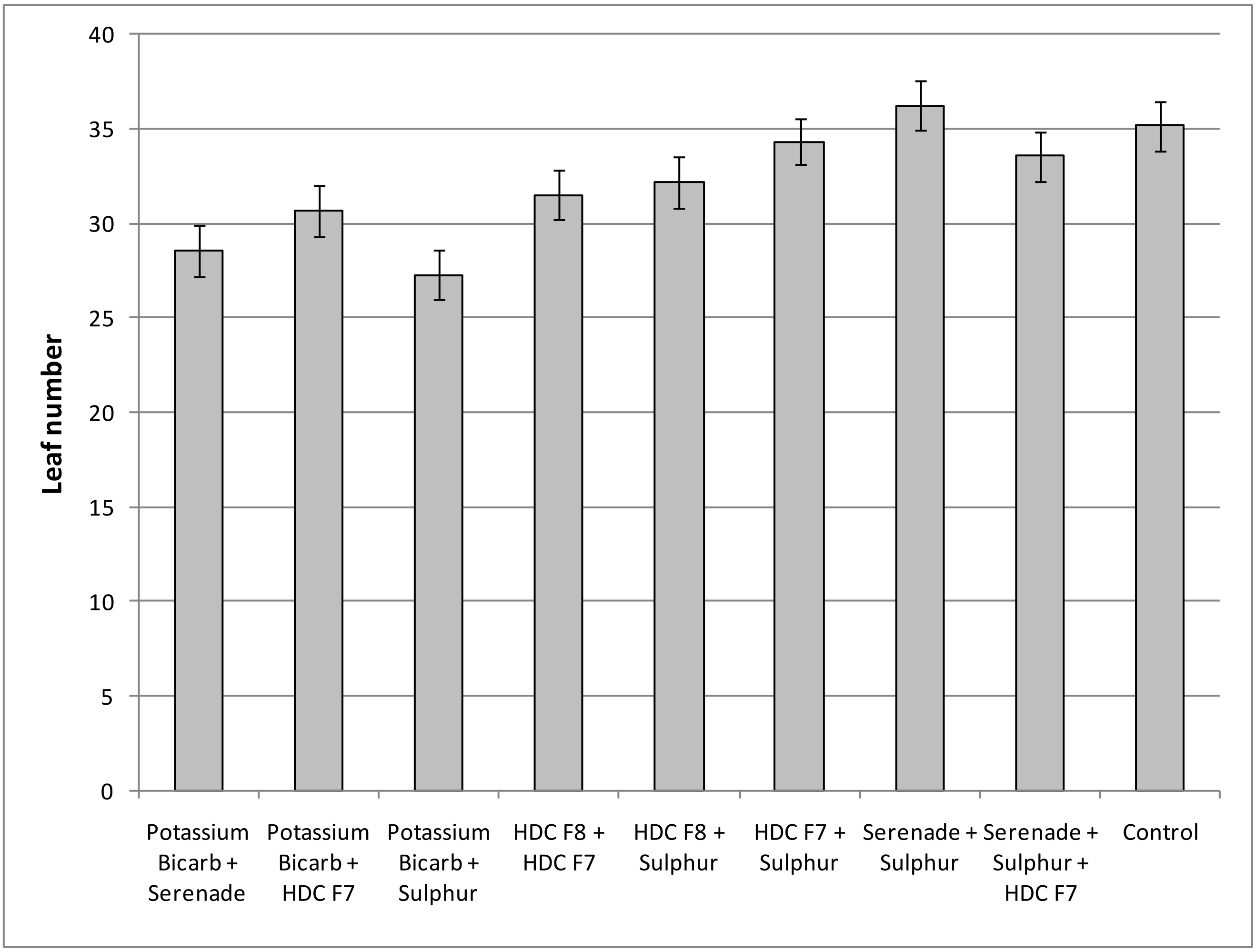

Figure 7. Effect of treatment combination on final leaf number at the end of the experimental period. Standard error bars are shown. The table below shows significance of results.

Table 5. Significance of differences between treatments are shown by letters – different letters show corresponding statistical differences at P<0.05.

Treatment	**Product combinations**	**Significance (P<0.05)**
1	Potassium bicarbonate + Serenade ASO	AB
2	Potassium bicarbonate + HDC F7	AB
3	Potassium bicarbonate + sulphur	A
4	HDC F8 + HDC F7	BC
5	HDC F8 + sulphur	BC
6	HDC F7 + sulphur	CD
7	Serenade ASO + sulphur	D
8	Serenade ASO + sulphur + HDC F7	CD
9	Control	CD

Discussion

The data described above provide useful information to strawberry growers on the control of mildew in strawberry. With the limited number of options of conventional fungicides available to fruit growers currently, alternative methods of control are needed. Of the combinations tested, only those containing potassium bicarbonate, sulphur or Serenade ASO are approved plant protection products but even only using these three products a useful level of control can be achieved. The advantage of the products tested is that they all offer the potential for residue free control of mildew in strawberry. It will be important to continue this work in other crops where mildew is an issue such as apples and some varieties of raspberries.

Sprinklers used during the establishment phase were able to prevent development of the symptoms of mildew when in use for the first four weeks following planting. The use of sprinklers is primarily aimed at reducing transpiration rates and cooling plants to improve yield. In a previous HDC project (Carew and Battey, 2002), it was shown that the use of sprinklers can increase yield by as much as 10% through effects on transpiration and reduced temperatures. It was also shown that mildew symptoms do not develop. Again in the project described here, the sprinklers achieved the same effect. No symptoms of mildew were seen during the period that the sprinklers were being used. As soon as the sprinklers were switched off, leaf cupping, mildew mycelium and purple blotching was seen. This may have been a coincidence but commercial experience supports the use of sprinklers as the first method of mildew control. Unfortunately the sprinklers have to be switched off once the plants start flowering and so mildew control after this period must be through applications made to the crop.

Once mildew mycelium had started to develop, the rate at which its severity increased was significant. Three weeks after its appearance, mildew mycelium was present on 50% of assessed leaves. Leaf cupping reached close to 100% only one week after the first cupping of leaves was seen. It is clear from these data and from commercial experience therefore that weekly applications of control products are necessary. Leaving applications for two weeks would simply be too long and would allow mildew severity to increase too greatly leaving the grower battling against mildew, potentially for the rest of the season.

Potassium bicarbonate, in particular when combined with sulphur, was the most effective combination and caused significantly lower levels of mildew than most other treatments. Potassium bicarbonate is an eradicant of mildew and because of this the severity of mildew decreased at three points during the experiment. This seemed to be connected with periods of cooler temperatures. In contrast, severity of mildew in the treatments only containing protectants increased throughout the experiment, only decreasing at the end of the experiment when temperatures declined significantly. The severity of mildew in these treatments increased at a more or less exponential rate suggesting that if these protectant treatments were applied to an everbearer / day-neutral crop, the severity of mildew would eventually increase to a point where control was lost. The use of potassium bicarbonate is therefore important in any commercial application of these treatments as it is the only product tested which was able eradicate mildew as opposed to reducing the rate at which it increased in severity.

There are two problems with the use of potassium bicarbonate. Firstly, its approval for outdoor strawberries limits the quantity applied to 60kg/Ha per year. At a concentration of 10g/L and a water volume of 500L per hectare, this means that only 12 applications would be permitted. This would provide sufficient coverage for a crop of June-bearers. However, some everbearer varieties are now being cropped from May to October, giving a potential cropping period of about 25 weeks. The second problem is that in the experiment described here, potassium bicarbonate appeared to have a phytotoxic effect on plant growth whereby leaf number was significantly reduced. It seems likely that making 25 weekly applications to an everbearer crop would have a significant effect on growth and yield. Repeated use of sulphur is known to have a phytotoxic effect on strawberry, whilst potassium bicarbonate can give rise to some leaf scorch if overused, particularly in hot conditions.

The maximum permitted quantity of potassium bicarbonate and the phytotoxicity effects therefore must be overcome either through alternating its application with for example Serenade ASO + sulphur or by using a lower concentration. To determine whether either method would still give sufficient control of mildew requires further work. It is also important to note that sulphur is harmful to certain biological controls (HDC, 1998). Yield records were not part of the experimental protocol but obviously in any system developed for commercial systems this would have to be determined.

Conclusions

- Sprinklers prevented the development of mildew symptoms throughout their period of use.
- Potassium bicarbonate + sulphur was the most effective combination tested and caused the lowest severity of mildew in the experiment described here.
- Weekly applications of control products are necessary as the rate at which mildew severity increased in the control treatment was significant.
- Potassium bicarbonate was the only product which was able to eradicate mildew.
- Potassium bicarbonate however caused a significant phytotoxic effect meaning that its repeated use over a number of months would not be recommended. Either its rate of

application needs to be reduced or a combination of products is needed for commercial production.

- Repeated use of sulphur is known to have a phytotoxic effect on strawberry, whilst potassium bicarbonate can give rise to some leaf scorch if overused, particularly in hot conditions. Therefore great care should be taken when using these products either singly or in combination over a period of time, with their effects monitored closely during management of the spray programme.

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Appendix 1

Photographs taken on 29th July 2010. At this point, mildew symptoms had not been seen in any of the treatments.

Treatment 1. Potassium bicarbonate + Serenade ASO.

Treatment 2. Potassium bicarbonate + HDC F7.

Treatment 3. Potassium bicarbonate + sulphur.


Treatment 4. HDC F8 + HDC F7.

Treatment 5. HDC F8 + sulphur.

Treatment 6. HDC F7 + sulphur.

Treatment 7.Serenade ASO + sulphur.

Treatment 8. Serenade ASO + sulphur + HDC F7

Treatment 9. Control treatment.

Treatment 9. Control treatment - leaf cupping was defined for the purposes of uniform assessment as being when the leaf margins are perpendicular to the leaf orientation.

Appendix 2

Photographs taken on 9th September 2010. At this point, mildew severity was significantly greater in the control treatment than any other treatment.

Treatment 1. Potassium bicarbonate + Serenade ASO.

Treatment 2. Potassium bicarbonate + HDC F7.

Treatment 3. Potassium bicarbonate + sulphur.

Treatment 4. HDC F8 + HDC F7.

Treatment 5. HDC F8 + sulphur.

Treatment 6. HDC F7 + sulphur.

Treatment 7. Serenade ASO + sulphur.

Treatment 8. Serenade ASO + sulphur + HDC F7.

Treatment 9.Control treatment.