FINAL REPORT TO THE HORTICULTURAL DEVELOPMENT COUNCIL

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Relevance to growers and practical application

APPLICATION

Two potential cane desiccants – sodium monochloroacetate (SMA) and fomesafen – have been evaluated over several years as cane management tools in experiments on cane vigour control and biennial cropping.

No seasonal or cumulative adverse effects have been found to date of single annual treatments of rows for cane vigour control with selected spray concentrations of either chemical, but the margin of crop tolerance to their use twice per year in alternate years for biennial cropping requires further investigation.

As a result of a successful application for Off-label Approval to use SMA (as Croptex Steel) for cane desiccation, growers can apply this treatment, at their own risk, for cane vigour control and biennial cropping.

Fomesafen is not yet commercially available in the United Kingdom, but inclusion of raspberry recommendations on the initial product label is being considered.

SUMMARY

Introduction

The banning of dinoseb–in–oil for cane desiccation in raspberry plantations after the 1987 growing season left growers with a major crop management problem, since no alternative desiccant treatment was available. Cane regulation techniques such as vigour control and biennial cropping, developed in the 1970s for United Kingdom conditions by SCRI scientists, utilising dinoseb–in–oil, had to be abandoned. In a comprehensive screening and evaluation programme carried out at SCRI since then, over 60 herbicides, desiccants, growth regulators and defoliants have been examined. For various reasons, including inadequate crop safety, poor efficacy and lack of commercial viability, most of them have been eliminated. Two potential cane desiccants – sodium monochloroacetate (SMA) and fomesafen – performed well, with the aid of wetting agents, in single treatment evaluation trials over several years. They were therefore included as cane management tools in experiments on cane vigour control and biennial cropping in an established, healthy plantation of Glen Clova. The objectives were to select the most appropriate spray concentrations and to determine whether or not there were any cumulative adverse effects of repeated treatment of the same plots.

Cane vigour control

This involved annual application of a single desiccant treatment to the first flush of primo–canes when they reached 10–20 cm high in spring. Row treatments were applied to a 30 cm band on either side of the centre of the crop row, using flat fan nozzles angled at 45° to the vertical. Hand–cut controls were included for comparison. SMA was applied as Croptex Steel (Hortichem Ltd) at spray concentrations of either 20 or 30 kg product plus 5 litres of the tallow amine wetter Wayfarer per 1000 litres of water. Four successive years of application of these treatments (1990–1993) have shown no seasonal or cumulative adverse effects on components of fruit yield or on vegetative cane production when compared with the hand–cut control. There was little to choose between the two spray concentrations in terms of efficacy of cane desiccation. A similar trial with fomesafen (Zeneca Crop Protection), applied at a range of spray concentrations between 0.5 and 1.5 litres of product

plus 5 litres of the non-ionic wetter Agral per 1000 litres of water, is now entering its third year. To date, yield and cane records have shown no evidence of potential problems in comparison with hand-cutting. Cane desiccation was only marginally better at the 0.15% than at the 0.05% v/v spray concentration. Both desiccants also gave excellent control of suckers growing in the alleys and of any annual broad-leaved weeds present at the time of treatment, including groundsel.

Biennial cropping

Two biennial cycles have been completed in the experiment with SMA. Plot rows were treated twice, with an interval of approximately one month between treatments, in both fruiting years and left untreated in the vegetative years. Hand-cut controls were again compared with SMA applied at the two spray concentrations detailed above. Yield and cane records have shown that the margin of tolerance to two applications in one season in alternate years may be considerably less than to one application made every year. Responses to the 2% w/v spray concentration were not significantly different from those on hand-cut plots, but at the 3% w/v spray concentration yield was reduced by 17% over the two fruiting years and total cane production by 13% in the fourth (vegetative) year. Fomesafen plots have only been through one biennial cycle so far. Hand-cut plots yielded slightly less than sprayed plots in 1992 and produced slightly more cane growth in 1993, but the differences were not significant. There was no evidence of any adverse response to increases in spray concentration of fomesafen between 0.05% and 0.15% v/v.

Discussion

Results from earlier trials at SCRI and from the current project formed the basis of the successful application by the National Farmers Union of Scotland for Off-label Approval (No. 0334/92) for the use of SMA (as Croptex Steel) as a cane desiccant. Growers can therefore apply this treatment, at their own risk, for cane vigour control and biennial cropping. Experiments at SCRI have suggested that there should be no cumulative adverse effects of repeated treatment for cane vigour control at the 2% w/v spray concentration specified in the approval schedule, provided the instructions are closely followed. However, as was the case

with dinoseb–in–oil, it is important to treat only well–established, healthy and vigorous plantations of cultivars capable of responding positively to this form of management. Particular care will be needed where biennial cropping is being practised, since the margin of safety to the 2% w/v spray concentration appears to be small when two treatments per year are applied. More work is needed to investigate the factors contributing to increased sensitivity and any steps which could be taken to minimise their effects. Again, biennial cropping should only be imposed on well–established, healthy and vigorous plantations of cultivars known to respond positively to this form of management. The results reported above for both cane vigour control and biennial cropping relate to only one experimental location and need to be evaluated over a wider range of plantations and environmental conditions in order to establish reliability of performance.

Fomesafen is not yet commercially available in the United Kingdom, but inclusion of raspberry recommendations on the initial product label is being considered. Results so far are very promising for both efficacy and crop tolerance, but a further two years' records are needed in order to select the most appropriate spray concentration and to assess any cumulative effects of repeated treatments. Trials also need to be conducted over a range of sites before label recommendations can be formulated.

Experimental section

INTRODUCTION

The banning of dinoseb–in–oil for cane desiccation in raspberry plantations after the 1987 growing season left growers with a major crop management problem, since no alternative desiccant treatment was available. Cane regulation techniques such as vigour control and biennial cropping, developed in the 1970s for United Kingdom conditions by SCRI scientists, utilising dinoseb–in–oil, had to be abandoned. In a comprehensive screening and evaluation programme carried out at SCRI since then, over 60 herbicides, desiccants, growth regulators and defoliants have been examined. For various reasons, including inadequate crop safety, poor efficacy and lack of commercial viability, most of them have been eliminated (Lawson, 1990).

As part of this project, field evaluation of three chemicals, sodium hydroxide (as caustic soda), monocarbamide dihydrogensulphate (as Enquik) and glufosinate–ammonium (as Challenge) plus sulphate of ammonia, was completed. Since the results were negative and have been reported elsewhere (Lawson & Wiseman, 1991; Lawson, Wiseman & Wright, 1991, 1993a), they are not repeated here. This report concentrates on two potential cane desiccants.– sodium monochloroacetate (SMA) and fomesafen – which had performed well in single treatment evaluation trials over several years (Lawson, Wiseman & Wright, 1993b, 1993c), and were therefore worth including as cane management tools in experiments on cane vigour control and biennial cropping. The objectives were to select the most appropriate spray concentrations and to determine whether or not there were any cumulative adverse effects of repeated treatment of the same plots.

MATERIALS AND METHODS

The experiments were laid out in an established plantation of raspberry cv. Glen Clova. Plot size comprised a single row of 12 raspberry stools, plus one half of the alley on each side of the row. Plot length was 9 m and the rows were 2 m apart. In Experiment I (commenced 1990) two spray concentrations of SMA were compared against hand–cutting on both

annually and biennially cropped plots. Plots were arranged in randomised block design with six replicates of each treatment. Experiment II (commenced 1992) was of similar design, but five spray concentrations of fomesafen were involved and there were only three replicates of each treatment.

The plantation was managed on the stool system, with no mechanical soil cultivation after establishment. On annually cropped plots a maximum of eight fruiting canes was tied in per stool every winter. On biennial plots all sound canes of one metre or more in height were retained for fruiting. A residual herbicide was applied in late winter every year. Paraquat was added to the spray solution if emerged weeds were present. If necessary, weeds surviving on hand-cut plots were hand-hoed in June. Insecticides and fungicides were routinely applied to ensure that pests and diseases did not adversely affect cane growth or fruit production. Fertiliser application was made in accordance with local practice for cv Glen Clova.

Scores (0–10) were taken of efficiency of overall desiccation of young canes and suckers. Experience has shown that a score of 7 out of 10 would be the minimum acceptable for effective results. Scores of 8.5 or above denote excellent desiccation. Detailed records were made of yield of fruit and of vegetative cane production. Plots were inspected regularly for signs of translocation of chemicals into unsprayed fruiting laterals or into young canes produced following desiccation. Fruit yields and cane production records were statistically analysed after co-variance on a uniformity assessment carried out prior to the imposition of the first cutting or spraying treatments in each experiment. As a result, cumulative fruit yield treatment means do not exactly match the sum of the means for individual years.

SMA, as Croptex Steel, Hortichem Ltd (950g a.i./kg) and fomesafen, Zeneca Crop Protection (250g a.i./litre) were applied at a range of spray concentrations, expressed as percentage weight of product per unit volume of spray solution. Dates of application of SMA and the spray concentrations used are shown in Tables I and II. Equivalent data for fomesafen is presented in Tables VII and VIII. Row treatments were applied by Oxford Precision Sprayer to a 30 cm band on either side of the centre of the crop row when young vegetative canes were 10–20 cm tall. All young growth below the bottom wire was treated, including any low

fruiting laterals. Alley treatments were applied, using the same equipment, to the area (approximately 60 cm wide) between the edge of the row band and the centre of the alley on either side of the crop row. SMA was applied to rows in a spray volume of 1500 litres/treated hectare, using Spraying Systems 50–10 flat fan nozzles angled at 45° to the vertical at 160 kPa pressure. For fomesafen the spray volume was reduced to 1000 litres/treated hectare, using 50–06 nozzles at 220 kPa pressure. With both desiccants, alley treatments involved application at 500 litres/treated hectare, using 50–05 nozzles spraying vertically down at 230 kPa pressure. For all applications an adjuvant was added at 0.5% v/v to the final spray solution. With SMA it was the tallow amine wetter Wayfarer (Hortichem Ltd), while the non–ionic wetter Agral, (Zeneca Crop Protection) was used with fomesafen. Hand–cut plots were treated within 24 hours of spray application on adjacent plots.

RESULTS

SMA (Experiment I)

Both spray concentrations of SMA gave rapid and effective desiccation of first–flush canes in all four years (Table II). Differences in performance in favour of the higher concentration were relatively small. Control of second–flush canes was more erratic, but within acceptable limits. At no time was there any visible evidence of translocation up the fruiting canes or into the next flush of vegetative canes.

Fruit yields in the annually cropped system were marginally higher on sprayed than on cut plots in every year (Table III), but there were no significant annual or cumulative differences between the two spray concentrations of SMA. Mean harvest dates, mean berry weights and numbers of berries per fruiting cane were also unaffected by method of annual cane removal (Table IV). Year–to–year fluctuations in fruit yield were largely a reflection of cane production in previous years (Table V). Sprayed plots tended to have slightly more and taller canes by the end of the growing season than cut plots, due mainly to the recovery of a small proportion of treated canes. A prolonged dry period in June 1992 resulted in considerably reduced overall cane production in that year, leading to a corresponding fall in yield of fruit

in 1993. Cane production recovered in 1993 and there was no evidence that sprayed plots were more adversely affected than hand–cut plots.

In the biennial system annual or cumulative fruit yields on plots treated with the 2% w/v spray concentration were not significantly different from those on hand–cut plots (Table III). With the 3% concentration yield was reduced by an average of 17% over the two fruiting years. Mean harvest dates were unaffected by treatments, as were mean berry weights (Table IV). Yield differences in both years were associated with numbers of berries harvested per fruiting cane. Mean cane length was greater on sprayed than on hand–cut plots in the vegetative years (Table V), but cane numbers were lowest on plots sprayed with the 3% spray concentration. This resulted in a reduction of 13% in total length of cane produced in 1993 in comparison with hand–cut plots

There were slightly higher yields on biennial plots in their fruiting years compared with those on adjacent plots given cane vigour control annually, except where the 3% concentration had been applied (Table III). In 1990, larger numbers of berries per cane on hand–cut biennial plots were the main contributors to yield differences. In 1992, mean harvest date was almost two days later and mean berry weight was smaller on biennially cropped plots. More canes were produced on biennial plots in their vegetative years than on annually cropped plots, other than in 1993 on those treated twice with the 3% spray concentration in the previous year.

All plots were due to be treated twice per year to control alley suckers, regardless of row treatment. This was carried out in all years except 1993, when regrowth after the initial removal was very slow and did not merit further treatment before fruit harvest. The efficiency of desiccation of alley suckers by SMA was almost identical to that achieved on row canes, despite the lower spray volume used. Sucker numbers declined during the first three years of the experiment, more so on annually than on biennially cropped plots (Table VI). Method of removal had no consistent influence; indications that spray treatment at either concentration was reducing sucker numbers by more than the hand–cut treatment from 1992 onwards, particularly on biennially cropped plots, were not borne out by second–flush records in 1993. Excellent control of any broad–leaved annual weeds present at the time of spray treatment was achieved at both spray concentrations of SMA.

Fomesafen (Experiment II)

All spray concentrations of fomesafen gave rapid and comprehensive desiccation of first-flush canes in both years (Table VIII). Treatment of second-flush canes on biennial plots in 1992 was less effective, although acceptable other than at the lowest spray concentration. Emergence of second-flush canes on all plots had been uneven, making it difficult to time the second treatment to suit all cane heights. Otherwise, differences in performance were small in comparison with the wide range of dose increments used. There was no evidence of movement of fomesafen up fruiting canes or into second-flush vegetative canes.

There were no differences in yield or in yield components in 1992 or 1993 between hand-cut and sprayed treatments on annually cropped plots, apart from a slight delay in mean harvest date on sprayed plots in the second year (Table IX). Nor was there any evidence of adverse response to increasing spray concentration. Fruit records in the biennially cropped system showed a similar lack of differences amongst cane removal treatments and were no better in 1992 than on annually cropped plots given vigour control. Similarly, cane production in 1993 was unaffected by growing system, cane removal method or spray concentration (Table X). As in Experiment I, mean cane heights in 1992 were lower than average, but not sufficiently so in this experiment to cause substantial yield loss in the following year.

Alley suckers were treated twice per year except in 1993 when, as in the other experiment, regrowth after the initial removal was very slow and plots were not re-treated. Again, the efficiency of desiccation was very comparable with that achieved on row canes, despite the lower spray volume used. Crop management had no effect in 1992, but second-flush records in 1993 showed fewer suckers on annually than on biennially cropped plots (Table XI). Sprayed plots recorded fewer second-flush suckers than hand-cut plots in 1992 and this also applied to first-flush counts in 1993. However, the second flush produced in the latter year showed no such response. There were no effects of increasing spray concentration on sucker numbers. Any broad-leaved annual weeds present at the time of treatment with fomesafen at any spray concentration were very effectively controlled.

DISCUSSION

Four successive years of application of SMA for cane vigour control at 2% or 3% w/v spray concentrations have shown no seasonal or cumulative adverse effects on fruit yield or on vegetative cane production when compared with the hand-cut control. The 2% w/v spray concentration was the preferred treatment in earlier trials (Lawson, Wiseman & Wright, 1993b). Results from these trials and from the current project formed the basis of the successful application by the National Farmers Union of Scotland for Off-label Approval (No. 0334/92) for the use of SMA as a cane desiccant (Appendix II).

Two biennial cycles have been completed in this experiment. Yield and cane records have shown that while two applications of the 2% w/v concentration in one season in alternate years produced results broadly in line with those obtained by hand-cutting, the margin of tolerance to any form of over-dosing is likely to be considerably less than where one application is made every year. No visible injury was caused to either fruiting canes or to successive flushes of young canes in the year of treatment with the 3% w/v spray concentration of SMA. However, yields were significantly lower in both fruiting years than on hand-cut plots. Number of berries produced per fruiting cane was implicated in both years. Cane numbers produced in the vegetative year may also have influenced yield in 1992 and appeared likely to affect potential yield in 1994. There may therefore be cumulative as well as seasonal effects of over-dosing, which need further investigation.

There was little to choose between the two spray concentrations in terms of efficacy of desiccation of first-flush canes. Poorer overall control of second-flush canes by spray treatments was due to erratic emergence of these canes, which occurred on both cut and sprayed plots. This meant that a proportion of canes was taller than 20 cm before the majority had reached 15 cm; the former were not fully controlled by SMA at either spray concentration. In commercial plantations it may be advisable to spray earlier to improve overall control, bearing in mind the small size of the "spraying window" for this operation (MacKerron & Lawson, 1982). Growers applying SMA for either cane vigour control or biennial cropping are unlikely to derive any benefit from using spray concentrations above 2% w/v. In order to minimise any risk of overdosing, especially in biennial cropping, they

would also be advised not to apply more than the maximum spray volume per treated hectare permitted in the approval schedule.

In the similar experiment with fomesafen, now entering its third year, desiccation of first-flush canes was very effective and was only marginally better at the 0.15% than at the 0.05% v/v spray concentration. As with SMA, control of second-flush canes was less complete, but was satisfactory other than at the lowest spray concentration used. Earlier experiments indicated that the optimum spray concentration required for reliable and efficient desiccation lies in the range 0.07-0.01 v/v fomesafen (Lawson, Wiseman & Wright, 1993c). Yield and cane records to date have shown no evidence of potential problems with fomesafen in comparison with hand-cutting for cane vigour control. Biennial plots have only been through one cycle so far. Hand-cut plots yielded slightly less than sprayed plots in 1992 and produced slightly more cane growth in 1993, but the differences were not significant. There was no evidence of any adverse response to increases in spray concentration of fomesafen between 0.05% and 0.15% v/v. It requires a further two years of treatment under both management regimes before cumulative responses can be assessed and the most appropriate spray concentration selected. Fomesafen is not yet commercially available in the United Kingdom, but inclusion of raspberry recommendations on the initial product label is being considered by the manufacturer.

With both desiccants, alley suckers were as well controlled as row canes, despite the lower spray volumes used in the alleys. In both experiments numbers were sometimes higher on hand-cut than on sprayed plots, but not consistently so and no cumulative effects could be detected. What did appear as the trials progressed was a clear trend for higher numbers of suckers to emerge in the alleys on biennially as compared with annually cropped plots. This may have been a response to the more complete removal of competition from adjacent row canes in the fruiting years of the biennial plots. All spray concentrations of SMA and fomesafen gave excellent control of any annual broad-leaved weeds present at the time of treatment, including groundsel.

These experiments were not carried out to compare the two chemicals, but desiccation scores taken in 1992 and 1993, when both were applied in adjacent trials in the same plantation

(Tables I and II, VII and VIII) showed slightly better performance by fomesafen, at least on first-flush canes. Raspberries may also have a greater margin of tolerance to fomesafen than to SMA at spray concentrations giving comparable levels of desiccation.

In neither experiment did biennially cropped plots substantially outyield annually cropped plots in the first fruiting year. In most reports comparing biennial cropped plots with conventionally managed annually cropped plots, e.g. Waister, Lawson & Cormack (1984), the removal of competition by vegetative canes on biennial plots increased berry numbers and/or size. However in the present experiments early competition was also removed by the cane vigour control treatment applied to the annual plots. There was therefore less potential for improved yields on biennial plots. While more canes were tied-in for fruiting on biennially than on annually cropped plots in the SMA experiment in 1992, there was no yield benefit, even disregarding plots treated with the higher spray concentration. Berries were smaller on biennial plots, which may have been a consequence of the prolonged dry spell which occurred during June of that year.

CONCLUSIONS

Following the successful application for Off-label Approval to use SMA (as Croptex Steel) for raspberry cane desiccation, growers can apply this treatment, at their own risk, for cane vigour control and biennial cropping. Experience at SCRI suggests that there should be no cumulative adverse effects of repeated treatment for cane vigour control at the 2% w/v spray concentration specified in the approval schedule, provided the instructions are closely followed. However, as was the case with dinoseb-in-oil, it is important to treat only well-established, healthy and vigorous plantations of cultivars capable of responding positively to this form of management.

Particular care will be needed where biennial cropping is being practised, since the margin of safety to the 2% w/v spray concentration appears to be small when two treatments per year are applied. More work is needed to investigate the factors contributing to increased sensitivity and any steps which could be taken to minimise their effects. Again, biennial cropping should only be imposed on well-established, healthy and vigorous plantations of

cultivars known to respond positively to this form of management. The results reported above for both cane vigour control and biennial cropping relate to only one experimental location and need to be evaluated over a wider range of plantations and environmental conditions in order to establish reliability of performance.

Results to date with fomesafen are promising in terms both of efficacy and crop tolerance, but a further two years' records are needed in order to select the most appropriate spray concentration and to assess any cumulative effects of repeated treatments. Trials also need to be conducted over a range of sites before comprehensive label recommendations can be formulated.

Although the HDC contribution towards funding of this project ceased in December 1993, the project itself is due to continue, with support from other sponsors.

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APPENDIX I

TABLES

TABLE I

Expt. I. Dates of cane removal treatments 1990-93

	1990		1991		1992		1993	
	I	II	I	II	I	II	I	II
Annual cropping								
Rows	20 April	-	7 May	-	13 May	-	4 May	-
Alleys	20 April	25 May	7 May	27 June	13 May	16 June	4 May	-
Biennial cropping								
Rows	20 April	25 May	-	-	13 May	16 June	-	-
Alleys	20 April	25 May	7 May	27 June	13 May	16 June	4 May	-

TABLE II

Expt. I. Efficiency of primo-cane desiccation with SMA

Treatment of primo-canes and suckers	Mean desiccation score (0-10)* three weeks after application to primo-canes					
	1990		1991	1992		1993
	Date I	Date II		Date I	Date II	
SMA 2% w/v	8.3	7.4	8.4	9.1	7.3	7.9
SMA 3% w/v	8.2	7.5	8.6	9.1	8.0	8.4

*0 = No effect, 10 = Leaves and stems completely killed.

TABLE III

Expt. I. Yield records

Treatment of primo-canes and suckers	Total wt fruit harvested (t/ha)					50% harvest date (Days after date of first pick)			
	1990	1991	1992	1993	Cum. yield	1990	1991	1992	1993
Annual cropping									
Cut by hand	16.1	11.0	15.6	7.1	50.0	14.8	14.2	10.5	8.6
SMA 2% w/v	16.5	12.4	16.2	7.6	52.8	14.5	14.5	10.8	9.2
SMA 3% w/v	16.2	12.8	15.7	8.2	53.1	14.0	14.3	10.3	9.3
Biennial cropping									
Cut by hand	18.4	-	16.9	-	35.7	14.5	-	12.1	-
SMA 2% w/v	17.3	-	16.5	-	33.4	13.4	-	12.7	-
SMA 3% w/v	15.7	-	14.3	-	29.7	13.8	-	12.3	-
S.E. mean ±	0.54	0.23	0.63	0.48	1.24	0.36	0.20	0.31	0.34
Sig. of effects									
Management (Ac v Bc)	NS	-	NS	-	***	NS	-	***	-
Removal method	*	***	NS	NS	NS	NS	NS	NS	NS
Interaction	*	-	NS	-	**	NS	-	NS	-

*,**,*** - Effect significant at P = 0.05, 0.01, 0.001. NS - Not significant.

TABLE IV

Expt. I. Berry records

Treatment of primo-canes and suckers	Weighted mean berry wt (g)				No. berries/fruiting cane			
	1990	1991	1992	1993	1990	1991	1992	1993
Annual cropping								
Cut by hand	2.36	2.83	2.26	3.15	96.6	107.5	93.0	64.8
SMA 2% w/v	2.33	2.81	2.21	3.04	97.0	104.8	88.0	63.0
SMA 3% w/v	2.41	2.84	2.23	2.94	89.9	102.8	87.1	62.2
Biennial cropping								
Cut by hand	2.38	-	2.16	-	107.3	-	90.2	-
SMA 2% w/v	2.50	-	2.07	-	97.8	-	93.0	-
SMA 3% w/v	2.47	-	2.08	-	90.5	-	80.0	-
S.E. mean ±	0.051	0.063	0.075	0.047	3.21	4.13	5.79	3.30
Sig. of effects								
Management (Ac v Bc)	NS	-	*	-	NS	-	NS	-
Removal method	NS	NS	NS	*	**	NS	NS	NS
Interaction	NS	-	NS	-	NS	-	NS	-

*,** - Effect significant at P = 0.05, 0.01. NS - Not significant.

TABLE V

Expt. I. Vegetative cane production records

Treatment of primo-canes and suckers	Total no. of canes produced/plot in				Mean height/cane (cm)			
	1990	1991	1992	1993	1990	1991	1992	1993
Annual cropping								
Cut by hand	156	170	117	167	114	123	88	124
SMA 2% w/v	170	166	124	178	121	131	95	132
SMA 3% w/v	170	164	130	182	125	131	97	131
Biennial cropping								
Cut by hand	-	205	-	204	-	149	-	120
SMA 2% w/v	-	200	-	191	-	160	-	127
SMA 3% w/v	-	183	-	168	-	158	-	126
S.E. mean ±	5.5	9.8	3.4	8.0	2.5	2.5	3.0	2.8
Sig. of effects								
Management (Ac v Bc)	-	***	-	NS	-	***	-	*
Removal method	NS	NS	NS	NS	*	**	NS	NS
Interaction	-	NS	-	*	-	NS	-	NS

*,**,*** - Effect significant at P = 0.05, 0.01, 0.001. NS - Not significant.

TABLE VI

Expt. I. Alley sucker records

Treatment of alley suckers	No. of alley suckers per 9 m²†						
	1990	1991		1992		1993	
	2nd flush	1st flush	2nd flush	1st flush	2nd flush	1st flush	2nd flush
Annual cropping							
Cut by hand	45.8	22.1	23.0	12.7	11.5	17.2	6.4
SMA 2% w/v	58.7	27.5	25.0	8.0	11.4	9.2	6.5
SMA 3% w/v	59.0	30.2	27.4	11.7	9.9	13.6	8.8
Biennial cropping							
Cut by hand	51.4	32.2	31.1	20.9	20.9	22.1	9.7
SMA 2% w/v	58.0	29.2	30.7	13.8	12.6	9.9	14.2
SMA 3% w/v	50.5	37.8	29.2	17.4	14.4	15.9	14.3
S.E. mean ±	4.18	3.54	2.46	3.00	1.71	2.74	2.48
Sig. of effect							
Management (Ac v Bc)	NS	*	*	*	**	NS	*
Removal method	NS	NS	NS	NS	*	**	NS
Interaction	NS	NS	NS	NS	NS	NS	NS

*,** - Effect significant at P = 0.05, 0.01. NS - Not significant.

† - After covariance on first-flush numbers recorded in 1990 prior to application of the first experimental treatments to rows or alleys (mean of 43 suckers/9m²).

TABLE VII

Expt. II. Dates of cane removal treatments 1992-93

	1992		1993	
	I	II	I	II
Annual cropping				
Rows	14 May	-	5 May	-
Alleys	14 May	16 June	5 May	-
Biennial cropping				
Rows	14 May	16 June	-	-
Alleys	14 May	16 June	5 May	-

TABLE VIII

Expt. II. Efficiency of primo-cane desiccation with fomesafen

Treatment of primo-canes and suckers	Mean desiccation score (0-10)* three weeks after application to primo-canes		
	1992		1993
	Date I	Date II	Date I
Fomesafen			
0.050% v/v	9.6	5.7	8.7
0.075% v/v	9.6	7.0	8.8
0.100% v/v	9.8	7.8	9.3
0.125% v/v	9.9	8.0	9.1
0.150% v/v	9.9	8.2	9.3

* 0 = No effect, 10 = Leaves and stems completely killed.

TABLE IX

Expt. II. Fruiting cane records

Treatment of primo-canes and suckers	Yield (t/ha)		No. of berries fruiting cane		Weighted mean berry wt (g)		50% of harvest date (Days after date of first pick)	
	1992	1993	1992	1993	1992	1993	1992	1993
Annual cropping								
Cut by hand	14.3	14.1	98.4	69.3	2.65	3.00	12.1	12.3
Fomesafen								
0.050% v/v	15.1	15.1	98.5	75.3	2.71	2.94	11.8	11.3
0.075% v/v	14.6	15.0	92.1	70.9	2.89	2.99	11.7	11.7
0.100% v/v	13.0	12.1	93.8	74.7	2.44	2.83	11.9	11.7
0.125% v/v	14.4	12.1	95.5	75.3	2.83	2.99	11.8	10.9
0.150% v/v	14.9	13.8	94.0	62.7	2.94	3.09	11.5	11.1
Biennial cropping								
Cut by hand	13.4	-	97.8	-	2.52	-	12.0	-
Fomesafen								
0.050% v/v	14.9	-	94.0	-	2.93	-	11.8	-
0.075% v/v	15.2	-	102.5	-	2.65	-	11.4	-
0.100% v/v	15.4	-	101.7	-	2.81	-	12.1	-
0.125% v/v	15.7	-	98.0	-	2.90	-	11.4	-
0.150% v/v	15.3	-	95.6	-	2.88	-	11.9	-
S.E. mean ±	0.69	2.23	3.21	6.97	0.170	0.133	0.39	0.38
Sig. of effects								
Management (Ac v Bc)	NS	-	NS	-	NS	-	NS	-
Cut v Sprayed	NS	NS	NS	NS	NS	NS	NS	*
Spray conc. (linear)	NS	NS	NS	NS	NS	NS	NS	NS
Interaction	NS	-	NS	-	NS	-	NS	-

* - Effect significant at P = 0.05. NS - Not significant.

TABLE X

Expt II. Vegetative cane records

Treatment of primo-canes and suckers	Total no. of canes produced/plot in		Mean ht/cane (cm)	
	1992	1993	1992	1993
Annual cropping				
Cut by hand	171	176	110	131
Fomesafen				
0.050% v/v	180	170	107	136
0.075% v/v	190	189	114	141
0.100% v/v	186	187	100	132
0.125% v/v	189	167	106	131
0.150% v/v	182	174	108	134
Biennial cropping				
Cut by hand	-	209	-	124
Fomesafen				
0.050% v/v	-	167	-	142
0.075% v/v	-	187	-	134
0.100% v/v	-	163	-	135
0.125% v/v	-	164	-	129
0.150% v/v	-	180	-	129
S.E. mean ±	8.2	16.2	6.4	6.7
Sig. of effects				
Management (Ac v Bc)	-	NS	-	NS
Cut v Sprayed	NS	NS	NS	NS
Spray conc. (linear)	NS	NS	NS	NS
Interaction	-	NS	-	NS

NS - Not significant.

TABLE XI

Expt. II. Alley sucker records

Treatment of alley suckers	No. of alley suckers per 9 m^2†		
	1992	1993	
	2nd flush	1st flush	2nd flush
Annual cropping			
Cut by hand	27.5	33.6	11.0
Fomesafen			
0.050% v/v	18.3	22.5	12.2
0.075% v/v	13.3	14.6	9.1
0.100% v/v	19.0	23.6	16.1
0.125% v/v	21.7	19.8	7.1
0.150% v/v	22.0	24.2	16.4
Biennial cropping			
Cut by hand	31.2	32.3	20.1
Fomesafen			
0.050% v/v	26.5	21.9	32.6
0.075% v/v	24.2	28.2	19.6
0.100% v/v	19.1	23.4	24.8
0.125% v/v	11.7	20.0	21.6
0.150% v/v	16.3	28.8	32.5
S.E. mean ±	3.65	5.81	6.39
Sig. of effect			
Management (Ac v Bc)	NS	NS	**
Cut v Sprayed	**	*	NS
Spray conc. (linear)	NS	NS	NS
Interaction	NS	NS	NS

*,** - Effect significant at P = 0.05, 0.01. NS - Not significant.

† - After co-variance on first-flush numbers recorded in 1992 prior to application of the first experimental treatments to rows or alleys (mean of 17 suckers/9 m^2).

APPENDIX II

NOTICE OF APPROVAL

NOTICE OF APPROVAL NO. 0334/92

FOOD AND ENVIRONMENT PROTECTION ACT 1985
CONTROL OF PESTICIDES REGULATIONS 1986
(S.I. 1986 NO. 1510):
APPROVAL FOR OFF-LABEL USE OF AN APPROVED PESTICIDE PRODUCT

This approval provides for the use of the product named below in respect of crops and situations, other than those included on the product label. Such "off-label use" as it is known is at all times done at the user's choosing, and the commercial risk is entirely his or hers.

The conditions below are statutory. They must be complied with when the off-label use occurs. Failure to abide by the conditions of approval may constitute a breach of that approval, and a contravention of the Control of Pesticides Regulations 1986. The conditions shown below supersede any on the label which would otherwise apply.

Level and scope: In exercise of the powers conferred by regulation 5 of the Control of Pesticides Regulations 1986 (SI 1986/1510) and of all other powers enabling them in that behalf, the Ministers of Agriculture, Fisheries and Food and the Secretary of State, hereby jointly give full approval for the use of

Product name: Croptex Steel containing

Active ingredient: 95% w/w sodium monochloroacetate

Marketed by: Hortichem Ltd under MAFF NO. 02418 subject to the conditions relating to off-label use set out below:

Date of issue: 6 April 1992

Date of expiry: Unlimited.

~~unlimited~~/subject to the continuing approval of MAFF 02418)

Field of use: **ONLY AS A HORTICULTURAL HERBICIDE**

Crops: *Raspberry*

Maximum individual dose: i) Row treatment: 22 kg product/treated hectare of crop row

and

ii) Alley treatment: 17 kg product/treated hectare of alley

Maximum number of treatments:

i) Row treatment: Two per year

and

ii) Alley treatment: Two per year

Latest time of application: 28 days before harvest

Operator protection:

(1) Engineering control of operator exposure must be used where reasonably practicable in addition to the following personal protective equipment:

(a) Operators must wear suitable protective gloves, eye protection (goggles) and approved respiratory equipment when handling the concentrate.

(b) Operators must wear suitable protective gloves and face protection (faceshield) when spraying.

(2) However, engineering controls may replace personal protective equipment if a COSHH assessment shows they provide an equal or higher standard of protection.

Environmental protection:

(1) Since this product is harmful to bees, crops must not be treated during flowering stage, and flowering weeds must be kept down.

(2) Livestock, especially poultry, must be kept out of treated areas for at least two weeks.

Other specific restrictions:

(1) This product must only be applied if the terms of this approval, the product label and/or leaflet and any additional guidance on off-label approvals have first been read and understood.

(2) When applied as a row or alley treatment, the maximum concentration must not exceed 20 kg product/1000 litres water.

(3) When applied as a row treatment, a minimum interval of 4 weeks must be observed between applications.

(4) The maximum concentration of the adjuvant "Wayfarer" (ADJ 0045) must not exceed 0.5% v/v of the final spray solution.

(5) The container must not be re-used for any purpose.

Signed .....
(Authorised signatory)

Date 6 April 1992

Application Reference Number: COP 92/00036

THIS NOTICE OF APPROVAL IS NUMBER 0834 of 1992

ADVISORY INFORMATION

This approval relates to the use of "Croptex Steel" to regulate cane and sucker production in raspberry crops by dessication of unwanted vegetation.

Growers must note that the maximum rates specified on this Notice of Approval relate to the maximum rate of product to be applied to a treated hectare of crop row or alley.

The product is to be applied by tractor mounted/knapsack sprayer with angled hydraulic nozzles providing a coarse spray. Band application should be used at the base of the crop row, directed application in the alleys between rows, or a combination of both may be used.

The product is to be applied at a maximum concentration of 20 kg/1000 litre water to run off, in a total spray volume of 850-1100litre/ha for row treatments and 450-850 litre/ha for alley treatments depending on height and density of the vegetation and spray band width.

"Wayfarer" (Adj 0045 The adjuvant) must be added at a maximum concentration of 0.5% v/v of the spray solution.

Application should be made when canes or suckers are 10-20 cm high. Drift to non-target canes and fruiting laterals must be avoided. For annual control of cane vigour, 1 application to cane rows should be made per year, in well established healthy plantations which produce large numbers of excessively tall canes. For biennial cropping or in the final year of any plantation, a maximum to 2 applications per year with a 4 week interval between treatments may be made to control successive flushes of vegetative canes. Alley suckers may be treated either alone or in conjunction with row treatments. A maximum of 2 row and 2 alley treatments may be made in any one year. A minimum Harvest Interval of 28 days must be observed for all treatments.

In times of drought, a second application of product to rows should not be made.

APPENDIX III

CONTRACT BETWEEN
SCOTTISH CROP RESEARCH INSTITUTE
AND THE
HORTICULTURAL DEVELOPMENT COUNCIL

Contract between the Scottish Crop Research Institute (SCRI) (hereinfafter called the "Contractor") and the Horticultural Development Council (hereinafter called the "Council") for a research/development project.

PROPOSAL

1. TITLE OF PROJECT: Contract No: SF/10(b)

RASPBERRIES; ASSESSMENT OF POTENTIAL DINOSEB REPLACEMENTS IN CANE VIGOUR CONTROL AND BIENNIAL CROPPING SYSTEMS.

2. BACKGROUND AND COMMERCIAL OBJECTIVE

Earlier work on finding possible alternatives to dinoseb for cane desiccation in raspberries led to the identification of several chemical treatments which appear to be both effective and safe to te crop in the year of treatment. The requirement now is to examine these treatments as management tools in both cane vigour control and biennial cropping systems, to assess whether or not their repeated use has cumulative adverse effects on the crop or its environment when compared against cane removal by hand. This information is essential if progress is to be made towards PSD approval of recommendations for commercial use by growers. In addition, a limited amount of screening will continue.

3. POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY

Estimates produced by the East of Scotland College of Agriculture have suggested that the benefit of cane vigour control treatment with dinoseb-in-oil was worth over £2M in additional harvest yield/annum to the Scottish raspberry industry. To this must be added ay benefits to equivalent English growers and to those in both countries wishing to practise biennial cropping. Cane vigour control and biennial cropping are essential techniques for optimising yield and returns in many raspberry crops. The banning of dinoseb has prevented growers from using these techniques in recent years. A successful conclusion to this investigation will restore the flexibility of management which growers enjoyed prior to 1987.

4. SCIENTIFIC / TECHINICAL TARGET OF THE WORK

It is proposed to examine the cumulative effects of new cane desiccation chemicals on the growth, yield and health of a raspberry plantation over a four-year period in order to devise suitable management recommendations and to identify and quantify any potential problems which may arise.

5. CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS

The original cane vigour control technique using dinoseb-in-oil was devised and developed at SCRI in the 1970s. SCRI has the

necessary expertise to evaluate new treatments as potential management tools in raspberry plantations. The project, as in the last 3 years, will continue to be funded mainly by DAFS with support from the relevant chemical companies and HDC.

6. DESCRIPTION OF THE WORK

Desiccant treatments will be applied to an established Glen Clova plantation once every spring for four years (cane vigour control) or two - three times every second year (two biennial corpping cycles) and compared against hand-cut controls. Detailed records will be taken on components of yield of the fruiting canes and on the growth, vigour and health of vegetative canes. Disease and pest interactions will be monitored, as will levels of residue of desiccants in fruit and soil. Particular attention will be paid to cumulative effects of treatment on the crop or its environment. The objective is to accumulate the necessary date for off-label approval and eventually incorporation of appropriate recommendations on to approved product labels. Progress towards this objective is very dependent on the goodwill and cooperation of the relevant chemical companies. In addition, the current screening programme will continue at a reduced level.

7. COMMENCEMENT DATE AND DURATION

This project is ongoing. The long-term investigation commenced in April 1990 and will run for four years.

8. STAFF RESPONSIBILITIES

Project Leader: H M Lawson (funded by DAFS).

Other staff: J S Wiseman, G Wright (funded by DAFS).

Temporary staff: Research assistant, employed for 20 weeks in 1990 and 40 weeks in each of the next three years.

9. LOCATION

Work will be restricted to the SCRI farm at Invergowrie and will be conducted in 1990 under a Automatic Experimental permit, with the fruit having to be destroyed. As yet, no permission is available for experimentation on commercial farms.

TERMS AND CONDITIONS

The Council's standard terms and conditions of contract shall apply except as follows:

This project is predominantly funded by DAFS, who will retain appropriate rights, as will chemical companies contributing to th project costs. HDC's rights shall reflect the size of HDC contributions in relation to the cost of the overall project.

Signed for the Contractor (s)

Signature.....

Position.....DIRECTOR.....

Date.....25/8/90.....

Signed for the Contractor (s)

Signature.....R.J. Killick.....

Position.....Secretary.....

Date.....28 August 19

Signed for the Council

Signature.....

Position.....CHIEF EXECUTIVE.....

Date.....22-8-90.....