Project Title	Hardy nursery stock: Evaluation of alternatives to aldicarb (Temik) for the control and management of leaf and bud nematodes
Project number:	HNS 131
Project leader:	Jude Bennison, ADAS
Report:	Final report, October 2007
Previous reports	First annual report, August 2005 Second annual report, August 2006
Key staff:	Jude Bennison, ADAS, Study Director Heather Maher, ADAS, Site Manager
Location of project:	ADAS Boxworth
Project coordinator:	John Adlam, Dove Associates
Date project commenced:	1 July 2004
Date project completed:	October 2007
Key words:	Leaf and bud nematode, *Aphelenchoides ritzemabosi*, *Aphelenchoides fragariae*, *Anemone japonica*, *Weigelia*, aldicarb, Temik 10G, abamectin, Dynamec, oxamyl, Vydate 10G, fatty acids, Savona, alginate polysaccharide, Agri-50E, garlic, *Steinernema carpocapsae*.

The results and conclusions in this report are based on a series of experiments conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION FOR HNS 131

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

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TABLE OF CONTENTS

GROWER SUMMARY

Headline

- With the imminent withdrawal of Temik 10G from use on 31 December 2007, Vydate 10G (oxamyl) has been identified as a potential cost-effective replacement on both herbaceous and woody HNS host plants.

Background and expected deliverables

Leaf and bud nematodes, *Aphelenchoides* sp., are common, persistent and damaging pests of a range of economically significant nursery stock plants including *Anemone japonica* (Japanese anemone), *Buddleia*, *Viburnum* and *Weigela*. Control currently depends on the use of Temik 10G (aldicarb) nematicide granules, which will be withdrawn from use in the UK on 31 December 2007. An alternative control measure is urgently needed and this was identified as a critical gap in the HDC Pesticide Gap Analysis (CP 17). A previous HDC-funded ADAS project (HNS 86) demonstrated that abamectin (Dynamec) could give useful suppression of the pest, but control was not as persistent or as robust as that given by Temik. The current project aims to build on knowledge and experience gained in project HNS 86, to evaluate alternatives to Temik for control of leaf and bud nematodes. The treatments to be tested in the project were selected by the HNS Panel, from a list of potential treatments given in the proposal.

The overall expected deliverables of the project were:

- Evaluation of alternative control measures to Temik.
- Provision of practical guidelines to growers on the control and management of leaf and bud nematodes in HNS before the withdrawal of Temik in 2007.

Summary of the project and main conclusions

In year 1 of the project, in a replicated pot experiment on Japanese anemone at ADAS Boxworth, Temik 10G (aldicarb) gave excellent and persistent control of leaf and bud nematodes. Foliar applications of Dynamec (abamectin), Savona (fatty acids), Agri-50E (alginate polysaccharide) and garlic did not control the pest. No suitable alternative treatments to Temik were identified to take forward into a trial on a commercial nursery.

In year 2 of the project, the replicated pot experiment was repeated on Japanese anemone, using plants at an earlier stage of infestation. The Dynamec treatments were included as in the year 1 experiment, and Vydate 10G (oxamyl) and an experimental product were tested as additional treatments. The experimental product was ineffective and as in year 1, Dynamec did not control the pest. Vydate 10G gave significant reduction of leaf and bud nematodes, although control was not as effective as that given by Temik 10G on the final two assessment dates, 34 and 48 days after treatment.

In year 3, the replicated pot experiment was repeated on *Weigela* to determine whether the systemic activity of Vydate 10G is as effective on a woody plant host as on the herbaceous host. Foliar sprays of 'Nemagold' (extracts of *Tagetes* and seaweed) and the entomopathogenic nematodes, *Steinernema carpocapsae* were also tested as additional treatments.

Therefore the aims of year 3 were to:

1. Test candidate alternatives to Temik 10G against leaf and bud nematodes on *Weigela*.

2. Provide practical guidelines to growers on control and management of leaf and bud nematodes in HNS, before the withdrawal of Temik on 31 December 2007.

Summary and conclusions from the whole project:

- Temik 10G and Vydate 10G gave excellent and persistent control of leaf and bud nematodes on both Japanese anemone and *Weigela*.

- The control given by Temik 10G was significantly better than that given by Vydate 10G on both Japanese anemone and *Weigela*. On the final assessment dates on Japanese anemone and *Weigela*, Temik 10G reduced numbers of nematodes from several hundred per g of leaf in untreated controls, to one and 0.3 per g of leaf respectively, whereas Vydate reduced numbers to 15 and nine per g of leaf respectively.

- Repeated foliar applications of Dynamec, garlic, Savona, Agri-50E, Nemagold, *Steinernema carpocapsae* and an experimental product did not reduce numbers of leaf and bud nematodes.

- Vydate 10G, applied at 55 kg/ha was the only candidate product that controlled leaf and bud nematodes in the three replicated pot experiments in this project. With the imminent withdrawal of Temik 10G from use in December 2007, Vydate 10G has been identified in this project as a potential replacement.

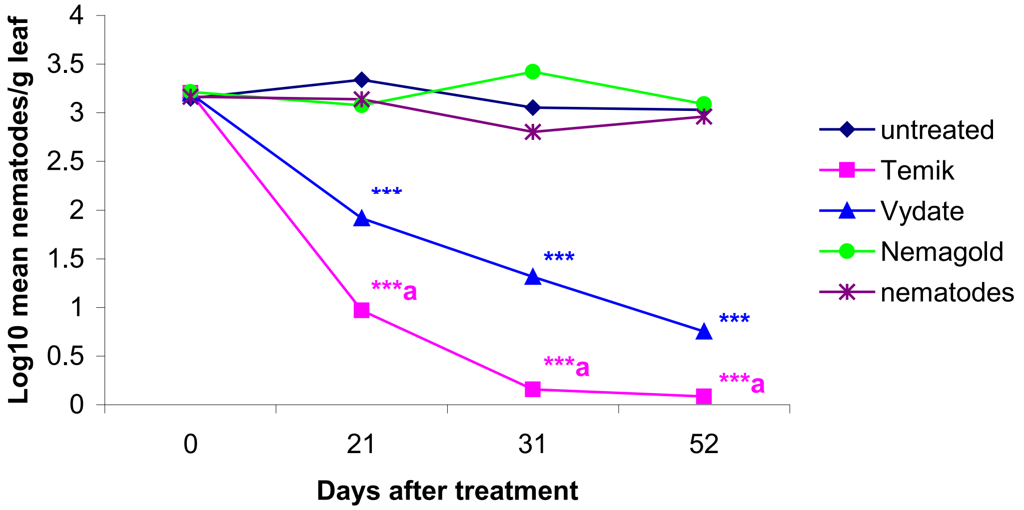

*Figure 1. Log_{10} mean numbers of leaf and bud nematodes per g leaf tissue at day 0, 21, 31 and 52 days after first treatment (*** significantly lower than in untreated controls; a Temik significantly lower than Vydate)*

Financial benefits

- The results of the project have demonstrated that Vydate 10G is an effective alternative to Temik 10G for the control of leaf and bud nematodes in both herbaceous and woody HNS hosts.
- The results will ensure that HNS growers can continue to control the pest, thus reducing commercial losses.
- Current retail prices of Vydate 10G and Temik 10G are approximately £64 and £135 per 10 kg. One application of Vydate 10G, at the rate used in this project (55 kg/ha) would cost the grower £352 per ha, whereas one application of Temik (at 80 kg/ha, the maximum SOLA rate for outdoor HNS) would cost £1,080 per ha.

Action points for growers

- The Specific Off-Label Approval (SOLA) for use of Temik 10G for control of leaf and bud nematodes (SOLA 1932/2000) will be revoked on 31 December 2007 and must not be used after this date.

- Vydate 10G can currently be used on both protected and outdoor ornamentals at grower's own risk, using SOLA 0020/93 (which is for control of alien leaf miner species).

- Vydate 10G can also be used on outdoor ornamentals using the Long Term Arrangements for Extension of Use (LTAEU), as it is approved for the control of soil and root-dwelling nematodes on outdoor field crops e.g. potato.

- HDC have been consulted on the need to issue a SOLA for the control of leaf and bud nematodes on protected and outdoor ornamentals, to include details of application methods and recommended rates per individual pot of varying sizes, as given on SOLA 1932/2000 for Temik 10G, which will be revoked on 31 December 2007.

- Despite the results of HDC project HNS 86, in which Dynamec gave suppression of leaf and bud nematodes, this pesticide did not control leaf and bud nematodes on Japanese anemone in years 1 and 2 of this project. There is no label recommendation for use of Dynamec for leaf and bud nematodes and any use of Dynamec against this pest is at grower's own risk.

- Cultural control methods remain an important component of the management of leaf and bud nematodes:
    - As the pest is commonly spread during plant propagation, growers should use cultural control methods including avoiding using infested stock plants, using hot water treatment of stock plants, or using root propagation where appropriate.
    - The pest can spread on infested plants and from plant to plant in films of water on the plant surface or in water splash, so holding plants under protection, spacing plants out and the use of capillary irrigation rather than overhead watering can minimise spread.

    - The pest can survive in a desiccated state in dry plant debris for several years, so strict nursery hygiene is an important cultural control component.

- The pest is unlikely to survive for more than four months in soil, in the absence of a host plant. However, many common weed species, e.g. chickweed and groundsel can be alternative hosts, so weed control should be maintained on previously infested ground.

SCIENCE SECTION

Introduction

Leaf and bud nematodes, *Aphelenchoides* sp., are common, persistent and damaging pests of a range of economically significant nursery stock plants including *Anemone japonica*, *Buddleia*, *Viburnum* and *Weigela* (Young, 1996). Control currently depends on the use of Temik 10G (aldicarb) nematicide granules, which will be withdrawn from use in the UK on 31 December 2007. An alternative control measure is urgently needed and this was identified as a critical gap in the HDC Pesticide Gap Analysis (CP 17). A previous HDC-funded ADAS project (HNS 86) demonstrated that abamectin (Dynamec) could give useful suppression of the pest, but control was not as persistent or as robust as that given by Temik (Young, 2000). The current project aims to build on knowledge and experience gained in project HNS 86, to evaluate alternatives to Temik for control of leaf and bud nematodes. The treatments to be tested in the project were selected by the HNS Panel, from a list of potential treatments given in the proposal.

The overall objectives of the project were to evaluate alternative control measures to Temik, and to give practical guidelines to growers on control and management of leaf and bud nematodes in HNS before the withdrawal of Temik in 2007.

In year 1 of the project, in a replicated pot experiment on Japanese anemone at ADAS Boxworth, Temik 10G (aldicarb) gave excellent and persistent control of leaf and bud nematodes. Foliar applications of Dynamec (abamectin), Savona (fatty acids), Agri-50E (alginate polysaccharide) and garlic did not control the pest. No suitable alternative treatments to Temik were identified to take forward into a trial on a commercial nursery.

In year 2 of the project, the replicated pot experiment was repeated on Japanese anemone, using plants at an earlier stage of infestation. The Dynamec treatments were included as in the year 1 experiment, and Vydate 10G (oxamyl) and an experimental product were tested as additional treatments. The experimental product was ineffective and as in year 1, Dynamec did not control the pest. Vydate 10G gave significant reduction of leaf and bud nematodes, although control was not as effective as that given by Temik 10G on the final two assessment dates, 34 and 48 days after treatment.

Work in year 3 of the experiment aimed to repeat the replicated pot experiment on *Weigela*, to determine whether the systemic activity of Vydate 10G is as effective on a woody plant host as on the herbaceous host, Japanese anemone, and to test three additional candidate treatments.

Candidate treatments

Vydate

Oxamyl (Vydate 10G) is a carbamate nematicide with known efficacy against leaf and bud nematodes, and was relied on for control of the pests in the USA until 1995, when it was withdrawn from the market (Jagdale & Grewal, 2002). Like Temik 10G it has systemic activity. Vydate 10G is currently approved in the UK for control of soil and root-dwelling nematodes on outdoor field crops, and it also has Specific Off-label Approval (SOLA 0020/93) for control of alien leaf miner species on both outdoor and protected ornamentals. Oxamyl has achieved Annex 1 listing in EU Directive 91/414, so the approvals for use of Vydate 10G should continue.

The suppliers of Vydate 10G were contacted to discuss which dose rate to use in the experiment in this project. Vydate 10G may be used at maximum rates of 55 kg/ha on outdoor ornamentals and 110 kg/ha on protected ornamentals, using SOLA 0020/93, which is recommended for control of alien leaf miners. The suppliers of Vydate 10G advised that 55 kg/ha should be sufficient for use as a nematicide (this is the label recommended rate for use against soil-dwelling nematodes on outdoor crops e.g. potato, and a lower rate, 35 kg/ha, is given on SOLA 0925/94 for control of stem nematodes on protected garlic).

Nemagold

Nemagold is a liquid extract of marigold (*Tagetes erecta*), seaweed and ‘organic matter’, marketed in Spain and certain other countries as an organic drench to be applied to the soil through the irrigation system. The product is not available in the UK. Nemagold is marketed as a biostimulant, but also for repelling and controlling soil-dwelling nematodes including cyst nematodes, root-knot nematodes and free-living nematodes. The product leaflet claims both contact and systemic effects against nematodes. However, correspondence with the supplier (Atlanta Agricola) confirmed that only local systemic activity and control of nematodes inside root tissue is claimed, (Sergio Aguilar, personal communication). The supplier has not tested the product to detemine whether it has full systemic activity, moving up to the leaves from the roots. Nor has the supplier tested the product as a foliar spray against leaf and bud nematodes.

Entomopathogenic nematodes

Entomopathogenic nematodes (EPNs), *Steinernema* spp. are currently used in the UK for biological control of various pests e.g. vine weevil, sciarid flies and thrips. The nematodes carry symbiotic bacteria which are released inside the insect gut once the nematodes have entered the insect host's body. It is the bacteria that kill the host, rather than the nematodes themselves. Although EPNs are unlikely to be able to penetrate other nematodes as they do with larger pests, the bacteria have been shown to act as a biological nematicide if released in water or soil containing nematodes. Research has been done in the UK on the use of bacteria from EPNs for the control of various pests including root-knot nematodes (Tabin *et al*, 2003) and this research is still in progress at Reading University and at other research institutes (Simon Gowen, personal communication). Recent work at Ohio State University, by the same research group that evaluated disinfectants against foliar nematodes (Grewal & Jagdale, 2002), has shown that bacteria from the same EPNs is highly toxic to leaf and bud nematodes. Although EPNs are available in the UK, use of the isolated symbiotic bacteria as a biopesticide is not currently approved. However, foliar sprays of the nematodes may lead to release of the bacteria or their metabolites on the leaf surface, either when the EPNs die, or if they invade and kill an alternative host which then dies, either in the compost or in leaves or buds (other research in the USA has shown that soil applications of either live or dead EPNs can lead to suppression of root lesion nematode populations, La Mondai *et al.*, 2000). A supplier of entomopathogenic nematodes in the UK (Becker Underwood) suggested using *Steinernema carpocapsae* in the experiment in this project.

Jet 5

Peroxyacetic acid (Jet 5) is widely used as a disinfectant in UK protected horticultural crops, to clean floors and benches etc between crops for control of disease pathogens. The same disinfectant (trade name ZeroTol) has been shown in the USA to have good activity against the leaf nematode *Aphelenchoides fragariae* (Jagdale & Grewal, 2002). This work showed that the disinfectant killed 100% of the nematodes within 48 hours in water suspension laboratory tests, and when used as a foliar spray on Hosta, it gave 73% reduction in nematode numbers 48 days after treatment, with no evidence of phytotoxicity. Jet 5 was also tested by ADAS against the stem nematode, *Ditylenchus dipsaci* for the bulb industry in HDC project BOF 49 (Lole, 2001). This in vitro laboratory work showed that 75% of the nematodes were killed within one hour.

Materials and methods

Experiment location and plant material

The work was done in a shade tunnel at ADAS Boxworth, Cambridge. The plants used for the experiment were *Weigelia* that were obtained from a commercial nursery and were naturally infested with leaf and bud nematodes.

Experiment design

The work was done as a randomised complete block design with five replicates of each of the six treatments. The sixth treatment (Jet 5) was not provided by the supplier until day 31 of the experiment and was therefore too late to be included. This sixth treatment was thus used as an additional untreated control. There were twelve plants in each plot, all plants having similar numbers of leaves with symptoms of leaf and bud nematode infestation. The twelve plants in each plot were contained in a plastic pallet with raised feet, so that any run-off of Temik or Vydate from treated compost during irrigation periods did not contaminate any pots in adjacent plots. When applying treatments as foliar sprays, a spray shield was used in the paths between the pallets to prevent the risk of cross-contamination between plots during application. The pallets were stood on woven groundcover matting on the floor of the shade tunnel. Treatment dose rates and application timings are given in Table 1.

Table 1. Experimental treatments, product dose rates and dates of application.

Code	Treatment	Product dose rate	Application timing
1	Untreated	-	-
2	Temik 10G	10% w/w granules at 80 kg/ha	24/7/07
3	Vydate 10G	10% w/w granules at 55 kg/ha	24/7/07
4	Nemagold	15 l/ha	24/7/07, 7/8/07, 21/8/07
5	*Steinernema carpocapsae*	500 million per 1000m^2	24/7/07, 31/7/07, 7/8/07, 14/8/07
6	Untreated	-	-

Treatment application methods

Nemagold and *Steinernema carpocapsae* were applied with a knapsack sprayer as foliar sprays to just before run-off in 1,000 litres water per ha. Temik was applied in accordance with Specific Off-Label Approval (SOLA) 1932/2000, by sprinkling the granules onto the compost followed by watering in to before run-off. Vydate was applied using the same method as used for Temik, at the 55 kg/ha rate given on SOLA 0020/93, which is the maximum rate for use on outdoor ornamentals.

Treatment timings

Nemagold was applied as a 3-spray programme (days 0, 14 and 28). The entomopathogenic nematodes, *Steinernema carpocapsae*, were applied as a 5-spray programme (days 0, 7, 14, 21 and 28). Temik and Vydate were applied as a single treatment (day 0).

Irrigation

Plants were watered overhead three times per day, in the morning, afternoon and early evening, using an automatic sprinkler. The plants were not irrigated for 24 hours after the foliar treatment sprays had been applied.

Assessments

Nematode infestations were assessed on four occasions:

1. Pre-treatment (day 0, 24 July 07)
2. 21 days after first treatment date (14 August 2007)
3. 31 days after first treatment date (24 August 2007)
4. 52 days after first treatment date (14 September 2007)

Assessment methods

At each assessment date, one leaf was sampled from each of eight plants (selected from the 12 plants) per plot. Leaves of similar size and showing similar damage symptoms were selected from the same location on each plant. The eight leaves from each plot were combined, weighed and chopped into evenly sized pieces. The chopped leaves from each plot were placed into beakers containing 600 ml of fresh tap water. The water in each beaker was aerated for 72 hours using air stones connected to aquarium pumps. The nematodes were then collected by pouring the suspension through a 43 micron sieve. Numbers of live nematodes were counted in a Doncaster dish under a low-power microscope. If nematode numbers were too high to count accurately the suspension was sub-sampled and diluted as appropriate.

Temperature records

Temperatures inside the shade tunnel were recorded for the duration of the experiment using a Tinytalk ® datalogger, placed inside an empty plant pot.

Statistical analysis

Mean numbers of nematodes per plot were converted to mean numbers per gram of leaf tissue before analysis. The raw data were subjected to a $\log_{10}$ transformation prior to doing an Analysis of Variance (ANOVA).

Results

Control of leaf and bud nematodes

The transformed ($\log_{10}$) mean numbers of leaf and bud nematodes per gram of leaf tissue at each assessment date are given in Figure 1. The transformed ($\log_{10}$) and back-transformed (i.e. transformed back to the original scale) data are given in Table 2. Untransformed means (of original raw data) are given in Table 3 in Appendix I.

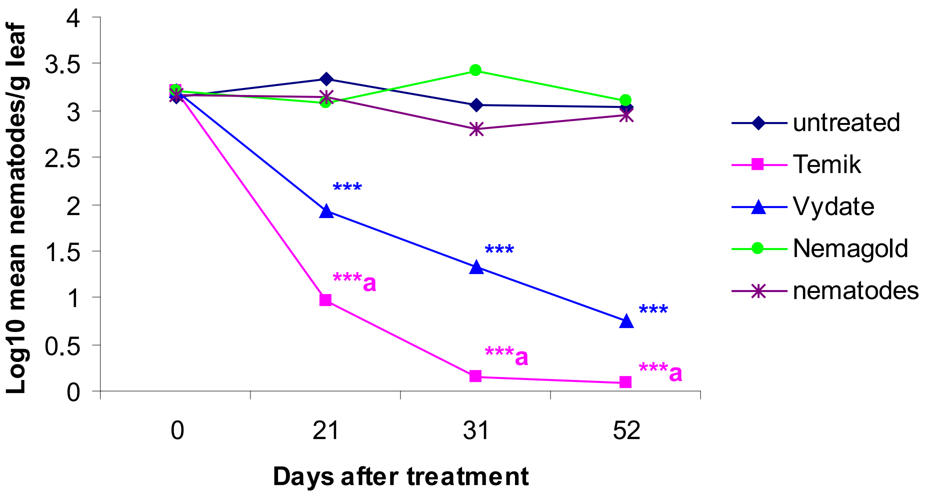

Figure 1. Log_{10} mean numbers of leaf and bud nematodes per g leaf tissue at day 0, 21, 31 and 52 days after first treatment. *** significantly lower than in untreated controls; a = Temik significantly lower than Vydate.

Table 2. Transformed ($\log_{10}$) mean numbers of leaf and bud nematodes per g leaf tissue at day 0 (pre-treatment) and 21, 31 and 52 days after treatment (back-transformed means are shown in brackets below the transformed means). ** significantly different from untreated controls, *P*<0.01. *** significantly different from untreated controls, *P*<0.001; a = Temik significantly different from Vydate, *P*<0.05

Treatment	Day 0 (pre-treatment)	Day 21	Day 31	Day 52
Untreated	3.15 (1411.5)	3.34 (2186.8)	3.05 (1131.4)	3.03 (1070.5)
Temik 10G	3.21 (1602.3)	0.97***a (8.3)	0.16***a (0.4)	0.09***a (0.2)
Vydate 10G	3.20 (1580.3)	1.92 (81.6)	1.32 (19.7)	0.75 (4.7)
Nemagold	3.21 (1635.8)	3.08 (1195.7)	3.42 (2629.3)	3.09 (1232.1)
Steinernema carpocapsae	3.16 (1457.8)	3.14 (1376.2)	2.80 (634.3)	2.96 (911.0)
SED for transformed data	0.14 min.rep 0.12 max-min	0.22 min.rep 0.19 max-min	0.25 min.rep 0.21 max-min	0.27 min.rep 0.24 max-min
Degrees of freedom (df)	(21 df)	(21 df)	(21 df)	(21df)

Temperature records

Temperatures during the experimental period are shown in Figure 2.

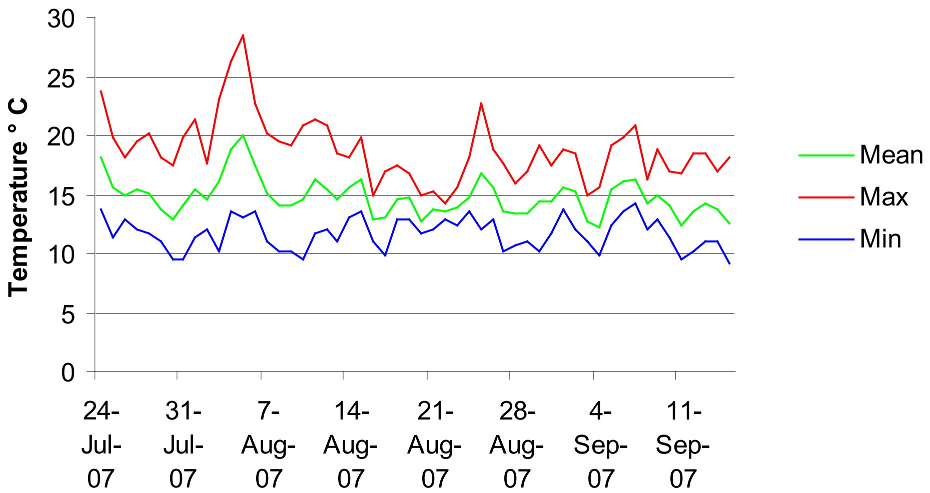

Figure 2. Mean, maximum and minimum temperatures in shade tunnel during the experiment.

Discussion

Mean numbers of nematodes per gram of leaf tissue were high in all plots at the start of the experiment, ranging from 1529 to 1826 per g of leaf (untransformed data, Table 3, Appendix I). These numbers were higher than those on Japanese anemone in the years 1 and 2 experiments (Bennison, 2005 and 2006).

There was no significant difference between pre-treatment infestation levels. On all three assessment dates (21, 31 and 52 days after the first treatments had been applied), both Temik 10G and Vydate 10G had significantly reduced numbers of nematodes ($P<0.001$), see Table 2 and Figure 1. On all three assessment dates, Temik gave significantly better reduction of nematodes than Vydate ($P<0.05$) and this result was similar to those in the year 2 experiment on Japanese anemone. At the final assessment, 52 days after treatment, Temik 10G and Vydate 10G had reduced numbers of nematodes from over 1,500 per g of leaf in untreated controls, to a mean of 0.3 and nine per g of leaf respectively (untransformed data, Table 3, Appendix I). These results with Temik 10G were similar to those given in the years 1 and 2 experiments on Japanese anemone, when numbers of nematodes were reduced to 0.5 and 1 per g of leaf, 55 and 48 days after treatment respectively. Vydate 10G was not included in the year 1 experiment, but in the year 2 experiment on Japanese anemone, the product gave similar control as in this experiment on *Weigela*, reducing numbers of nematodes to 15 per g of leaf, 48 days after treatment.

Vydate 10G can currently be used on both protected and outdoor ornamentals, using SOLA 0020/93, which is recommended for control of alien leaf miners. Vydate 10G can also be used on outdoor ornamentals using the Long Term Arrangements for Extension of Use (LTAEU), as the product is approved for use on outdoor field crops e.g. potato, for control of soil and root-dwelling nematodes. However, HDC will be consulted regarding issuing a SOLA for the control of leaf and bud nematodes on protected and outdoor ornamentals, to include details of application methods and recommended rates per individual pot of varying sizes, as given on SOLA 1932/2000 for Temik 10G, which will be revoked on 31 December 2007.

Nemagold did not give effective control of nematodes at any assessment date (Figure 2 and Table 1). This result confirms that although the product claims to control soil-dwelling nematodes when applied as a soil drench, it does not control leaf and bud nematodes in plant tissue when applied as foliar sprays.

The entomopathogenic nematodes, *Steinernema carpocapsae* did not give control of leaf and bud nematodes at any assessment date (Figure 2 and Table 1). Temperatures in the shade tunnel remained within the activity range of *S. carpocapsae* (12-32°C) for the majority of the experimental period (Figure 2).

Jet 5 was provided by the supplier too late to be included in the experiment. Recent results in HDC-funded project, HNS 147, showed that a similar product to Jet 5, peroxyacetic acid plus silver (Geosil) was ineffective against leaf and bud nematodes when detached infested leaves of Japanese anemone or *Weigela* were immersed in the product for one hour (Lole, 2007).

Conclusions

Conclusions from work in years 1, 2 and 3 of the project are summarized below:

- Temik 10G and Vydate 10G gave excellent and persistent control of leaf and bud nematodes on both Japanese anemone and *Weigela*.
- The control given by Temik 10G was significantly better than that given by Vydate 10G on both Japanese anemone and *Weigela*. On the final assessment dates on Japanese anemone and *Weigela*, Temik 10G reduced numbers of nematodes from several hundred per g of leaf in untreated controls, to one and 0.3 per g of leaf respectively, whereas Vydate reduced numbers to 15 and nine per g of leaf respectively.
- Repeated foliar applications of Dynamec, garlic, Savona, Agri-50E, Nemagold, *Steinernema carpocapsae* and an experimental product did not reduce numbers of leaf and bud nematodes.
- Vydate 10G was the only candidate product that controlled leaf and bud nematodes in the three replicated pot experiments in this project. With the imminent withdrawal of Temik 10G from use in December 2007, Vydate 10G has been identified in this project as a potential cost-effective replacement.

Technology Transfer

Technology Transfer activities in years 1, 2 and 3 of the project are given below:

- Jude Bennison discussed the aims of the project in a presentation on IPM on UK hardy nursery stock, at the IOBC conference 'IPM in glasshouse crops' in

Finland, April 2005.

- Jude Bennison discussed the results of the project to date with HNS growers and ADAS horticultural consultants and suppliers of the experimental treatments, throughout the life of the project.
- Jude Bennison summarised the results of the project to date in HDC News articles, November 2005 and January 2007.
- An article is planned for HDC News in autumn 2007, giving practical guidelines to growers on control and management of leaf and bud nematodes in HNS, before the withdrawal of Temik 10G on 31 December 2007.

Acknowledgements

Thanks to the following for supplying materials free of charge for the year 3 experiment in 2007:

- All HNS growers who kindly supplied *Weigela* plants.
- Bayer Crop Science for supplying the Temik 10G.
- DuPont (UK) Ltd for supplying the Vydate 10G.
- Becker Underwood for supplying the *Steinernema carpocapsae*.
- Atlanta Agricola (Spain) for supplying the Nemagold.

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Appendix I

Table 3. Untransformed mean numbers of leaf and bud nematodes per g leaf tissue at day 0 (pre-treatment) and 21, 31 and 52 days after treatment.

Treatment	Day 0 (pre-treatment)	Day 21	Day 31	Day 52
Untreated	1529	3194	1398	1595
Temik 10G	1701	9	0.6	0.3
Vydate 10G	1610	97	23	9
Nemagold	1826	1335	2964	1382
Steinernema carpocapsae	1742	2213	1193	1222

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