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The results and conclusions in this report are based on a series of experiments conducted over a three 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.

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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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Signature .... Date ....**17 November 2008**

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GROWER SUMMARY

Headline

- Shark (carfentrazone-ethyl) is now available for spawn control in raspberries and blackberries.

Background and expected deliverables

Established summer fruiting raspberries contain both floricanes (fruiting) and primocanes (spawn). Uncontrolled and excessive spawn production can lead to an increase in disease levels and reduce picking speeds by impeding access to fruit. This problem is worse under tunnels where higher temperatures lead to more vigorous growth.

The industry has relied on Croptex Steel (sodium monochloroacetate) for spawn control in the past, but the active ingredient was not supported in the EC review to harmonise the use of pesticides across the European Union. A replacement was required from 2008 onwards.

This aim of this project was to screen potential replacement desiccants for sodium monochloroacetate, with the aim of securing a Specific Off-label Approval (SOLA) for the most promising alternative material. The specific deliverables were:

- Assessment of candidate desiccants for spawn control efficacy and effect on berry weight on Glen Ample in 2005, 2006 and 2007 in Spanish tunnels.
- Assessment of the most promising desiccants on spawn control on Octavia, grown outdoors and under tunnels in 2007.
- Assessment of the effects of treatments on crop safety and cane vigour.

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Summary of the project and main conclusions

The experiments were conducted in existing plantations of field-grown Glen Ample and Octavia in Staffordshire by kind permission of Stephen McGuffie of R.D. McGuffie and Sons. It was agreed with the HDC Panel that candidate desiccants should be assessed under polythene tunnels in 2005 and 2006 to reflect majority current commercial practice. In addition, in 2007, yield and average berry weights were recorded from selected 2006 tunnelled treatments, This allowed a check for possible crop damage in the year following application. In 2007, the most promising treatments were assessed in an uncovered plantation to assess efficacy at lower temperatures.

Four candidate desiccants and wetting agents were chosen for assessment following discussion with the agrochemical industry. These are listed in Table 1. These were all compared with Croptex Steel (sodium monochloroacetate) and hand removal of the spawn as controls.

Table 1 Desiccants evaluated for raspberry spawn control on tunnelled cv. Glen Ample in 2005 and 2006

Product (active ingredient)	Rate of Use*	Wetting Agent (rate of use)

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Shark (carfentrazone-ethyl)	2.56 l/ha (as 256 ml per 100 litres of water)	Silwet L-77 - 2.0 l/ha (as 200 ml per 100 litres of water)
Cultamide (calcium cyanamide)	100 l/ha (as 10 litres per 100 litres of water)	Silwet L-77 - 2.0 l/ha (as 200 ml per 100 litres of water)
Reglone (diquat)	4.0 l/ha (as 400 ml per 100 litres of water)	Agral - 1.0 l/ha (as 100 ml per 100 litres of water)
Harvest (glufosinate ammonium)	7.5 l/ha (as 750 ml per 100 litres of water)	Ammonium sulphate - 100 kg/ha (as 10 kg per 100 litres of water)
Croptex Steel (sodium monochloroacetate)	20 kg/ha (as 2 kg per 100 litres of water)	Wayfarer - 5.0 l/ha (as 0.5 litres per 100 litres of water)

∗**Application method:** applied at 100 ml spray solution per m^2 (= 1000 l/ha) to the point of run-off.

At the time of selection for the trial, the approval status of each was as follows:

- **Shark** - full UK Approval on potato
- **Cultamide - not approved as a pesticide in the UK**
- **Reglone** – full UK Approval on edible crops
- **Harvest** – full UK Approval on all cane fruits
- **Croptex Steel** - full UK Approval on kale and leeks, specific off-label approval (SOLA 2004/1460, expired December 2007) on raspberries

In 2006, additional observation plots for the coded product 212H and Regalis (prohexadione-calcium) were included for observation. Details are listed in Table 2.

Table 2 Additional treatments tested in 2006 on tunnelled cv. Glen Ample

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Product (active ingredient)	Rate of Use*	Wetting Agent (rate of use)
212H (coded product)	0.2 kg/ha (as 50g in 100 litres of water)	Agral – 1.0 l/ha (as 100 ml per 100 litres of water)
Regalis (prohexadione-calcium)	1.25 kg/ha (as 313g in 100 litres of water)	Exchange – 2.5 l/ha (as 250 ml per 100 litres of water)

***Application method** – applied at 40 ml spray solution per m^2 (= 400 L/ha).

At the time of selection for the trial, the approval status of each was as follows:

- **212H** – experimental Approval only
- **Regalis** – full UK Approval on apples – no UK approval on raspberry

It became clear that the Shark rate used in 2005 and 2006 was unnecessarily high and that it was possible to achieve effective spawn control with lower rates than those used initially. Two lower rates were therefore tested in 2007 on outdoor and tunnelled plots of Octavia (Table 3).

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Table 3 Desiccants evaluated for raspberry spawn control on outdoor and tunnelled cv. Octavia

Product (active ingredient)	Rate of Use*	Wetting Agent (rate of use)
Shark (carfentrazone-ethyl)	1.6 l/ha (as 160 ml per 100 litres of water	Silwet L-77 – 2.0 l/ha (as 200 ml per 100 litres of water)
Shark (carfentrazone-ethyl)	0.8 l/ha (as 80 ml per 100 litres of water	Silwet L-77 – 2.0 l/ha (as 200 ml per 100 litres of water)
Control – Croptex Steel (sodium monochloroacetate) –	20 kg/ha (as 2 kg per 100 litres of water)	Wayfarer – 5.0 l/ha (as 0.5 litres per 100 litres of water)

***Application method** – applied at 100 ml per m^2 to the point of run-off

Each desiccant was applied with or without a wetting agent, and in each case one application was compared with two applications. In addition, these treatments were compared with hand-removal of the spawn, carried out once or twice.

The experiment was conducted in a randomised complete block design with all treatments replicated four times. Plot size was 3 m of crop row, equating to six stools or an average of 24 canes.

Assessments were made of spawn die back, fruiting cane quality, signs of phytotoxicity, and yield and berry weights for each plot.

Following three years of work, the following conclusions were drawn:

- In every year, Shark (carfentrazone-ethyl) applied at 1.6 L/ha or 0.8 L/ha provided more complete control of the primocanes than the other candidate desiccants (including sodium monochloroacetate).
- All other candidates provided less effective control.

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- Stray droplets to leaves produce a clear brown margin, with no diffuse yellowed edges. In 2006, the absence of detectable residues in fruit tests suggested that carfentrazone-ethyl is not translocated in the plant.
- Following one application per season of Shark, adequate numbers of return primocanes (spawn) were produced and these were of medium thickness.
- Following a second application of Shark, the return primocanes (spawn) were weaker than the previous return flush of primocanes. They were also thinner, variable in height and fewer in number.
- The 2007 treatments showed very good spawn control with Shark, although the higher rates and higher frequency possibly showed advanced weakening.
- The experiment has shown that over-use of Shark will weaken emerging spawn by reducing girth and causing height variability. Shark's ability to weaken emerging cane was noted on both single and double applications in the first year of the experiment and thereafter.
- Nevertheless, this did not lead to a significant difference in yield or berry size (at 95% probability), even by year three.
- However, this effect suggests that with a weakly-growing crop, or in a difficult growing season, plantations should receive only one application of Shark rather than two. Where plantations are already very weak, no application should be made at all. This would be exactly the same approach to spawn management as used with Croptex Steel in previous years.
- Glen Ample is known as being very vigorous. Other cultivars such as Tulameen and many that are likely to be planted in the future (including Malling Juno, Glen Doll) are less vigorous, and are therefore more likely to be damaged by repeated treatments.
- Harvest (glufosinate ammonium plus ammonium sulphate) was moderately effective, but not as effective or easy to use as Shark.
- Of the two additional observation plots treated, the experimental material 212H was too severe in its effect on cane vigour, whereas Regalis was relatively mild, giving rise to slightly twisted leaves, but no primocane control.

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- Having proved to be the most effective candidate desiccant, HDC has secured a Specific Off-Label Approval (SOLA 2008/0551) for Shark for use in raspberries, blackberries and rubus hybrids.

Financial benefits

- Use of Shark will provide effective control, helping to speed up picking, reduce cost of hand labour in cane management, reduce disease levels (by reducing the size of the canopy) and provide better fruiting canes that are not over sized in the following year.

- As labour for picking and tying in is the principal cost in cane fruit production, any reduction in such costs will show a direct benefit in the gross margin.

Action points for growers

- Under the terms of its Specific Off-Label Approval (2008/0551), growers can now use Shark (carfentrazone-ethyl) at 0.8 L/ha to control and suppress excessive primocanes (spawn) in protected and outdoor raspberries, blackberries and rubus hybrids.

- The SOLA states that the adjuvant 'Silwet L-77' (ADJ 0193) may be used at a rate of 200 ml/100L of water.

- Growers are advised to test a small area of crop prior to use on new varieties. It is also important to ensure that the sprayer is thoroughly cleaned after every application.

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- In weak plantations or in difficult growing seasons, growers should seek advice from a qualified agronomist before deciding on whether or not to use Shark and how many applications to make.

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Science Section

Introduction

Established summer-fruiting raspberries contain both flori (fruiting) canes (one year old) and primocanes (i.e. spawn), the latter being produced in the current season. Some varieties produce excessive quantities of spawn and, if left uncontrolled, this can lead to an increase in disease levels and reduce picking speeds by impeding access to fruit. This problem can be further increased by the move to tunnel production, where the higher temperatures lead to increased growth.

For many years, raspberry growers in the UK have relied upon chemical control to suppress the vigour of newly emerging primocanes (spawn) in mainseason raspberry plantations. The use of dinoseb in oil was relied upon until the late 1980s, when its use was withdrawn. Research work conducted at the Scottish Crop Research Institute (SCRI) identified sodium monochloroacetate (Croptex Steel) as a replacement and a Specific Off-Label Approval was secured for this product in 1991. It has been employed by raspberry growers ever since.

With the advent of tunnel growing for cane fruit, the bulk of the area of raspberries is now covered, making it even more important to have a form of spawn control available. Sodium monochloroacetate was not supported in the EC review to harmonise the use of pesticides across the European Union. However, the active ingredient received a 'stay of execution' following an application to secure continuing approval under the 'essential use' category. This lapses in 2008, after which the UK industry will have no desiccation products approved for use in raspberry crops.

This aim of this project was to screen potential replacement desiccants for sodium monochloroacetate, with the aim of securing a Specific Off-label Approval (SOLA) for the most promising alternative material by 2009.

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In 2005 and 2006, the full range of candidate desiccants were assessed on tunnel-grown raspberries (cv. Glen Ample), and full results are reported in previous annual reports. In summary:

- Shark (carfentrazone-ethyl) provided the most complete control of primocane in 2005 and 2006. It gave better spawn control than all other experimental treatments and out-performed the standard treatment, Croptex Steel (with wetter).
- All other treatments, including additional materials observed in 2006, gave inadequate primocane control for commercial purposes.
- Adequate numbers of new canes were produced in 2005 and 2006, following one treatment of Shark, applied to remove the first flush of primocane when 15-20 cm in height on average. These canes, intended for cropping under the protection of Spanish tunnels the following summer, had reached the desired height and thickness to be tied-in by the end of November.
- In contrast, where two applications of Shark were applied to remove both the first and second flushes of primocane, the number of canes that emerged later was weaker, thinner, very variable in height and fewer in number.
- Shark's ability to weaken emerging cane was noted with both single and double applications in the first year of trial and thereafter, though yield was unaffected over this period. However, this is a clear indication that overuse is likely to eventually damage vigour.

For the 2007 experiments, only active ingredients that were likely to survive the EU review process were included. Concerns of possible crop damage were addressed by assessing yield and average berry weight of the cumulative Shark, Croptex Steel and hand removal treatments applied in 2005 and 2006 in the original trial. This was to establish if there was cumulative damage from applications made in those years.

Information from the manufacturer of Shark suggested that substantially lower rates of this product could also be utilised, potentially with no loss of efficacy. To test this

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and the effect of these treatments on crops not protected by tunnels, a nearby crop of the variety Octavia, both non-tunnelled and tunnelled, was treated with reduced rates of Shark, compared with the industry standard, sodium monochloroacetate, to establish efficacy of these treatments. Crop yield was not assessed from this experiment. This was mainly because it was considered that the effects of any treatment on yield would be more reliably assessed from the previously-treated experiment area, following two years of applications, (2005 and 2006), when significantly higher rates of Shark had been applied.

Materials and methods

Experiment 1: evaluation of accumulated desiccant effects on tunnelled Glen Ample

Using the existing plots of field-grown, tunnelled Glen Ample from 2005 and 2006, selected plots were assessed for the cumulative effects of the previous two years of treatments. The potential for yield loss was assessed by completely picking the crop to establish total yield and berry size. Yield was only assessed from plots where the most effective treatments were applied in 2005 and 2006 (Table 4). Treatments with insufficient potential were not recorded; these were Cultamide (calcium cyanamide), Reglone (diquat) and Harvest (glufosinate ammonium).

The crop was fleeced and tunnelled in March to advance bud burst and picked as a tunnelled crop between 18 June 2007 and 20 July 2007.

Experiment design

The experiment drew on exactly the same plots as those treated in 2005 and 2006. These included 20 treatments in a randomised complete block design with each treatment replicated four times. No further treatments were made in 2007.

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Assessments

To assess any cumulative effect on cane quality following two seasons of treatment, berry yield per plot was recorded through the entire cropping season and average berry weight per plot on five occasions:

- A record of yield per treatment at every pick, starting 18 June 2007 and finishing 20 July 2007.
- An average berry weight recorded as the weight of 50 berries picked on five dates, 21 and 25 June, 2 , 9 and 16 July.

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Table 4. Treatments used on Glen Ample in 2005 and 2006 used to assess yield on Glen Ample in 2007

Code	Product	Rate/ treated ha	Rate/100L of water	Applied 2005 & 2006
1	Shark x 1	2.56L	256 ml	Once to first flush of primocane
2	Shark + Silwet L-77 x 1	2.56L	256 ml + 200 ml	Once to first flush of primocane
3	Shark x 2	2.56L	256 ml	Once to first flush of primocane, followed by a second application approximately 21 days later when sufficient primocane present
4	Shark + Silwet L-77 x 2	2.56L 200 ml	256 ml + 200 ml	Once to first flush of primocane, followed by a second application approximately 21 days later when sufficient primocane present
5	Croptex Steel + Wayfarer x1	22kg/ha of crop row	2.2 kg + 500ml	Once to first flush of primocane
6	Croptex Steel + Wayfarer x2	22kg/ha of crop row	2.2 kg + 500ml	Once to first flush of primocane, followed by a second application approxi-mately 21 days later when sufficient primocane present
7	Hand removal x 1			Once to first flush of primocane
8	Hand removal x 2			Once to first flush of primocane, followed by a second application approxi-mately 21 days later when sufficient primocane present

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Experiment 2: evaluation of desiccant effects on tunnelled and non-tunnelled Octavia

In addition to the original Glen Ample crop, a separate established plantation of the main season variety Octavia was chosen to assess desiccant performance on tunnelled and outdoor crops. Only a reduced range of treatments were tested, comprising Shark and the former industry standard Croptex Steel (Table 5). The choice of treatments was guided by the results of the previous two season's experiments on Glen Ample. In addition to choosing candidate desiccants, suitable wetting agents and rates of use were selected (Table 5), drawing on personal experience and that obtained through consultation with other crop sector specialists.

The experiment used adjacent polytunnels of cv. Octavia within 200 m of the Glen Ample site. The tunnelled Octavia was covered before treatments were applied. The 'non-tunnelled' crop was covered later, just before picking; this comprised the 'outdoor' or unprotected site.

Experiment Design

For both the protected and unprotected crops, the experiment consisted of eight treatments replicated four times in a randomised complete block design. Each individual plot was 3.0 m in length (containing approximately 6 plants or stools), with a gap of 0.5m between plots.

Treatments

The Shark rate was significantly lowered for 2007 from 2.56 l/ha to 1.6 and 0.8 l/ha. The full treatment list is given in Table 5. All treatments were applied as soon as the first 'flush' of primocane has reached an average height of 15-20 cm, as for the 2005/6 trial. Treatments were applied at 100 ml per m^2 onto target primocane to the point of run-off. This equates to a volume of 1000 l/treated ha. All treatments were applied as a directed spray using a knapsack sprayer. Environmental conditions at the time of application are given in Appendix 3.

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Table 5. Desiccant treatments applied to protected and unprotected cv. Octavia in 2007

Code	Product	Rate of Use	Wetting Agent	Applied 2007
1	Shark	1.6 l/ha (as 160 ml per 100 litres of water)	None	Once to first flush of primocane
2	Shark + Silwet L-77	1.6 l/ha (as 160 ml per 100 litres of water)	Silwet L-77 -2.0 l/ha (as 200 ml per 100 litres of water)	Once to first flush of primocane
3	Shark	0.8 l/ha (as 80 ml per 100 litres of water)	None	Once to first flush of primocane
4	Shark + Silwet L-77	0.8 l/ha (as 80 ml per 100 litres of water)	Silwet L-77 -2.0 l/ha (as 200 ml per 100 litres of water)	Once to first flush of primocane
5	Shark	0.8 l/ha (as 80 ml per 100 litres of water)	None	Once to first flush of primocane, followed by a second application approximately 21 days later when sufficient primocane regrowth present
6	Shark + Silwet L-77	0.8 l/ha (as 80 ml per 100 litres of water)	Silwet L-77 -2.0 l/ha (as 200 ml per 100 litres of water)	Once to first flush of primocane, followed by a second application approximately 21 days later when sufficient primocane regrowth present
7	Croptex Steel + Wetter	20 kg/ha (as 2 kg per 100 litres of water)	Wayfarer - 5.0 l/ha (as 0.5 litres per 100 litres of water)	Once to first flush of primocane
8	Croptex Steel + Wetter	20 kg/ha	Wayfarer - 5.0 l/ha	Once to first flush of primocane, followed

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	(as 2 kg per 100 litres of water)	(as 0.5 litres per 100 litres of water)	by a second application approximately 21 days later when sufficient primocane regrowth present

Assessments

Cane height and numbers of the 2007 fruiting cane were assessed as a measure of the effect of desiccant treatments applied in 2007. The heights of all canes in the middle metre of each 3 m plot were measured on 25 August 2007. Assessments of the condition of the floricane, primocane and height of primocane were also made on both the protected crop and outdoor crop on two occasions (20 June 2007 and 25 August 2007).

Results and discussion

Experiment 1: evaluation of accumulated desiccant effects on tunnelled Glen Ample

Average yields per treatment are given in Figure 1. Berry weight data are presented in Figure 2.

Figure 1. Average yield per plot from tunnelled Glen Ample in 2007 following treatment in 2005 and 2006. LSD (least significant difference) at P=0.05, 4.149, 21 df. See Table 4 for treatment codes

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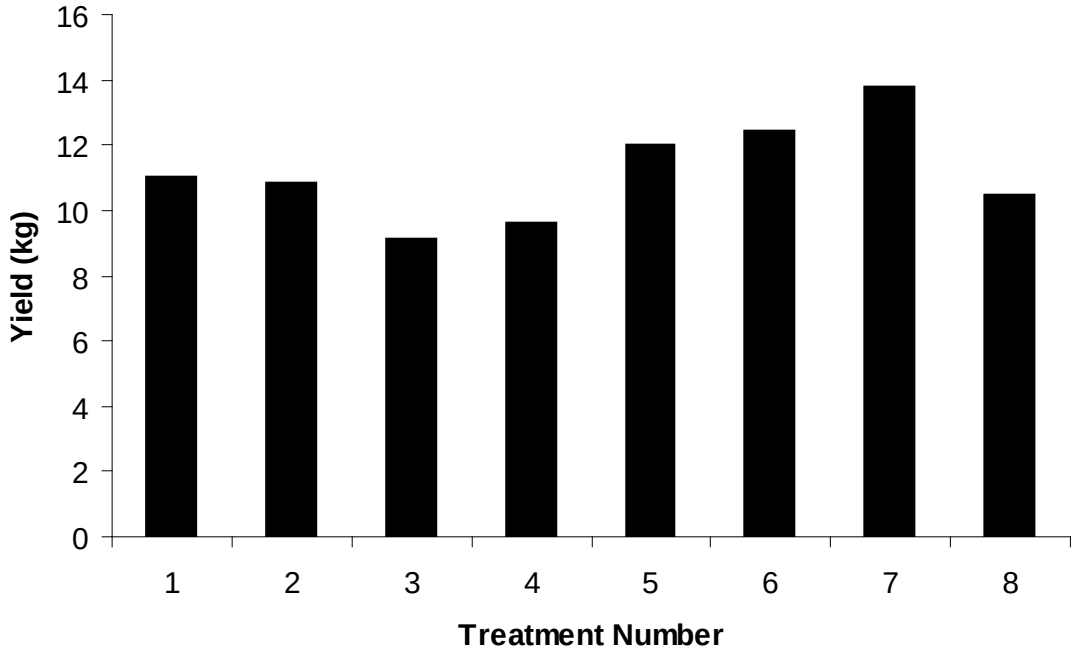

No significant treatment differences in yield were noted between treatments. This is important, as the rate of carfentrazone-ethyl (Shark) used, at 2.56 L/ha, was much higher than the eventual Off-Label rate of 0.8 l/ha and indicates that Shark does not have a detrimental effect on yield relative to Croptex Steel treatment or hand-removal of spawn.

Figure 2. Mean berry weights from tunnelled Glen Ample in 2007 following treatment in 2005 and 2006. LSD (least significant difference) at P=0.05, 0.406, 21 df. See Table 4 for treatment codes

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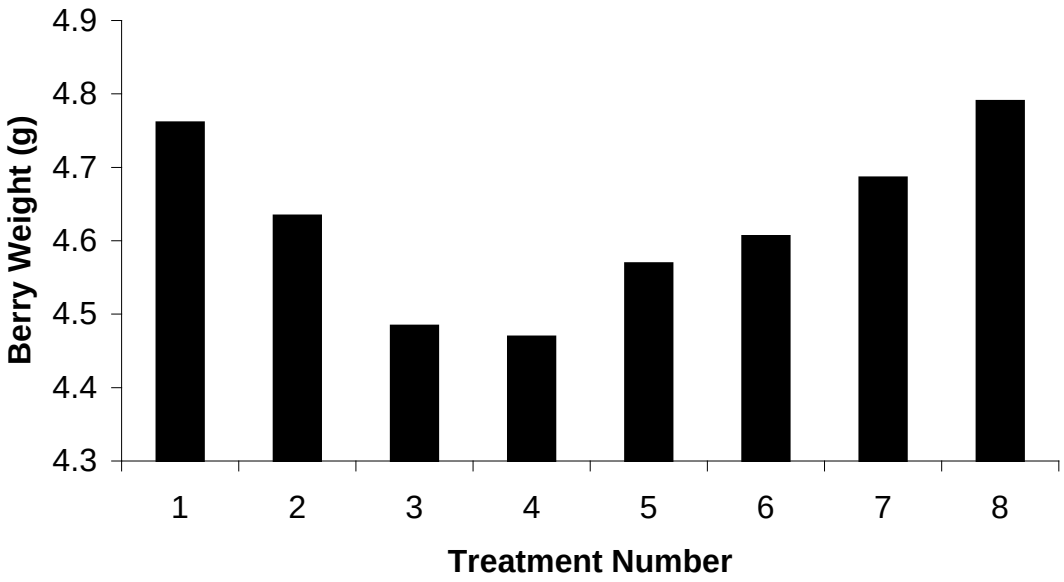

No significant treatment differences in berry size were noted between treatments. Again, this is worth noting as the high Shark rate used (2.56 L/ha) did not have a deleterious effect on berry size and the lower rate quoted for the SOLA (0.8 L/ha) should ensure a larger margin of crop safety.

Overall, these data (from 2007) and results from earlier years (2005 and 2006) has not identified any marked reduction in yield produced as a result of the loss of plant, individual cane vigour, number, height and diameter that has resulted from the repeated use of these products. Nonetheless, visual assessment of the canes showed a shorter cane and a thinner cane with more frequent Shark use. Such canes can still deliver a respectable yield due to pruning out and maintained internode numbers. This effect can only be sustained for a limited period before vigour declines further and yield is affected. Although the two years of treatment with repeated applications of Shark at a high rate were insufficient to show a yield decline, it remains possible that continued years of high Shark use may result in reduced yields through reduced crop vigour. This is of particularly importance in that the target cultivar used for this experiment, Glen Ample, is recognised (and was chosen) because of its often unacceptably excessive vigour, especially in the early years of a plantation's life. However, other cultivars in current usage, e.g. Tulameen,

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and many of those that are likely to be planted by industry in the future, such as Malling Juno and Glen Doll, are less vigorous, and could be more likely to be damaged by repeated treatments with an unsuitable desiccant.

Experiment 2: evaluation of desiccant effects on tunnelled and non-tunnelled Octavia

The results for cane height distribution are given in Figure 3 for the unprotected (outdoor) crop and in Figure 4 for the protected (tunnelled) crop.

Figure 3. The effect of treatment on cane height distribution (m) for the outdoor crop of cv. Octavia in 2007. LSD (least significant difference) at P=0.05, 21 df: 0.5-1.0m = 0.519, 1.0-1.5m = 1.43, 1.5-2.0m = 3.09, >2.0m = 5.34. See Table 5 for treatment codes

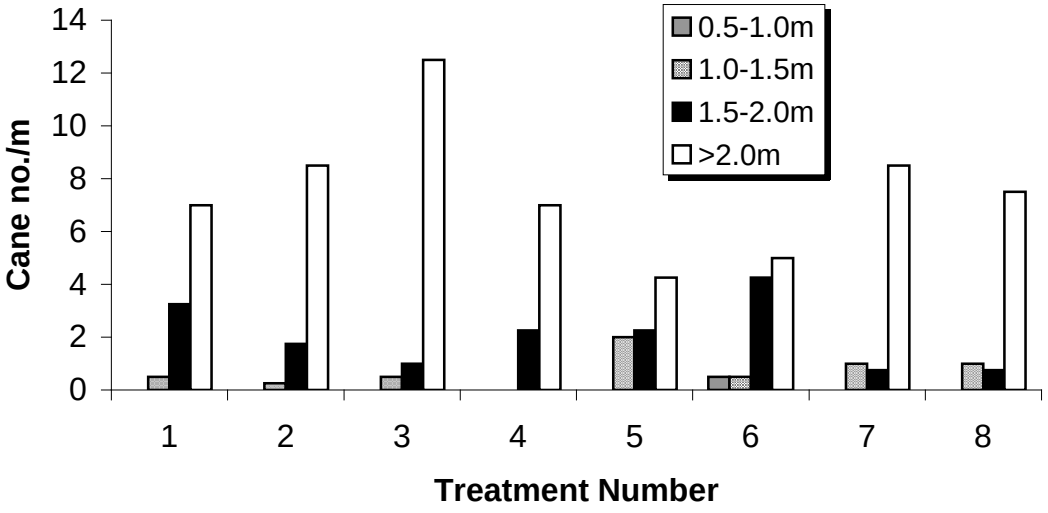

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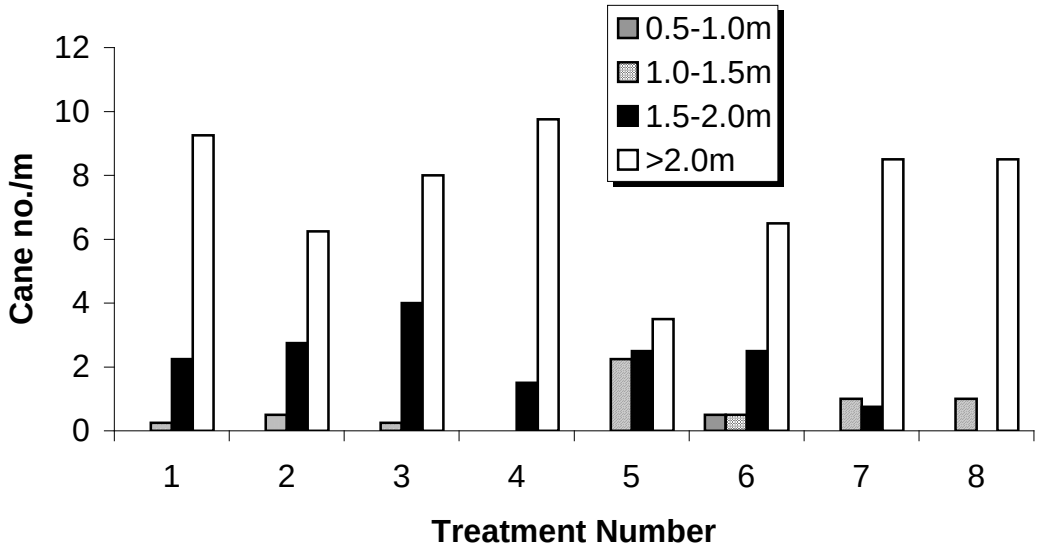
Figure 4. The effect of treatment on cane height distribution (m) for the protected (tunnelled) crop of cv. Octavia in 2007. LSD (least significant difference) at P=0.05, 21 df: 0.5-1.0m = 0.519, 1.0-1.5m = 1.30, 1.5-2.0m = 3.09, >2.0m = 5.90. See Table 5 for treatment codes



No meaningful difference was seen between the effects of treatments on tunnelled and non-tunnelled cropping. All treatments were effective and showed that a second application was more likely to reduce cane vigour, as seen in the previous two year's experiments with tunnelled Glen Ample. The addition of a wetter to the Shark treatments did not improve efficacy.

The effect of treatment on overall cane numbers in both the outdoor and protected crops of Octavia are given in Figure 5.

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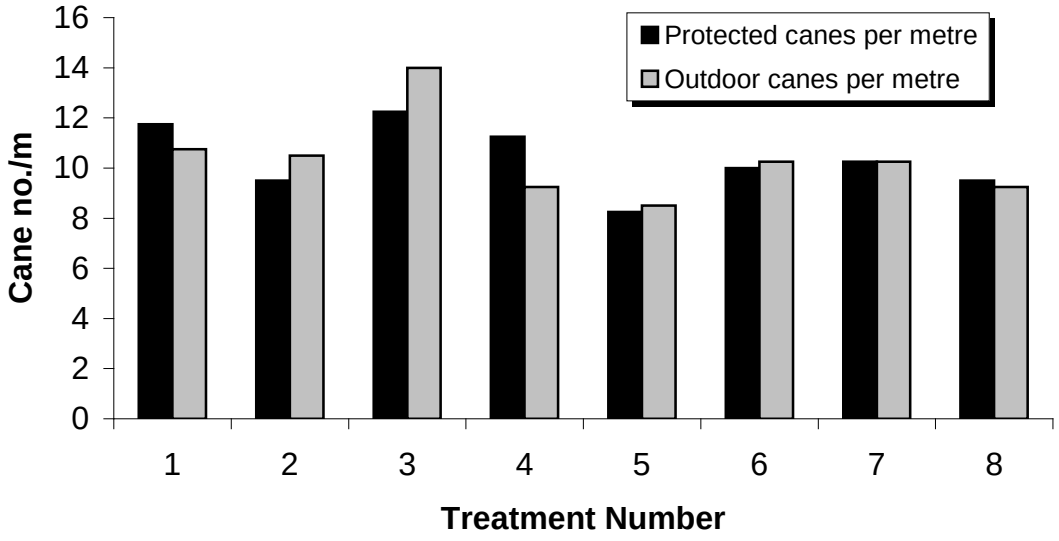
Figure 5. The effect of treatment on the relative numbers of canes (0.5 m to >2.0 m) produced in protected and unprotected cv. Octavia in 2007. LSD (least significant difference) at P=0.05, 21 df: protected = 3.484; outdoor = 3.040. See Table 5 for treatment codes



These results indicate that the effect of the desiccant treatments on overall cane number was broadly similar on both tunnelled and non-tunnelled crops of Octavia.

As cane height of 1.5 to >2.0 m would be a useful primocane height (i.e. these canes would be retained for fruiting the following year) when measured in late August, the data showing this particular range of cane heights are presented in Figures 6 and 7. All treatments showed a satisfactory number of canes to select for the following season. The poorer control of spawn re-growth by either single or double applications of Croptex Steel allowed for a much higher proportion to develop to >2m compared to the Shark treatments.

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Figure 6. The effect of treatment on the relative numbers of canes in the height range 1.5 m to 2.0 m produced in protected and unprotected cv. Octavia in 2007. LSD (least significant difference) at P=0.05, 21 df: protected = 3.09; outdoor = 3.09. See Table 5 for treatment codes

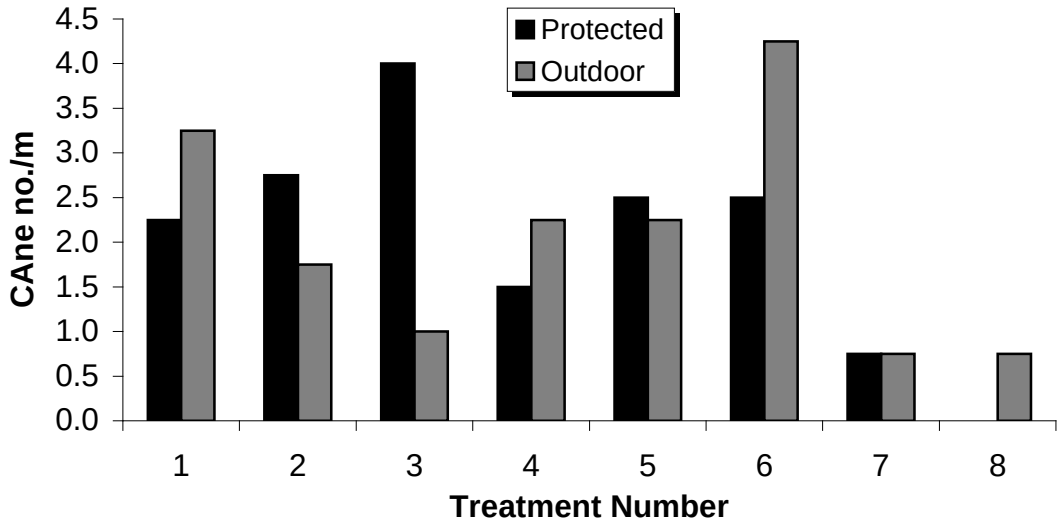
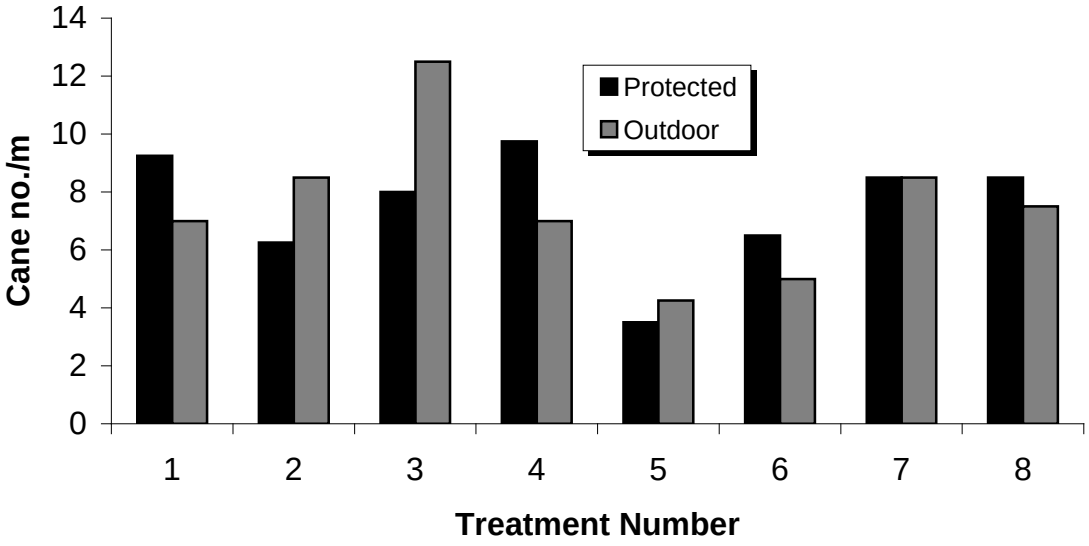


Figure 7. The effect of treatment on the relative numbers of canes in the height range >2.0 m produced in protected and unprotected cv. Octavia in 2007. LSD (least significant difference) at P=0.05, 21 df: protected = 5.90; outdoor = 5.34. See Table 5 for treatment codes



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Inconsistent differences are seen between the effects of non-tunnelled and tunnelled cropping. All treatments were effective and showed that a second application was more likely to reduce cane vigour, as seen in the previous two years with tunnelled Glen Ample. The differences may be of interest if noted over more seasons.

The very variable root zones due to disease and vine weevil makes a reliable interpretation of the effect of protection on treatment unreliable. Raspberry root rot (*Phytophthora fragariae* var. *rubi*), which occurred in patches, was noticeable in the experimental crop of Octavia. It affected cane number, diameter and height; it was particularly evident in many of the plots of the protected experiment site. In addition, although it could not be quantified, some loss of plant vigour was suspected due to feeding of vine weevil larvae and variable soil conditions in part of the outdoor experiment site. Consequently, caution has to be used in assessing the results of the cane vigour-related records taken. In addition, the abnormally wet 2007 is likely to have increased outdoor summer growth compared with the more normal moisture levels found in the protected treatment. A drier season could well have reduced the outdoor treatment's vigour.

The results of the assessments of the effect of treatment on condition of the floricane, primocane and height of primocane are given in Table 6 and 7 (protected crop) and Table 8 and 9 (outdoor crop).

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Table 6. Effect of treatment on the condition of the floricane, primocane and height of primocane on the outdoor crop of Octavia (assessed 20 June 2007)

Treatment	Condition of floricane	Condition of primocane	Height of primocane
1. Shark @ 1.6L/ha one application	Healthy but variable in height and number in plots	Healthy stand variable from adequate – very dense	0.45-1.5m (most 0.45-0.90m)
2. Shark @ 1.6L/ha + Silwet L-77 one application	Healthy in all plots except one where variable and some very weak. Some lower fruiting laterals killed	Healthy stand variable to dense	0.45 – 1.5m (most 0.60-1.0m)
3. Shark @ 0.8L/ha one application	Healthy. Some lower fruiting laterals killed	Healthy stand dense	0.30-1.5m (most 0.30-0.90m)
4. Shark @ 0.8L/ha + Silwet L-77 one application	Healthy in all plots except one where all plants dead due to *Phytophthora*. Other plots cane variable in height. Some lower fruiting laterals killed	Except for one plot healthy and adequate stand of cane	Most 0.30-0.90m in height a few 1.0 – 1.5m
5. Shark @ 0.8L/ha x 2 applications	Healthy variable cane height and number, noticeable loss of some lower fruiting laterals	Healthy, thin stand dead cane from last herbicide application still visible	Majority 0.30-0.45m in height a few up to 0.70cm
6. Shark @ 0.8L/ha + Silwet L-77 x 2 applications	Some cane loss to *Phytophthora* in two plots, other wise healthy cane. Some lower fruiting laterals lost	Some lack of cane in one plot due to *Phytophthora* root rot Healthy, thin open stand dead cane from last herbicide application still visible	Majority 0.30-0.45m in height a few up to 0.90cm
7. Croptex Steel @ 22kg/ha + wetter	Some cane loss to *Phytophthora* in two plots other wise healthy cane. Some lower fruiting	Healthy, adequate to dense stand of cane	0.60-1.5m most 0.60m in height

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	laterals lost		
8. Croptex Steel @ 22kg/ha + wetter x 2 applications	In one plot canes killed by *Phytophthora*, other wise healthy cane all lower fruiting laterals lost	Thin open stand of primocane dead cane from last herbicide application still visible	Most 0.30-0.45cm some 1.0m in height

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Table 7. Effect of treatment on the condition of the primocane, diameter of the primocane and density of primocane on the outdoor crop of Octavia (assessed 25 August 2007)

Treatment	Condition of primocane	Diameter of primocane	Density of primocane
1. Shark @ 1.6L/ha one application	All healthy But suspected some loss of plant vigour and cane height due to *Phytophthora* root rot in one plot	A few stout but most of medium thickness, noticeably thin in two plots	Variable cane density inadequate i.e. very sparse and short in two plots
2. Shark @ 1.6L/ha + Silwet L-77 one application	All healthy	Variable most of medium thickness	Some variability in cane density, generally adequate but very sparse but stout tall canes in one plot
3. Shark @ 0.8L/ha one application	Obvious *Phytophthora* root rot in one plot	Medium to stout in all plots except one where very variable with high % of medium to thin cane	Adequate cane stand except in one plot (due to plant loss to *Phytophthora* root rot in one plot
4. Shark @ 0.8L/ha + Silwet L-77 one application	*Phytophthora* root rot in two plots. In one all plants dead Canes weak but apparently healthy in two plots	Where alive all canes very thin in diameter	All inadequate stand of cane
5. Shark @ 0.8L/ha x 2 applications	All healthy	Majority of cane thin	Variable and inadequate stand of cane in all plots
6. Shark @ 0.8L/ha + Silwet L-77 x 2 applications	*Phytophthora* root rot affecting all plots in three plots. Canes dying as a result of this disease	All thin, weak in poor condition	Inadequate stand of cane in all plots
7. Croptex Steel @ 22kg/ha + wetter	All plants dead or dying due to *Phytophthora* root rot in one plot.	Medium to stout cane. Medium to thin in one plot	Poor inadequate cane stand in one plot. In other plots adequate

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	Plants in other plots healthy		
8. Croptex Steel @ 22kg/ha + wetter x 2 applications	All healthy	With exception of one plot where a high proportion of stout cane, cane medium to thin in diameter	Adequate in all plots except one plot where stand variable and in places very sparse

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Table 8. Effect of treatment on the condition of the floricane, primocane and height of primocane on the protected crop of Octavia (assessed 20 June 2007)

Treatment	Condition of floricane	Condition of primocane	Height of primocane
1. Shark @ 1.6L/ha one application	Healthy	Healthy, adequate to dense stand of cane	0.90-1.8m (most 1.00 - 1.50m)
2. Shark @ 1.6L/ha + Silwet L-77 one application	Healthy	Healthy, adequate to dense stand of cane dead cane from last herbicide application still visible	0.90-1.8m (most 1.00 - 1.50m)
3. Shark @ 0.8L/ha one application	Healthy	Healthy, adequate to dense stand of cane	0.45-1.8m (most 1.00 - 1.40m)
4. Shark @ 0.8L/ha + Silwet L-77 one application	Healthy	Healthy, dense stand of cane	0.90-1.8m (most 1.00 - 1.60m)
5. Shark @ 0.8L/ha x 2 applications	Some cane killed by *Phytophthora* root rot in two plots. Otherwise healthy cane	Healthy, adequate to thin stand of cane dead cane from last herbicide application still visible	0.30-1.4m (most 0.45 - 1.20m)
6. Shark @ 0.8L/ha + Silwet L-77 x 2 applications	Some cane killed by *Phytophthora* root rot in one plot otherwise healthy cane	Healthy, adequate to stand of cane dead cane from last herbicide application still visible	0.45-1.6m (most 0.45 - 1.20m)
7. Croptex Steel @ 22kg/ha + wetter	Healthy	Healthy, dense stand of cane	1.0-1.9m (most 1.00 - 1.60m)
8. Croptex Steel @ 22kg/ha + wetter x 2 applications	Some cane killed by *Phytophthora* root rot in one plot otherwise healthy cane	Healthy, adequate to thin stand of cane dead cane from last herbicide application still	0.60-1.6m (most 1.00 - 1.50m)

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		visible	

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Table 9. Effect of treatment on the condition of the primocane, diameter of the primocane and density of primocane on the outdoor crop of Octavia (assessed 25 August 2007)

Treatment	Condition of primocane	Diameter of primocane	Density of primocane
1. Shark @ 1.6L/ha one application	All healthy	Medium to thin in one plot all other plots medium to stout cane	Adequate in three plots. Excessive number in one plot
2. Shark @ 1.6L/ha + Silwet L-77 one application	All healthy	Medium to stout in diameter	Adequate stand of cane plots in 3 plots, thin and only just adequate in one plot
3. Shark @ 0.8L/ha one application	All healthy but a bit weak in one plot	Medium to very stout cane in two plots, medium to thin in one plot and very thin in diameter in another plot	Adequate except in one plot where they were very sparse
4. Shark @ 0.8L/ha + Silwet L-77 one application	All healthy	Medium to stout in all plots	Adequate in number three plots, excessive number in one plot
5. Shark @ 0.8L/ha x 2 applications	*Phytophthora* root rot suspected in one plot. All other plots healthy	Medium to thin cane very thin and weak in one plot	Adequate cane number in two plots, variable and sparse in some sections of one plot and very sparse in another plot
6. Shark @ 0.8L/ha + Silwet L-77 x 2 applications	All healthy	Medium to stout cane except in one plot where all thin	Adequate with exception of one plot where sparse and inadequate number
7. Croptex Steel @ 22kg/ha + wetter	All healthy	Stout cane in one plot in all others variable medium to thin	Adequate number in all plots

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8. Croptex Steel @ 22kg/ha + wetter x 2 applications	All healthy	Medium to stout canes except in one plot where mainly medium to thin in diameter	Adequate number except in one plot where variable and in places sparse inadequate stand of cane

The eight treatments showed no significant difference between each other in terms of cane height and range of cane height when applied to either the tunnelled or outdoor crop, though there was a reduction of cane height in treatment 5 (Shark @ 0.8L/ha two applications) whether tunnelled or outdoor. This corresponds with the Glen Ample findings that a second application of Shark decreases cane vigour.

Technology transfer

- The main output from this work from this work was the production via HDC of a Specific Off-label Approval (SOLA) for Shark (carfentrazone-ethyl) for the control of spawn re-growth in outdoor and protected raspberry, blackberry and rubus hybrids (SOLA number 2007/01503). This was available in time for the 2008 season.
- Open Day in 2005
- One presentation at the HDC/ADAS/EMR National Soft Fruit Conference
- HDC News articles

Acknowledgements

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Appendix 1. Photographs of the effect of experimental treatments

2006: Tunnelled Glen Ample treatments on 17 May 2006

All of the first treatments were applied on 20 April and all of the second on 11 May.

	
Hand Removal x 1	Hand Removal x 2
	
Shark x 1 (Shark 2.56 l/ha)	Shark x 2 (Shark 2.56 l/ha)
	
Shark + Silwet x 1 (Shark 2.56 l/ha + Silwet L-77 2.0 l/ha)	Shark + Silwet x 2 (Shark 2.56 l/ha + Silwet L-77 2.0 l/ha)

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Croptex Steel + Wayfarer x 1 (Croptex Steel 20 kg/ha + Wayfarer 5.0 l/ha)	Croptex Steel + Wayfarer x 2 (Croptex Steel 20 kg/ha + Wayfarer 5.0 l/ha)
	
Harvest x 1 (Harvest 7.5 l/ha)	Harvest x 2 (Harvest 7.5 l/ha)
	
Harvest + Amm. Sulphate x 1 (Harvest 7.5 l/ha + Amm.Sulp 100 kg/ha)	Harvest + Amm. Sulphate x 2 (Harvest 7.5 l/ha + Amm.Sulp 100 kg/ha)

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Reglone x 1 (Reglone 4.0 l/ha)	Reglone x 2 (Reglone 4.0 l/ha)
	
Reglone + Agral x 1 (Reglone 4.0 l/ha + Agral 1.0 l/ha)	Reglone + Agral x 2 (Reglone 4.0 l/ha + Agral 1.0 l/ha)

	
Cultamide x 1 (Cultamide 100 l/ha)	Cultamide x 2 (Cultamide 100 l/ha)

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Cultamide + Silwet x 1 (Cultamide 100 l/ha + Silwet L-77 2.0 l/ha)	Cultamide + Silwet x 2 (Cultamide 100 l/ha + Silwet L-77 2.0 l/ha)

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2007: protected Octavia on 17 May 2007

All of the first treatments were applied on 18 April and all of the second on 5 May.

	
Shark x 1 (Shark 0.8 l/ha)	Shark x 2 (Shark 0.8l/ha)
	
Shark + Silwet x 1 (Shark 0.8 l/ha + Silwet L-77 2.0 l/ha)	Shark + Silwet x 2 (Shark 0.8 l/ha + Silwet L-77 2.0 l/ha)
	
Shark x 1 (Shark 1.6 l/ha)	Shark + Silwet x 1 (Shark 1.6 l/ha + Silwet L-77 2.0

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	l/ha)
	
Croptex Steel + Wayfarer x 1 Croptex Steel @ 22kg/ha + wetter	Croptex Steel + Wayfarer x 2 Croptex Steel @ 22kg/ha + wetter

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2007: outdoor Octavia on 4 June 2007

All of the first treatments were applied on 22 April and all of the second on 17 May.

	
Shark x 1 (Shark 0.8 l/ha)	Shark x 2 (Shark 0.8l/ha)
	
Shark + Silwet x 1 (Shark 0.8 l/ha + Silwet L-77 2.0 l/ha)	Shark + Silwet x 2 (Shark 0.8 l/ha + Silwet L-77 2.0 l/ha)
	
Shark x 1 (Shark 1.6 l/ha)	Shark + Silwet x 1 (Shark 1.6 l/ha + Silwet L-77 2.0

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	l/ha)
	
Croptex Steel + Wayfarer x 1 Croptex Steel @ 22kg/ha + wetter	Croptex Steel + Wayfarer x 2 Croptex Steel @ 22kg/ha + wetter

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2006: observation plots

	
212H one week after application (212H 0.2 kg/ha + Agral 1.0 l/ha)	Regalis+Exchange one week after application (Regalis 1.25 l/ha + Exchange 2.5 l/ha)

HDC Crop Walk 4th May 2006

Tunnelled Glen Ample trial site 2005-2007

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Octavia, Non Tunnelled, 4th June 2007	Octavia, Tunnelled, 4th June 2007

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Appendix 2. Experimental diaries

Experiment 1: evaluation of accumulated desiccant effects on yield of tunnelled raspberry, cv. Glen Ample

Mid March	Fleeced and tunnelled
18th June 2007	Start Picking
21st June 25th June 2nd July 9th July 16th July	Average Berry Weight Assessments
20th July 2007	Finish Picking

Experiment 2: evaluation of selected desiccant effects on tunnelled and non-tunnelled raspberry, cv. Octavia

18th April 2007	First spray to tunnelled crop
22nd April 2007	First spray to outdoor crop
5th May 2007	Second spray to tunnelled crop
17th May 2007	Second spray to outdoor crop
20th June 2007	Cane assessments of all treatments
16th July 2007	Outdoor crop tunnelled for picking
25th August 2007	Cane assessments of all treatments

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Appendix 3. Environmental conditions at time of treatment application (Experiment 2)

cv. Octavia	Spray date	Weather conditions
Tunnelled	18th April 2007	Sun and cloud, mid 20s °C
Tunnelled	5th May 2007	Dull cloud. Warm days, though cold nights around treatment date. Outdoor plots spawn still surprisingly slow to get moving at this stage for their second spray; it must be the cold nights.
Outdoor	22nd April 2007	Dull cloud, 2 to 3 minutes of very light drizzle, insufficient to coalesce on the car roof.
Outdoor	17th May 2007	Dull cloud. Dry foliage though a showery start to the day. Possibly rain to follow at night.

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