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PRACTICAL SECTION FOR GROWERS

Background and objectives

Sciarid flies *(Bradysia* sp) are common on all UK nurseries growing protected crops, and this includes crops grown in rockwool or coir slabs, as well as crops grown in conventional peat based media. Most growers are familiar with the behaviour of the flies, as they are easy to see on the plants or on the compost surface.

The majority of flies caught on yellow sticky traps in the greenhouse also tend to be sciarid flies, and this again is a measure of their abundance and widespread distribution. However sciarid larvae are not always seen, because they live in the compost and avoid the light. Growers may notice that, when numbers of larvae are high, the compost surface may be coated with a silvery secretion. Plant leaves that touch the compost are often eaten by larvae in these situations.

A variety of control measures are used to control sciarid fly, including sprays or low volume mist applications of insecticides to kill the adult flies, and drenches of products such as Nemolt or Dimilin to control larvae. There is an increasing trend for growers to move to IPM measures for this pest however, and nematodes and *Hypoaspis* predators are commonly used.

Work in a previous HDC funded project (PC 147) confirmed that sciarid fly larvae can cause serious damage to plants such as poinsettia at the propagation stage, by feeding on roots and tunnelling into the cutting. Well established plants can tolerate some degree of sciarid infestation, but if levels of the pest are high, plant quality can be reduced, and there is increased risk of root pathogens such as *Pythium* or *Phytophthora* being transmitted. (Goldberg and Stanghellini, 1990, Biddulph and Entwhistle, 1996). The problem for growers is knowing how often control measures for sciarid should be applied, and how cost effective they are at various stages of plant production. With the continued pressure on margins, no grower wants to apply inputs such as insecticides unless they are absolutely necessary. These trials evaluated the level of sciarid fly control from control measures in the plug stage only, at both plug and potting on stage, or at just the potting on stage, using a range of both chemical and biological treatments.

The overall objective of the work was to determine the effect on sciarid fly control of control measures in either or both the plug and pot stage. Plant quality assessments, as well as counts of pest numbers were a key feature of the trials. They were designed to answer the following questions:

1. At what stage does sciarid fly do most damage?

2. Will controls in the plug stage alone be sufficient?

3. Would there be an additional bonus from controls in the final potting stage?

At the conclusion of the work, the relative costs of the different control measures was calculated.

Summary of results

Two trials were carried out; one on fuchsias (cultivar - Display) and one on poinsettias (cultivar - Sonora) grown among a commercial crop on growers holdings. The trial evaluated granular formulations of Intercept 5GR, suSCon Indigo 10G, and Fipronil incorporated into the compost during the plug and /or potting-on phases of production. Drench treatments of nematodes (Nemasys) and Spinosad were also evaluated in the propagation and production phases. The final treatment was Hypoaspis predatory mites.

Counts of the number of sciarid fly larvae after potting showed that incorporation of the granular insecticides Intercept 5GR (Imidacloprid) or suSCon Indigo 10G (Chlorpyrifos) gave acceptable control of sciarid fly in most cases but the new granular insecticide Fipronil (due to be Approved in the UK shortly), gave poor results. Treatment of the plug and pot with granular insecticides provided the best plant quality of poinsettias. Quality was also improved compared to the control where only the plug phase was treated. However, at a cost of 1p per pot to the grower, the extra improvement shown in these trials by the combined plug and pot treatment indicates that treatment of both stages is worthwhile. The improvement in plant quality from insecticide granular treatment of poinsettias was dramatic, whereas the visual effects with fuchsias were not so marked.

Nematodes (*Steinernema feltiae*, Nemasys) also gave good results when applied at both the plug and potting stage, but the best results were from the *Hypoaspis* treatment applied at both stages. Both plant quality and the reduction in the number of emerging sciarid flies was excellent with this treatment, which was the most effective treatment overall in the trials for both fuchsias and poinsettias.

Conclusions

There was a direct relationship between numbers of sciarid fly larvae and plant quality measured as % marketability of poinsettias. Since sciarids are a potential problem on most nurseries growing this crop, detailed attention should be given to control measures.

The relationship between levels of sciarid fly and plant quality of fuchsias was not as defined, but in some circumstances high levels of sciarid larvae can decrease root weights.

Incorporation of insecticide granules, such as Intercept 5GR or suSCon Indigo 10G into the plug gave an improvement in plant quality, but did not give the best control of sciarids.

Incorporation of insecticide granules into the plug and pot gave a further improvement in plant quality of poinsettia, and better sciarid control overall.

Hypoaspis predatory mites when applied at both the plug stage (i.e., while rooting) and after potting, gave the best overall control of sciarid fly and the best plant quality with both fuchsia and poinsettia. There may be scope to reduce the rate of *Hypoaspis* and therefore the cost, but further work is needed to confirm this.

Action points for growers

- The degree of damage caused by sciarid fly varies between different plant subjects; this study has confirmed that poinsettias are very vulnerable to larval damage and should be protected at both the plug and final potting stage. The returns in extra quality and % marketability will normally be well worth the extra cost of inputs involved (see section on practical and financial benefits).

- With fuchsias, the improvement in quality from treatment of plug and pot was not so marked, but in terms of control of larvae (and emergence of adult flies) control may still be worthwhile, especially if supermarket customers are sensitive to the presence of flies on the finished product.

- Imidacloprid (Intercept 5GR) and Chlorpyrifos (suSCon Indigo 10G) granules performed well in these trials, but the best results in terms of plant quality and reduction in sciarid fly numbers was given by the *Hypoaspis* treatment (applied twice during propagation and three times after potting up). It may be possible to use insecticides such as Intercept 5GR and suSCon Indigo 10G in the plug and still use *Hypoaspis* after potting up, but detailed trials information is needed to confirm this.

- Fipronil granules (a new active ingredient not yet Approved in the UK), appeared to give little or no control of sciarids in both trials with poinsettia and fuchsia.

Anticipated practical and financial benefits

The conclusion from this work is that, while treatment of the plug stage alone is worthwhile (and usually very cost effective) a further improvement in both root weight and sciarid fly control can be gained by treatment of the final pot stage as well. The reduction in numbers of sciarid fly may also contribute to an overall reduction in the incidence of plant pathogens, as many studies have confirmed that sciarids can and do vector pathogens such as *Pythium*, *Thielaviopsis* and *Phytophthora*. Improvements in plant quality, especially of poinsettias may continue on into shelf-life.

Costs of sciarid fly control in propagation

It is important to remember that the propagators would bear this cost, and it is very unlikely that they would be able to charge customers extra for treating the cuttings against sciarid fly. However, if the propagating company wished to reduce plant losses, and promote their plants as having protection against sciarid fly, this could be an effective marketing strategy.

Costings for sciarid control in propagation*

a) Intercept 5GR @ 280g/m^3 = £10.00 per 28,000 plugs

b) suSCon Indigo 10G @ 500g/m^3 = £8.75 per 28,000 plugs

c). Nemasys @ 0.5 x 10^6/m^3 = 16.3p/m^2 (184 plugs) = £24.80 per 28,000 plugs

d) *Hypoaspis* @ 250/m^2 = 16.0p/m^2 (184 plugs) = £24.35 per 28,000 plugs

*Assuming a plug or paper pot of approximately 35ml volume, a cubic metre of compost produces about 28,000 plugs.

Costings for sciarid control in the final pot#

Assuming a final plant spacing of 8 plants per m^2 for fuchsia or poinsettia grown in 13cm (1 litre) pots.

a). Intercept 5GR @ 280gm/m^3 = 1p per pot.

b). suSCon Indigo 10G @ 500g/m^3 = 0.9p per pot.

c). Nemasys @ 0.5 x 10^6/m^2 = 2p per pot. Three applications of nematodes made in the trial = 6p per pot in total.

d). *Hypoaspis* @ 250m^2 = 2p per pot. Three applications of *Hypoaspis* made in the trial = 6p per pot in total.

SCIENCE SECTION

Introduction

Most growers need to apply control measures for sciarid fly at some stage in the cropping cycle of protected ornamentals. However, information about the effectiveness of different control methods, and their cost - effectiveness in the commercial situation is limited. Sprays of insecticides to control adult flies, or application of insecticides as a drench to control larvae are applied with little knowledge of how effective they are or what the cost/benefit ratio is likely to be.

With the continued pressure on growers' margins, and the need to reduce applications of insecticides to a minimum compatible with good pest control and acceptable plant quality, more information in this area is badly needed. The aims of this project were therefore to investigate a range of control measures, both biological and chemical, at both propagation and/or potting stage, and relate this to both efficacy against the pest and cost-effectiveness to the grower. This was achieved by applying treatments to plants either just in the plug stage, at potting on , or at both stages. Trial plants were placed among the growers crop under typical commercial conditions, so that the results were representative of nurseries in the UK.

Methods and materials.

The trials took place at separate nursery sites, but the treatments used in each trial were identical.

Trial 1: Fuchsia (variety Display).	W. J. Findon Ltd Bordon Hill Nursery Stratford-upon-Avon CV37 9RY
Trial 2: Poinsettia (variety Sonora).	Young Plants Ltd Alveston Stratford-upon-Avon CV37 7JQ

The trials commenced in April 2000 and concluded in December 2000. Unrooted cuttings were rooted in loose fill plugs (fuchsias), or Elle pots (poinsettias), on the nurseries above using bottom heat and mist to ensure rapid rooting.

Table 1 shows the combinations of treatments applied at either the plug or final pot stage.

Table 1. Treatments used in the trials.

Treatment / Plant Stage		Rate	Approval status of insecticides
Plug	**Final Pot**		
1. Untreated	Untreated	-	-
2. Intercept 5GR	Untreated	280g/m^3	Approved
3. Intercept 5GR	Intercept 5GR	280g/m^3	Approved
4. Untreated	Intercept 5GR	280g/m^3	Approved
5. suSCon Indigo 10G	Untreated	500g/m^3	Approved
6. suSCon Indigo 10G	suSCon Indigo 10G	500g/m^3	Approved
7. Untreated	suSCon Indigo 10G	500g/m^3	Approved
8. Fipronil 0.1G	Untreated	1000g/m^3	Not approved
9. Fipronil 0.1G	Fipronil 0.1G	1000g/m^3	Not approved
10. Untreated	Fipronil 0.1G	1000g/m^3	Not approved
11. Spinosad drench	Spinosad drench	100ml/100 litres	Not approved
12. Nemasys drench	Nemasys drench	0.5 x 106/m^2	-
13. Nemasys drench	Untreated	0.5 x 106/m^2	-
14. Hypoaspis	Hypoaspis	250/m^2	-
15. Hypoaspis	Untreated	250/m^2	-

Experimental design.

Each treatment consisted of one full plug tray. The best 20 rooted cuttings were selected and potted on into 13cm (1 litre) pots. Each replicate consisted of 4 pots arranged in a Randomised Block Design on the glasshouse bench.

There were 5 replicates per treatment, and with 15 treatments this made a total of 300 pots in the trial.

Growing Media.

Trial 1 (fuchsia) used Sinclair Pot and Bedding Compost, while Trial 2 (poinsettia) used Bulrush Poinsettia Compost. Both were peat based media.

Method of mixing insecticide granules into compost.

An ADAS Standard Operating Procedure (Hort/002) was used to ensure accurate and even mixing of the three insecticide granular products (Intercept 5GR, suSCon Indigo 10G and Fipronil 0.1G) used in the trials, both for the plug compost and the final potting on compost. The granules were designed to persist for the life of the plant and so repeat applications were unnecessary.

Drenches.

The Spinosad and the nematode treatments were applied to the plugs at sticking and approximately two weeks later in both trials. Once the plugs were rooted and potted on, drenches were applied within a week, and then every two weeks for a total of 3 applications in all in the cropping phase. In the case of the plugs, the solution was applied in sufficient volume to ensure it just ran through, whereas both the final pot drenches were applied at 20% of pot volume. All the final pots were 13cm diameter (1 litre volume), so 200mls of drench per pot was applied on each occasion.

Hypoaspis predatory mites.

Because these predators are highly mobile, the trays of plugs receiving this treatment were kept on a separate bench in the glasshouse, to avoid cross-contamination. Similarly, once potted on into final pots, these were kept separate from the rest of the trial to avoid the predators moving onto other treatments. A measure was used to carefully sprinkle mites plus carrier (peat/perlite) around the base of each plant; this equated to approximately 250 mites/m^2. This was a high rate (preventative rate is normally 100/m^2), but was calculated to provide a high level of control. *Hypoaspis* was applied twice to the plugs during rooting, and three times after the plants were potted up.

Sciarid infestation.

In order to ensure an even level of sciarid fly in the trials an extensive colony was maintained. Larvae were obtained from this colony and inoculated into the final pots (not the plugs) within 14 days of potting on in each trial, at the rate of 5 per pot. There was also a natural background infestation at each nursery. The species involved was *Bradysia paupera*.

Assessments:

Sciarid fly larvae.

There were no sciarid larval assessments during the plug/rooting stage as this was not practical, but once plants were potted on into the final 13cm pots, potato halves were pressed onto the compost surface (cut edge down) and this allowed larvae to congregate on the under-surface of the potato. Numbers of larvae were counted weekly, using a hand lens. The potato half was renewed at each occasion repeating the process every 7 days until at least 5 weekly counts were completed.

Plant quality.

At intervals during the trial, plant vigour was scored, using a scale of 1 to 5 where:

1. = Very poor, stunted plants.

2. = Some stunting obvious, low plant vigour.

3. = Medium vigour and growth, but not acceptable for market.

4. = Moderate vigour, good branching, acceptable for market.

5. = Very vigorous plants, well branched stems, good leaf colour.

Once the plants were mature, the foliage was cut off at compost level and fresh foliage weights were calculated. In the case of fuchsia, maturity was when the plants were well grown, about 30cm high, and full of bud and flowers. In the case of poinsettias, maturity was when the plants had fully expanded red bracts, with *Cyathia* just visible.

At this time, the root ball was scored for vigour, using a scale of 1 to 5 as for the plant vigour scores. Subsequently (after the sciarid fly emergence counts were finished), the root balls were taken back to the laboratory, dried at 50°C for 48 hours, and dry root ball weights calculated.

Sciarid fly counts.

After harvesting plants for foliage weight, each replicate of 4 pots (20 pots per treatment) was placed in a polystyrene emergence cage. A bridge of wire mesh was then erected over the top of the cage, and a yellow sticky trap (10cm x 20cm) tied horizontally over the pots. The whole cage was then covered with fine mesh muslin to make a seal. Emerging sciarid flies became caught on the traps, and were counted after a period of 2-3 weeks incubation to allow the majority of flies to emerge. For a picture of the cage apparatus, see Colour Plates in the Appendix. Flies were counted by removing the sticky trap and examining closely with a hand lens. Shore flies (*Scatella stagnalis*) were also caught on the traps, but were not counted in this project.

Statistical analysis.

Analysis of variance was carried out on the following:

a. Counts of sciarid larvae on each assessment date.

b. Counts of adult sciarid flies on sticky traps.

c. Fresh weight of foliage and dry root ball weights.

Visual scores for crop vigour or root ball vigour were not analysed.

RESULTS

Fuchsia

Assessments for the trial with fuchsias are shown in Tables 2-6.

Table 2 shows the results of Sciarid larval counts made weekly between 06/05/00 and 08/06/00.

Table 2. Mean numbers of sciarid larvae per pot; potato half monitoring method.

Treatment		Mean number of larvae per pot						Overall
		6/05	11/05	17/05	25/05	02/06	08/06	Mean
1.	Untreated	4.2	13.2	19.6	6.4	20.4	19.2	13.8
2.	Intercept 5GR plug only	3.2	7.4	20.8	9.4	14.0	21.2	12.7
3.	Intercept 5GR plug & pot	0	1.6	8.8	4.0	4.8	11.0	5.0
4.	Intercept 5GR pot only	0.2	3.4	10.0	1.8	7.2	9.6	5.4
5.	suSCon Indigo plug only	1.2	7.6	11.2	6.6	15.2	17.4	9.9
6.	suSCon Indigo plug and pot	0.0	1.4	7.2	3.2	5.8	17.0	5.8
7.	suSCon Indigo pot only	0.0	1.8	2.8	2.0	1.0	11.0	3.1
8.	Fipronil plug only	1.6	12.8	33.8	7.2	9.4	20.6	14.2
9.	Fipronil plug and pot	0.8	12.8	20.4	14.6	19.6	15.6	14.0
10.	Fipronil pot only	0.0	5.9	12.0	14.4	17.6	20.0	11.7
11.	Spinosad drench	1.4	7.8	19.8	1.8	22.6	36.2	14.9
12.	Nemasys plug and pot	0.2	11.4	23.2	20.0	29.4	7.8	15.3
13.	Nemasys plug only	0.8	10.4	17.2	4.8	17.8	30.6	13.6
14.	*Hypoaspis* plug and pot	0.2	0.6	5.2	0.0	0.2	0.2	1.1
15.	*Hypoaspis* plug only	0.2	4.0	8.4	5.4	11.0	11.4	6.7
S.E.D.		0.99	4.93	5.79	4.86	5.82	7.86	------

The potato monitoring method generally worked well, although there were occasional problems with potatoes being accidentally dislodged, or becoming infected with bacterial soft rot. Detailed laboratory work has indicated that potato monitoring traps around 60-70% of the total larval population in a pot (Bedford, pers.com), so the counts are not an absolute measure of the larval population, but rather a measure of their relative abundance.

Numbers of larvae tended to build up rapidly from the first assessment on 6th May. Where only the plug had been treated with Intercept 5GR or suSCon Indigo 10G granules, there was little reduction in mean numbers of larvae compared with untreated pots. This was expected, since

the small volume of plug compost (approximately 35mls) contained a limited amount of active ingredient. Imidacloprid (Intercept 5GR) has systemic activity, while chlorpyrifos (suSCon Indigo 10G) is relatively immobile in compost and neither product would be likely to affect sciarid larvae in the surrounding compost in this situation. Where Intercept 5GR or suSCon Indigo 10G granules were incorporated into both plug and final pot, there was a reduction in sciarid larvae compared to untreated pots. This was also true where the granules had been incorporated only into the final pot (i.e. the plug was untreated).

The new insecticide Fipronil (as a 0.1% granule) is at present being evaluated by PSD for Approval in the UK. All combinations of this insecticide had little or no effect on numbers of sciarid larvae in this trial. Spinosad, also undergoing approval evaluation by the PSD, applied as a drench, gave little or no control of sciarid larvae numbers.

Nematodes (*Steinernema feltiae* as Nemasys) were ineffective in this trial. By contrast, *Hypoaspis* predators when applied both during the plug stage (two applications) and potting on stage (three applications) gave excellent control of sciarid fly larvae, and was an effective treatment. During the assessments, mites were often seen moving about on the compost surface. When *Hypoaspis* was only applied during the plug stage, control was less.

Table 3 shows the results of the fresh foliage weight assessments, obtained by cutting plants off at compost level and immediately weighing the foliage.

Table 3. Mean foliage weight of fuchsias (variety Display) in the trial.

Treatment		Mean Foliage Weight (g)
1.	Untreated	243.4
2.	Intercept 5GR plug only	212.5
3.	Intercept 5GR plug & pot	225.2
4.	Intercept 5GR pot only	240.8
5.	suSCon Indigo 10G plug only	201.1 *
6.	suSCon Indigo 10G plug and pot	152.0 *
7.	suSCon Indigo 10G pot only	129.6 *
8.	Fipronil plug only	229.6
9.	Fipronil plug and pot	231.9
10.	Fipronil pot only	205.0
11.	Spinosad drench	230.5
12.	Nemasys plug and pot	240.3
13.	Nemasys plug only	222.8
14.	*Hypoaspis* plug and pot	293.4
15.	*Hypoaspis* plug only	220.6
S.E.D.		24.8

* Repeat tests with suSCon Indigo 10G and Fuchsia (variety Display) showed no detrimental effects on foliage weight. Please see Table 7.

There was little correlation between the estimated level of sciarid larvae populations and fresh foliage weights. Where suSCon Indigo 10G granules had been used in both plug and pot, or pot only, foliage weights were significantly ($P < 0.05$) lower than for untreated pots. ***This dramatic result lead to queries on the methodology and repeat tests with suSCon Indigo 10G and Fuchsia (variety Display) showed no detrimental effects on plant weight (see Table 7).*** The most effective treatment (*Hypoaspis* applied to plug and pot) did however show an increase in fresh foliage weight over untreated pots, although this just failed to reach significance at the 5% level.

Table 4 shows the results of Root Vigour Scores, carried out at the same time as foliage weights were calculated.

Table 4. Mean Root Vigour Scores (1-5 scale where 1 = poor root and 5 = excellent.

Treatment		Mean Root Vigour Score
1.	Untreated	2.9
2.	Intercept 5GR plug only	2.8
3.	Intercept 5GR plug & pot	2.6
4.	Intercept 5GR pot only	2.7
5.	suSCon Indigo 10G plug only	2.8
6.	suSCon Indigo 10G plug and pot	2.2
7.	suSCon Indigo 10G pot only	2.0
8.	Fipronil plug only	2.9
9.	Fipronil plug and pot	2.8
10.	Fipronil pot only	2.8
11.	Spinosad drench	2.8
12.	Nemasys plug and pot	2.8
13.	Nemasys plug only	2.8
14.	*Hypoaspis* plug and pot	3.1
15.	*Hypoaspis* plug only	2.5

Only the *Hypoaspis* treatment (to plug and pot) increased the mean score of root vigour in this assessment.

Table 5 shows the mean numbers of adult sciarid flies caught on sticky traps inside emergence cages. The counts can be regarded as a good indicator of the total numbers of flies per treatment, as the traps were left in position long enough for the majority of flies to emerge and become caught.

Table 5. Mean numbers of Sciarid flies per cage.

Treatment		Mean number of flies per cage
1.	Untreated	54.4
2.	Intercept 5GR plug only	65.4
3.	Intercept 5GR plug & pot	22.0
4.	Intercept 5GR pot only	30.0
5.	suSCon Indigo 10G plug only	75.6
6.	suSCon Indigo 10G plug and pot	24.0
7.	suSCon Indigo 10G pot only	20.2
8.	Fipronil plug only	79.6
9.	Fipronil plug and pot	97.4
10.	Fipronil pot only	88.2
11.	Spinosad drench	86.6
12.	Nemasys plug and pot	103.4
13.	Nemasys plug only	68.8
14.	*Hypoaspis* plug and pot	8.8
15.	*Hypoaspis* plug only	86.8
S.E.D.		18.6

Traps from plants treated with *Hypoaspis* in both plug and pot stage generally looked clean, with just a few sciarid flies, whereas traps from some other treatments were densely covered in flies. See Colour Plates in the Appendix for details. *Hypoaspis* in plug and pot continued as in previous assessments (Tables 2 to 4) to be the most effective treatment; numbers of sciarid flies were significantly lower ($P<0.05$) than untreated plants.

Where both plug and pot had been treated with Intercept 5GR or suSCon Indigo 10G, the number of flies was reduced compared to untreated pots, and also compared to plug treatment alone, but the differences were not significant.

Fipronil granules, or drenches of Spinosad or Nemasys, did not reduce the number of sciarid flies emerging.

Table 6 shows the mean dry root ball weights of fuchsias (cultivar Display), after drying in the laboratory at ADAS Rosemaund.

Table 6. Mean dry root weights (g).

Treatment		Mean dry root weight (g)
1.	Untreated	366.2
2.	Intercept 5GR plug only	361.0
3.	Intercept 5GR plug & pot	433.2
4.	Intercept 5GR pot only	458.4
5.	suSCon Indigo 10G plug only	362.5
6.	suSCon Indigo 10G plug and pot	448.9
7.	suSCon Indigo 10G pot only	415.9
8.	Fipronil plug only	372.9
9.	Fipronil plug and pot	309.0
10.	Fipronil pot only	345.9
11.	Spinosad drench	361.3
12.	Nemasys plug and pot	375.0
13.	Nemasys plug only	415.2
14.	*Hypoaspis* plug and pot	523.4
15.	*Hypoaspis* plug only	446.5
S.E.D.		18.7

These figures show that, where Intercept 5GR or suSCon Indigo 10G granules were incorporated only into the plug, there was no significant difference in root weight from untreated pots. Where the granules had been incorporated into both plug and pot, or pot alone, root ball weights were significantly increased ($P < 0.05$), treatments 3, 4, 6 and 7. Fipronil granular treatments tended to reduce mean root ball weight, and where both plug and pot had been treated, the root ball weight was significantly reduced ($P < 0.05$). The most effective treatment against sciarid fly was *Hypoaspis* applied to both plug and pot giving a highly significant increase in root ball weight.

The incorporation of suSCon Indigo 10G in both plug and pot (treatments 6 and 7) had the most marked reduction in foliage weight. (Table 3). In order to check this result, a repeat trial was carried out using the same variety of fuchsia (cultivar Display), and only three treatments, untreated, Susan Indigo at the label rate of 500g/m^3, and twice the label rate i.e., 1000g/m^3.

The trial was set up in the same glasshouse as the first trial, but the cuttings were rooted in mid summer (July) and potted up in 1 litre pots using Sinclair peat based media on 11th August 2000.

There were 10 replicates of each treatment arranged in a randomised block design on the greenhouse bench. Crop vigour scores were made on 07/09/00 and 26/09/00. Subsequently the plants were cut off at compost level and fresh foliage weights calculated.

Table 7 shows the crop vigour scores, made using a scale of 1-5 where 1 = very poor and 5 = excellent, and also the fresh foliage weight in g.

Table 7. Crop vigour scores and fresh foliage weight in the repeat fuchsia trial.

Treatment	Mean Crop Vigour Scores		Mean Fresh Foliage Weight (g)
	07/09	26/09	
Untreated	3.7	3.7	71.8
suSCon Indigo 10G (500g)	3.6	3.6	77.3
suSCon Indigo 10G (1000g)	3.1	3.3	63.4
S.E.D.	----	----	8.8

The crop vigour scores, made twice during the growing on phase, showed that there were no visual differences between untreated fuchsias and those with the label rate of suSCon Indigo 10G incorporated. Where twice the label rate had been used, a slight reduction in crop vigour was noted. This was seen as a decrease in height and plant vigour, and persisted through the life of the plants. Fresh foliage weights confirmed these visual assessments; the double rate of suSCon Indigo 10G had the lowest foliage weight, although the differences were not significant at the 5% probability level.

In the original fuchsia trial, foliage weights were significantly ($P < 0.05$) decreased when suSCon Indigo 10G was incorporated into the final pot at the label rate. It is likely, given the severity of the effects, that a mistake was made with the original calculation when mixing the suSCon Indigo 10G, and a higher than label rate was incorporated into the media. This would account for the effects on plant growth seen. The repeat trial, using the label rate of 500g/m^3 showed no such effect and was carried out under similar conditions to the first trial. ***This confirms experience from commercial use of suSCon Indigo 10G, where adverse reactions in terms of crop growth has <u>not</u> been noted.***

Poinsettia

Assessments for the second trial, using Poinsettias (variety Sonora) are shown in Tables 8 - 14. This trial used exactly the same treatments, and was carried out in the same manner as the Fuchsia trial. However, the plug was different (a paper pot as opposed to a loose-fill plug) and the growing media was a coarse compost designed specifically for Poinsettias (Bulrush poinsettia medium), rather than fine peat media (Sinclair pot plant medium) used for the fuchsia trial.

Table 8 shows the results of the potato half monitoring method for sciarid fly larvae. Because the growing period for poinsettias was much longer than for the fuchsias, the total number of these assessments was greater. The poinsettia cuttings were potted up in early August and reached market specification in mid November.

Table 8. Mean numbers of sciarid larvae per pot: Poinsettia.

Treatment		Mean number of larvae per pot						Overall
		15/08	21/08	29/08	05/09	13/09	18/09	Mean
1.	Untreated	3.6	12.4	2.8	7.4	14.8	19.4	10.1
2.	Intercept 5GR plug only	1.4	4.2	1.8	5.2	11.6	11.8	6.0
3.	Intercept 5GR plug & pot	0.2	3.8	7.2	7.6	32.6	11.0	10.4
4.	Intercept 5GR pot only	1.2	8.2	5.8	6.0	19.1	13.6	8.9
5.	suSCon Indigo 10G plug only	2.8	12.0	2.2	13.0	27.2	22.4	13.3
6.	suSCon Indigo 10G plug and pot	1.4	4.4	12.4	11.6	23.2	10.6	10.6
7.	suSCon Indigo 10G pot only	1.6	2.8	8.4	12.8	21.6	19.8	11.2
8.	Fipronil plug only	1.0	8.0	3.4	16.2	40.4	36.6	17.6
9.	Fipronil plug and pot	2.6	5.0	2.2	15.6	32.4	23.4	13.5
10.	Fipronil pot only	0.8	8.2	2.2	20.2	38.4	39.4	18.2
11.	Spinosad drench	1.8	8.6	11.8	13.0	25.6	13.6	12.4
12.	Nemasys plug and pot	0.2	1.0	1.4	15.6	20.8	12.0	8.5
13.	Nemasys plug only	1.2	0.6	17.2	16.8	22.0	7.0	10.8
14.	*Hypoaspis* plug and pot	0.0	0.2	0.0	0.0	0.0	0.0	0.0
15.	*Hypoaspis* plug only	0.0	1.2	4.8	6.2	5.4	0.8	3.1
S.E.D.		1.1	2.3	2.9	5.0	7.7	8.2	------

The assessments of sciarid larvae from potato halves gave variable results in the poinsettia trial. No consistent reduction in numbers of larvae was seen in the Intercept 5GR or suSCon Indigo 10G treated pots. All the pots treated with Fipronil granules had higher mean numbers of larvae than untreated pots. As in the previous trial with fuchsias, the treatment with *Hypoaspis* predators at both plug and potting stages was outstanding in terms of larval control. At each assessment, mites could easily be seen on the compost surface and this was the case even at the final assessment on 18/09/00. The poinsettia compost was designed to be very free draining and open, and this may have helped the movement of these mites.

The poinsettia trial was scored for crop vigour using the normal scale of 1 to 5 on 26/09/00, when the bracts had just started to expand, but were not red. This was carried out with the help of the Project Co-ordinator, Mr Andrew Fuller, and the grower, Mr Rob Caithness, who added their commercial experience to the scoring process. (A colour plate of the foliar and root growth of plants scored from 1-5 is shown in the Appendix for reference). Table 9 shows the results of this assessment.

Table 9. Crop vigour scores for poinsettia.

Scale used: 1 to 5 where 1 = very poor and 5 = excellent. Scored on plant height, vigour and branching.

Treatment		**Mean crop vigour score**
1.	Untreated	2.3
2.	Intercept 5GR plug only	3.4
3.	Intercept 5GR plug & pot	4.0
4.	Intercept 5GR pot only	4.0
5.	suSCon Indigo 10G plug only	3.1
6.	suSCon Indigo 10G plug and pot	4.3
7.	suSCon Indigo 10G pot only	4.0
8.	Fipronil plug only	2.5
9.	Fipronil plug and pot	2.8
10.	Fipronil pot only	2.9
11.	Spinosad drench	4.0
12.	Nemasys plug and pot	3.9
13.	Nemasys plug only	3.5
14.	*Hypoaspis* plug and pot	4.6
15.	*Hypoaspis* plug only	4.3

The visual scores showed that poinsettias untreated for sciarid fly were the least vigorous. Treatment of the plug with granules of Intercept 5GR or suSCon Indigo 10G did give an increase in crop vigour score, but the most marked visual improvement was in plants where both plug and pot, or pot alone, had been treated.

Poinsettias treated with Fipronil granules did not score highly for crop vigour; this seems to correlate with the lack of control of sciarid larvae by this product.

The best treatment was again *Hypoaspis* applied to plug and pot (Treatment 14), which follows the trend seen in the earlier fuchsia trial. This crop vigour assessment was followed by an assessment of marketability, carried out on 17/11/00 by nursery staff, when the crop had fully expanded red bracts and was ready for marketing. The results are shown in Table 10.

Table 10. Commercial marketability of poinsettias (% plants grade I where n=20).

Treatment		**% Grade I**
1.	Untreated	45
2.	Intercept 5GR plug only	90
3.	Intercept 5GR plug & pot	95
4.	Intercept 5GR pot only	85
5.	suSCon Indigo 10G plug only	60
6.	suSCon Indigo 10G plug and pot	100
7.	suSCon Indigo 10G pot only	85
8.	Fipronil plug only	95
9.	Fipronil plug and pot	90
10.	Fipronil pot only	90
11.	Spinosad drench	100
12.	Nemasys plug and pot	95
13.	Nemasys plug only	60
14.	*Hypoaspis* plug and pot	100
15.	*Hypoaspis* plug only	95

This assessment, which was carried out by senior nursery staff, correlated more or less with the crop vigour scores, and showed the value of sciarid fly controls in poinsettia. Only 45% of untreated plants were considered Grade I marketable. Treatment of the plug only with Intercept 5GR granules was very effective in increasing % Grade I plants, but suSCon Indigo 10G in the plug only was less effective. However, when both plug and pot were treated with these granular

insecticides the % Grade I was improved to 95% or more. Interestingly, while the fipronil treated plants had been assigned poorer crop vigour scores, the percentage of plants reaching Class I was 90 to 95%.

At harvest, all the poinsettias were cut off at compost level, and fresh foliage weights recorded. The results are shown in Table 11.

Table 11. Fresh foliage weights of poinsettia (variety Sonora).

Treatment		**Mean foliage weight (g)**
1.	Untreated	99.0
2.	Intercept 5GR plug only	103.7
3.	Intercept 5GR plug & pot	109.6
4.	Intercept 5GR pot only	102.6
5.	suSCon Indigo 10G plug only	89.9
6.	suSCon Indigo 10G plug and pot	103.8
7.	suSCon Indigo 10G pot only	106.1
8.	Fipronil plug only	91.5
9.	Fipronil plug and pot	96.0
10.	Fipronil pot only	98.3
11.	Spinosad drench	108.3
12.	Nemasys plug and pot	111.8
13.	Nemasys plug only	96.8
14.	*Hypoaspis* plug and pot	133.0
15.	*Hypoaspis* plug only	118.0
S.E.D.		5.7

Within the pesticide treatments, differences were not significant at the 5% probability level. The treatment with *Hypoaspis* predators at both plug and potting stages was again the best treatment, giving a highly significant increase in foliage weight.

Table 12 shows the Root Vigour Scores, carried out at the same time as foliage weights were assessed. The same scale of 1-5 was used as for the fuchsia trials.

Table 12. Mean root vigour scores.

Treatment		Mean root vigour score
1.	Untreated	3.26
2.	Intercept 5GR plug only	3.74
3.	Intercept 5GR plug & pot	3.88
4.	Intercept 5GR pot only	3.64
5.	suSCon Indigo 10G plug only	3.68
6.	suSCon Indigo 10G plug and pot	3.74
7.	suSCon Indigo 10G pot only	3.86
8.	Fipronil plug only	3.18
9.	Fipronil plug and pot	3.18
10.	Fipronil pot only	3.22
11.	Spinosad drench	3.74
12.	Nemasys plug and pot	3.78
13.	Nemasys plug only	3.32
14.	*Hypoaspis* plug and pot	4.26
15.	*Hypoaspis* plug only	3.78

These scores followed a similar pattern to the crop vigour data, and showed an improvement in root vigour where sciarid fly had been controlled. As in previous assessments, the root vigour in pots treated with *Hypoaspis* in plug and final pot was outstanding, and was the highest recorded in this trial.

Table 13 shows the mean number of flies caught on yellow sticky traps, which were placed over individual replicates of poinsettias once the foliage had been removed. (The cages used and sticky traps in place are shown in the colour plates in Appendix 1).

Table 13. Mean number of sciarid flies per trap.

Treatment		**Mean number of flies per trap**
1.	Untreated	10.4
2.	Intercept 5GR plug only	5.0
3.	Intercept 5GR plug & pot	5.8
4.	Intercept 5GR pot only	4.8
5.	suSCon Indigo 10G plug only	9.0
6.	suSCon Indigo 10G plug and pot	8.8
7.	suSCon Indigo 10G pot only	9.6
8.	Fipronil plug only	5.6
9.	Fipronil plug and pot	5.2
10.	Fipronil pot only	6.8
11.	Spinosad drench	2.4
12.	Nemasys plug and pot	4.2
13.	Nemasys plug only	1.8
14.	*Hypoaspis* plug and pot	15.6
15.	*Hypoaspis* plug only	4.8
S.E.D.		3.74

The results of trap counts were surprising, there were no significant differences between mean numbers of sciarid flies emerging from the untreated pots and any of the treatments. The reasons for this are unclear.

Table 14 shows the final assessment carried out on poinsettias. This was root ball dry weight.

Table 14. Dry root ball weights of poinsettias.

Treatment		Mean root ball weight (g)
1.	Untreated	681.3
2.	Intercept 5GR plug only	777.7
3.	Intercept 5GR plug & pot	758.0
4.	Intercept 5 GR pot only	765.0
5.	suSCon Indigo 10G plug only	723.5
6.	suSCon Indigo 10G plug and pot	713.7
7.	suSCon Indigo 10G pot only	703.5
8.	Fipronil plug only	770.4
9.	Fipronil plug and pot	724.5
10.	Fipronil pot only	755.6
11.	Spinosad drench	771.0
12.	Nemasys plug and pot	774.2
13.	Nemasys plug only	702.9
14.	*Hypoaspis* plug and pot	800.9
15.	*Hypoaspis* plug only	726.5
S.E.D.		28.8

These results showed that Intercept 5GR, incorporated into the plug, plug and pot, or pot alone, gave a significant increase in dry root ball weight over untreated pots. suSCon Indigo 10G treatment also increased root ball weights, but the increases were not statistically different at the 5% probability level. Again, the treatment with the highest root ball weight was the *Hypoaspis* treatment to both plug and pot.

Costs of the various treatments.

These costs have been calculated after discussion with the nurseries hosting the trials, to ensure that data on plant spacing, etc., was accurate.

Costs of sciarid fly control in propagation.

It is important to remember that the propagators would bear this cost, and it is very unlikely that they would be able to charge customers extra for treating the cuttings against fly. However, if the propagating company wished to reduce plant losses, and promote their plants as having protection against sciarid fly, this could be an effective marketing strategy. The results from PC 147 showed clearly that % losses from sciarid fly larval damage could be reduced by incorporation of insecticide granules into the plug compost.

Costings for sciarid fly control in propagation *

a) Intercept 5GR @ 280g/m^3 = £10.00 per 28,000 plugs

b) suSCon Indigo 10G @ 500g/m^3 = £8.75 per 28,000 plugs

c). Nemasys @ 0.5 x 10^6/m^3 = 16.3p/m^2 (184 plugs) = £24.80 per 28,000 plugs

d) *Hypoaspis* @ 250/m^2 = 16.0p/m^2 (184 plugs) = £24.35 per 28,000 plugs

* Assuming a plug or paper pot of approximately 35ml volume, a cubic metre of compost produces about 28,000 plugs.

Costings for sciarid control in the final pot #

Assuming a final plant spacing of 8 plants per m2 for fuchsia or poinsettia grown in 13cm (1 litre) pots.

a). Intercept 5GR @ 280gm/m^3 = 1p per pot.

b). suSCon Indigo 10G @ 500g/m^3 = 0.9p per pot.

c). Nemasys @ 0.5 x 10^6/m^2 = 2p per pot. Three applications of nematodes made in the trial = 6p per pot in total.

d). *Hypoaspis* @ 250m^2 = 2p per pot. Three applications of *Hypoaspis* made in the trial = 6p per pot in total.

Safety of Insecticide treatments of Beneficial Insects used in Biocontrol.

Treatment of the plug with either Intercept 5GR or suSCon Indigo 10G granules is unlikely to adversely affect beneficial organisms such as *Encarsia* parasites or *Amblyseius* or *Hypoaspis* predatory mites, because the volume of compost in the plug is small compared to the final pot (approx 35ml plug in 1000ml compost), and the plug would tend to be planted below the compost surface. Several of the biological control companies, including Koppert, Syngenta Bioline and BCP, were consulted before drawing this conclusion. However, safety to beneficial organisms cannot be guaranteed without trials work (carried out to EPPO/IOBC standards) to prove safety.

When both plug and pot have Intercept 5GR granules incorporated, there would be no point in using Encarsia parasites, as whitefly would be well controlled. However, growers might want to use *Amblyseius* predatory mites to control Western Flower Thrips or *Phytoseiulus* mites to control two-spotted spider mite.

In the Koppert side-effect list, drench applications of Intercept are classified as Harmless to both beneficials, so a combination of Intercept 5GR and the above would be possible in an IPM programme.

If a drench of Intercept was safe, then incorporated granular treatments would be likely to also be safe in an IPM programme.

There is little information regarding the safety of suSCon Indigo 10G to beneficials, but growers may well consider using *Encarsia* and/or *Amblyseius* in an IPM programme when this product has been incorporated into the compost. The active ingredient, chlorpyrifos, is stable in compost and has no systemic activity, so foliar pests such as whitefly are not controlled. If only the plug was treated with suSCon Indigo 10G, any effect on beneficials used in the final pot would be minimal, but no such guarantee can be given if the final pot was treated. Detailed trials work on the safety of this product to *Encarsia*, *Amblyseius* and *Phytoseiulus* is needed to establish compatibility with this insecticide.

There is no information available regarding the effects of Fipronil on beneficial organisms at present. Once the product is Approved in the UK, there may be a need for work to evaluate this.

Spinosad is under consideration by PSD for Approval in the UK as a foliar spray for control of thrips and leaf miners. The environmental profile of this product is excellent. Data from Dow Agrosciences has been obtained that show Spinosad is safe to predatory mites, but parasitic *Hymenoptera* such as *Encarsia* and *Aphidius* are sensitive to spray applications. The foliar residues degrade rapidly however, and parasites can be safely introduced within 1-2 weeks. (Miles and Dutton, 2000).

Discussion

These trials have shown that the response of plants to sciarid fly attack is dependent upon the species of plant. Fuchsias tolerated high numbers of sciarid fly larvae when established, but the response to control of the pest was generally seen in a significant increase in root ball weights rather than fresh foliage weight. Therefore control of this pest on fuchsia may not result in obviously improved plant quality. The shelf life may be improved, but this aspect was not tested.

Poinsettias are very susceptible, both to damage from sciarid fly larvae feeding on the roots, and to a reduction in quality and % marketability of the finished plant when larvae are not controlled. Treatment of the plug or paper pot alone with insecticide granules is worthwhile in poinsettias. Previous HDC funded work (PC 147) showed that % losses were reduced and sciarid control was excellent when the plugs were protected with Intercept 5GR or suSCon Indigo 10G.

This project has shown that a further improvement in quality and % marketability of poinsettias can be gained if both plug and pot are treated with either Intercept 5GR or suSCon Indigo 10G. The costs for pot treatment are 1.0p and 0.9p per pot, respectively, but against this has to be offset the increase in % marketability and improvement in sciarid fly control, compared with treating the plug alone. If costs are a limiting factor in poinsettia (or fuchsia) production, then treatment of the plug alone is the most cost-effective option, and this cost is likely to be borne entirely by the propagator.

If the aim is to produce top quality poinsettias, then treatment of both plug and pot is likely to be worthwhile. The reduced risk of losses from pathogens such as *Pythium* and *Phytopthora* due to sciarid control are also likely to be important, but are difficult to quantify.

Fuchsias are less likely to give a cost-effective return from insecticide granules in the plug and final pot, but again there are other considerations to be made. Some finished fuchsias or other plants are sleeved; if sciarid flies emerge they can be caught in the sleeve and cause problems with buyer rejection.

Throughout both the fuchsia and the poinsettia trials, the most successful treatment was the application of *Hypoaspis* predatory mites to both plug and final pot. The results in terms of sciarid fly control and plant quality were consistently highest in this project. The rate of *Hypoaspis* used (approximately 250 mites/m^2 on 3 occasions) was, however, expensive at 6p per litre pot. Many growers use *Hypoaspis* on a routine basis, but often at a low rate which may not always give good results.

There was no scope in this project for evaluating a range of rates of *Hypoaspis* but in future this would be worthwhile, to determine if the rates could be lowered without affecting sciarid control or plant quality.

The drench treatments used in the trials (Spinosad and the nematode *Steinernema feltiae*) did not give the best sciarid control. It is probable that they did not persist for long enough in the compost to provide long term control. However, the poor results with Nemasys were a surprise as in previous work and in commercial usage, results have generally been good. Drenches are time consuming to apply, especially to the final pot, and the cost of application must be added to the cost of the product in order to reach a total grower cost.

Hypoaspis predators are relatively easy to apply, as they are just shaken over the compost surface. Even with this technique, there is room for improvement, especially for large numbers of pots. A mechanical dispenser of some type could be the answer, but no work on such methods for *Hypoaspis* have been reported. Dispensers are available for *Amblyseius*, and they may be capable of being adapted. The persistence of *Hypoaspis*, and its ability to survive for extended periods even in the absence of prey (Chambers et al, 1993) are crucial to its success in these trials, and in commercial usage.

Conclusions.

1. There is a direct relationship between numbers of sciarid fly larvae and plant quality measured as % marketability of poinsettias. Since sciarids are a potential problem on most nurseries growing this crop, detailed attention should be given to control measures.

2. The relationship between levels of sciarid fly and plant quality of fuchsias is not as defined, but in some circumstances high levels of sciarid larvae can decrease root weights.

3. Incorporation of insecticide granules, such as Intercept 5GR or suSCon Indigo 10G into the plug gives an improvement in plant quality, but does not give the best control of sciarids.

4. Incorporation of insecticide granules into the plug and pot gives a further improvement in plant quality of poinsettia, and better sciarid control overall.

5. *Hypoaspis* predatory mites when applied at both the plug stage (i.e., while rooting) and after potting, gave the best overall control of sciarid fly and the best plant quality with both fuchsia and poinsettia. There may be scope to reduce the rate of *Hypoaspis* and therefore the cost, but further work is needed to confirm this.

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