Grower Summary

HNS 185

Understanding and managing crop protection through Integrated Crop Management

Final 2012

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Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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Headline

- Survey results indicate HNS growers should not have difficulty demonstrating compliance with Sustainable Use Directive (SUD) requirements
- There is potential to increase the level of ICM and further reduce use of pesticides without loss of plant quality

Background

Integrated Crop Management (ICM) combines the use of non-chemical and reduced or alternative chemical pesticide practices for the effective management of pests, diseases and weeds. Specifically, it comprises:

- The use of cultural control measures, notably good crop husbandry
- Regular monitoring and reporting of problems and awareness of pest / disease thresholds
- Prompt follow-up actions following monitoring
- A preference for and adoption of non-chemical control measures where possible
- Specific and targeted use of pesticides (where possible)
- Avoiding routine chemical programmes that may lead to pest or disease resistance
- Promoting and adopting the use of lower risk plant protection products (where risk relates to their likely safety for humans and the environment), where possible.
- Regularly reviewing and appraising the success – or otherwise - of ICM programmes and implementing corrective actions promptly as necessary

The nursery stock industry in the UK has adopted ICM to varying degrees and this project has sought to clarify the situation in terms of broader industry uptake. The EC Directive on the Sustainable Use of Pesticides (SUD) requires adoption of general principles by all professional users by 1 January 2014, determination of the current level of adoption of available ICM measures and any research and development and knowledge transfer activities still required. There is a need to combine current best industry practice with research information, so that HNS growers are better able to adopt and develop ICM as their first option for long term sustainable crop protection.

The main purpose of the work was to help the industry understand and manage crop protection and plan for the future. The overall aims were as follows:

- To assess and critically review the current use of ICM by the UK Hardy Nursery Stock (HNS) sector.
- To identify the potential for wider uptake to enable producers to develop and adopt practical, economically-viable ICM practices to replace, reduce or remove the use of pesticides, particularly those pesticides which are at a higher risk of being lost to the industry.

The specific objectives were:

1. To establish the current extent of use of ICM and determine the strengths and weaknesses of available strategies and identify gaps in current ICM programmes for HNS.

2. To identify, list and assess the feasibility and practicality of current ICM practices.

3. To briefly describe the potential impact on HNS growers from ongoing changes to plant protection product legislation and the implementation of the EC Sustainable Use Directive (SUD).

4. To provide guidance on the ICM practices required to improve – or at least maintain at present levels - production efficiency in an environmentally sustainable way.

5. To create a publication for the HNS sector on practical, cost-effective ICM practices currently available and guidance on how to adopt them.

Summary

Current use of ICM on UK nurseries

All 30 respondents to a postal questionnaire and telephone survey of UK HNS growers in spring 2011 were using Integrated Crop Management (ICM). The extent of use reported by growers ranged from 7-68% of potential measures identified as applicable to the main crop on their nursery (assuming the usual range of problems for that crop occur). A third of growers were using at least 50% of potential measures relevant to their main crops. The importance of well-informed staff, good growing conditions, hygiene measures and regular monitoring were recognised as key to the successful implementation of ICM.

Notable biological control successes reported were strategies available for vine weevil, slugs and caterpillars, with biocontrol methods for sciarid flies reported as moderate to good. Biological control of aphids, thrips and two-spotted spider mite (TSSM) was reported as less reliable, giving mostly moderate control only. Integration of pesticides was thus usually needed for these pests and this allowed good control within the ICM programmes. Biological control of whitefly control was reported as unreliable, with several growers obtaining only moderate or poor control. Training and on-site guidance in best practice for use of biological control agents were noted as being required.

Good *Botrytis* control by Serenade ASO (*Bacillus subtilis* QST 713) and powdery mildew by potassium bicarbonate was reported. No biological control products were available in 2011 for many diseases (e.g. downy mildew, leaf spots). Nurseries were selecting a range of chemical fungicides for particular diseases and obtaining good control. Herbicides were universally effective, with Ronstar G (oxadiazon) and Flexidor 125 (isoxaben) use dominating. Although a few growers had instead managed to achieve control using bark toppings on pots, there is a lack of alternatives for weed control on container plants.

Feasibility and practicality of current ICM practices

A total of 47 measures were identified as current ICM practices on HNS. Measures were considered for their feasibility for use on individual crop types, their practicality, efficiency (effort : reward ratio) and success.

The number of measures feasible for each crop type, grouped according to problem type and strategy, are shown in Table 1. The main ICM strategies for pests were monitoring (five measures) and use of biological control agents (nine measures); the main strategies available for diseases were crop husbandry (11 measures), (micro) biological products (three measures) and hygiene (six measures). Options identified for ICM of weeds were very limited (two measures only). The 47 individual measures and their likely current feasibility are shown in the matrix in the Science section of the report (Table 6.1).

The overall practicality of the 47 measures for protected containers is shown in Table 2 using a 1-5 index where 1 = inefficient in action; high effort, low reward and 5 = very efficient in action; low effort, high reward. Measures considered most practical (index 4 or 5) for pest control were the use of biocontrols and monitoring; measures considered most practical for disease control were growing media selection, environment control and removal of infected material. In outdoor crops, some environmental control measures are not possible, but there

is increasing importance of electronically monitored irrigation and the use of weather records and forecasting for pest and disease prediction.

Table 1: Number of current ICM practices available and relevant for growers to use on different HNS crop types (F = field, C=container grown), grouped according to pest type and strategy – March 2012.

	Number of ICM practices available:							
	Pests			**Diseases**				**Weeds**
Crop type	**Monitoring**	**Biocontrol**	**Other**	**Husbandry**	**Biological products**	**Hygiene**	**Other**	**Any**
Alpines	5	7	3	10	2	6	4	2
Aquatics	2	0	1	5	2	6	4	2
Climbers	5	9	3	9	2	6	4	2
Conifers	5	3	3	10	2	6	4	2
Edible (herbs)	5	9	3	11	3	6	4	2
Heathers	3	3	3	10	3	6	4	2
Hedging (CG)	5	1	2	8	2	6	5	2
Hedging (FG)	3	0	2	8	2	6	3	2
Herbaceous	5	9	3	9	2	6	4	2
Roses (CG)	4	6	3	9	3	6	5	2
Roses (FG)	2	0	2	8	3	6	3	2
Shrubs	5	9	3	11	3	6	4	2
Trees (CG)	3	1	2	10	3	6	5	2
Trees (FG)	3	0	2	8	3	6	3	2
Ceanothus	4	5	2	10	3	6	4	2
Choisya	4	5	2	10	3	6	4	2
Clematis	4	8	3	9	2	6	4	2
Cordyline / Phormium	2	4	2	10	3	6	4	2
Hebe	4	2	3	10	3	6	4	2
Photinia	4	6	3	9	2	6	4	2
Lavender	4	4	3	10	3	6	4	2
Total number identified	5	9	4	11	3	6	5	2

There is increased grower uptake of biological control methods for pests on outdoor containerised HNS in Denmark and in soft fruit crops in the UK. There is scope for much wider uptake on outdoor HNS in the UK.

Table 2: Overall practicality rating of current ICM practices from the survey for pest, disease and weed control on HNS in protected containers (1 = inefficient in action; high effort, low reward; 5 = very efficient in action; low effort, high reward)

Pest control	**Rating**	**Disease control**	**Rating**	**Disease control contd.**	**Rating**
Monitoring by:		Husbandry:		Hygiene:	
Sticky traps	4	Growing media selection	5	Sweeping	4
Pheromone traps	3	Clean seed, cuttings etc	4	Covered disposal	4
Plant inspection	5	Cleaned water	4	Pressure-washing	4
Indicator plants	2	Sub or drip -irrigation	3	Removal of infected material	5
Quarantine areas	3	Electronic water monitoring	4	Disinfection of beds etc.	3
Biocontrols for:		Spot watering	4	Sterilise pots/trays	3
Aphids	5	Irrigation scheduling	4		
Caterpillars	5	Crop grouping by water need	4	**Weed control**	
Leaf miners	5	Spacing	4	Nursery weed clearing/hygiene	4
Sciarid fly	5	Diagnostic kits	3	Biofumigants	1
Slugs/snails	5	Environment control	5		
TSSM	5	Products:			
Vine weevil	5	Bio-stimulants	3		
Western flower thrips	5	Bio-pesticides	4		
Other:		Microbial products	2		
Crop rotation	2	Other:			
Selective pesticides	4	Weather records/forecasts	4		
Pot toppers/mulches	4	Disease forecasting	2		
Banker plants	2	Water sampling	3		
		Water baiting	3		

Note – The ratings shown are an overall assessment and can be expected to vary with crop type, nursery growing practices and pest or disease pressure.

Impact of changing pesticide legislation and the SUD on HNS growers

The availability of pesticides for use on HNS crops is reducing due to:

- Failure of products to make Annex 1 listing on re-registrations under 91/414/EEC;
- The introduction of a new EU regulation for pesticide approvals: the Plant Protection Products Regulation 1107/2009, with new hazard criteria;
- Implementation of the Water Framework Directive (WFD);
- Implementation of the Sustainable Use Directive (SUD);

- Gradual loss of the Long Term Arrangements for Extensions of USE (LTAEU) as individual products are assessed for Specific Off Label Approvals (SOLAs) and more recently Extension of Authorisation for Minor Use (EAMUs);
- Application of re-entry intervals following pesticide use in glasshouse crops;
- Commercial decisions by agrochemical / marketing companies.

At the same time, new pesticides and biopesticides are being introduced to the UK market, some with label or EAMU approvals for use on HNS crops. As the changing pesticide legislation and implementation of the SUD and WFD are taking place over a number of years, and because the future introduction and withdrawal of products for commercial reasons is unknown, any impact assessment is only valid at the time it is done.

An assessment in December 2011 identified which of the products named in the questionnaire as being currently used on nurseries had a final use date before 31 December 2015. These comprised 10 insecticides/acaricides, 11 fungicides and six herbicides. Key losses (identified by having a high score for current grower usage) include the pesticides Calypso (thiacloprid) and Hallmark (lambda-cyhalothrin), the fungicides Bravo 500 (chlorothalonil), Rovral WG (iprodione), Filex (propamocarb hydrochloride) and Fubol Gold WG (mancozeb + metalaxyl-M) and the herbicide Roundup (glyphosate). However, bifenthrin is harmful to biological control agents and thus does not represent a major loss to growers using full ICM programmes. The identification of suitable ICM-compatible replacement products and the securing of on-label or EAMU approvals for them are required.

An examination of regulations within the SUD alongside information on current industry practice gained in this project indicates that UK HNS growers should have no difficulty demonstrating compliance.

Guidance on ICM practices to maintain/improve production efficiency in an environmentally sustainable way

A wide range of specific ICM practices were identified by which growers can maintain/improve production efficiency in an environmentally sustainable way. These are listed under Action Points for Growers.

Additionally, this project identified many knowledge transfer and research and development activities that are likely to increase the uptake and level of ICM by UK HNS growers. These are listed in full in the Science section of this report and summarised below.

Key points are:

Knowledge transfer

- Demonstration sites of ICM programmes under commercial conditions including e.g. Integrated Pest Management (IPM), water cleaning, and irrigation control
- Regular workshops across the country on optimising ICM, with updates on new products and methods e.g. improved monitoring techniques
- Regional based training in ICM methods and management for various staff levels
- Crop-specific guidelines for ICM
- More factsheets e.g. on aphid control within IPM programmes
- Greater use of Smartphones for information dissemination and tips for recognition of pests, diseases and weeds

Research and development

- Improved monitoring for pests and pathogens
- Control of leaf and bud nematode, scale insects, capsid bugs and phormium mealybug
- Banker plants and parasitoid/predator dispersal
- Disease suppressive growing media
- Control of bacterial diseases
- Application of disease and pest forecasting
- Seed meals, bark mulches and growing media composition for weed and liverwort control

Financial Benefits

The prevention of pests and diseases by monitoring for early detection and avoiding conditions so as to not favour their development, will reduce plant damage, save on pesticide application and overall will maintain a higher quality crop.

The greater use of biocontrols rather than chemical pesticides will remove hazardous material from use on the nursery and prevent the need for out-of-hours application by spray operators and subsequent re-entry restriction periods.

Action Points

All action points have been assessed for their impact on improving the control of pests, diseases and/or weeds in HNS on nurseries and their importance within ICM. Whether or not

the measures could be implemented, or at least tested, immediately on nurseries has been noted, with any constraints such as the purchase of new equipment noted. Most measures require some additional work to substitute or integrate them on the nursery and the main inputs have been noted. Action points have been divided into knowledge transfer and practical measures against pests, diseases and weeds both as integrated approaches and individually. Opportunities for research and development are given in the Science section.

1) Knowledge Assimilation and Training

Impact - High

Importance - High

Timeframe for implementation – Immediate

1.1 Up-to-date pesticide information

- It is important that nurseries check the current approval status of individual products (expiry, withdrawals or use-up) on the CRD website www.pesticides.gov.uk, (or LIAISON website if a subscriber) and contact their consultant if further guidance is required.
- All the plant protection products being used on nurseries should be reviewed at least annually to ensure they are the best currently available (effective mode of action/low risk to biocontrols).
- Growers should be set up to receive weekly e-mails from the HDC as this will notify them of any new SOLAs/EAMUs and provide the document for the required downloading and on-site filing.

Constraints – None.
Additional work required – Time dedicated by grower and consultant to seek and review.

1.2 Staff training and pest and disease identification

- Ensure that all staff members are given training so they can be alert for pests and diseases and that as many as possible can identify them and know what action can be taken against them.
- Distinction between fungal, bacterial, nematode, pest feeding damage, scorch, nutrient deficiency and other causes of discolouration or necrosis is not easy and growers may need to use a plant clinic or external advisor to ensure that the correct control measures are used.

Constraints – Training takes time and may not be seen as relevant for production staff. Cost and extra work involved in sending off samples and the associated paperwork.
Additional work required – Training in-house or obtaining an external trainer/advisor. Time to collect appropriate samples of the damage for plant clinic diagnosis. Early correct diagnosis will, however, allow good control and save time on repeated treatments.

1.3 Grower sharing of knowledge on biocontrol agent deployment

- Growers who do not use biocontrol agents (BCAs) against pests should see their use on another nursery and seek more information from suppliers of the products.

Constraints – Availability of a demonstration nursery to visit with the same crop types/systems as the home nursery.
Additional work required – Arrangement with another nursery for a visit.

Impact - Medium

Importance - Medium

Timeframe for implementation – Immediate

1.4 Spray application

- The HDC distributed DVD on the use of plant protection products and application equipment should be viewed by all spray operators, those in charge of operators and site safety to refresh themselves on the techniques and management required.

Constraints – Time, opportunity and computer or DVD player and screen.
Additional work required – Viewing and discussion of DVD.

- Growers need to be aware of the benefits of DNA-based detection and quantification of pest and pathogen presence and ongoing developments in these techniques.

Constraints – Information would be best sourced at a training workshop although information on projects using this technology is available from the HDC.
Additional work required – Attendance at a workshop and ongoing updating.

2) Practical Activities on the nursery
Integrated Programmes:

Impact – High

Importance - High

Timeframe for implementation – Immediate

2.1 Monitoring for pests and diseases

- Nurseries without a monitoring procedure for bought-in stock should adopt one.
- Where possible, a quarantine area should be set aside for in-coming plants.

Constraints – Staff with the ability to pick out unhealthy plants are required and they will need extra time for detailed inspections. Some pests, diseases and weeds may not show at delivery. There may not be space to keep old and new plants apart and if plants are moved twice after delivery then this adds extra labour costs.
Additional work required – Time and staff for inspection and possibly for moving plants a second time if a quarantine area is established.

2.2 Staff training

- Production staff (including seasonal workers) moving and watering plants should also be encouraged to look out for problems and to report them.

Constraints – Lack of knowledge of staff, particularly temporary staff.
Additional work required – Staff training on arrival and at regular intervals thereafter.

2.3 Prompt and contained removal of affected material

- Removal of affected tissue/plants or spot treatment should be implemented to prevent explosions in the occurrence of pest, diseases or weeds.
- Procedures for the regular contained removal of pest, disease and weed affected material should be agreed with staff and monitored.
- Small amounts of diseased or pest infested waste should be bagged in-situ.

Constraints – Staff will need to be able to recognise problems and notify someone else or to have the authority to carry out treatment/plant disposal themselves. Provision of disposal bags.
Additional work required – Staff training and clear procedures for control actions.

2.4 Plant waste disposal

- Nurseries should review and, if necessary, make improvements to their plant waste disposal areas to ensure pests, disease and weeds are killed and/or contained.
- Where the aim is to compost plant waste, the regular management and monitoring of a series of heaps needs to be put in place.

Constraints – Alternative arrangements for disposal may need to be set up and use of an unmanaged open disposal heap cease.
Additional work required – Provision of covered disposal areas or skips and the giving of instructions to all workers on waste management.

2.5 Target setting

- Each nursery should consider the range of ICM measures that might reasonably be carried out on their crops and produce their own targets for substituting or adopting additional measures.
- Non-chemical plant protection methods including cultural and biological control should be the first course of action if effective methods are available.
- Growers should determine whether there are ICM measures they or their staff could do easily now or, could do with changes to equipment or with technical assistance, or would require major changes and the likely investments required and benefits to be gained.

Constraints – Information required on the measures available and their likely success on the crops grown at the home nursery.
Additional work required – A review of ICM measures and the seeking of advice on pest biocontrol leading to nursery tests to determine the most appropriate organisms to be used.

2.6 Managing pesticide resistance

- Growers should ensure that they are using a mixture of plant protection products with varying modes of action to reduce the chance of resistance developing.

Constraints – Knowledge of the different modes of action will need to be sought from product labels and/or websites and guidance may need to be sought on how products should be alternated.
Additional work required – Checking the modes of action of products and then the creation of spray programmes.

2.7 Managing irrigation

- Growers should investigate the use of electronic sensors for water management in their crops to save wasted water, run-off and unsuitable conditions for healthy root growth.

Constraints – Lack of information on products and their selection. While water is not too expensive the use of devices has not been a priority.
Additional work required – Sourcing information and ideally visiting a nursery with functioning monitoring. Fitting of devices and training of staff in their use.

Impact - Medium
Importance - Medium
Timeframe for implementation – Immediate

2.8 Use of less susceptible varieties

- Growers should determine whether particular species or cultivars have known

susceptibility to particular diseases and pests and try to alter selections accordingly.
- If susceptible cultivars need to be grown then they should be known to staff and given extra checks.

Constraints – Variety selection is not always possible as markets may demand a particular one.
Additional work required – Records to be kept of problem cultivars. Clients to be persuaded that an alternative line is as good/better than their normal one.

2.9 Selecting effective plant protection products

- Growers should continue to try out new plant protection products and note their effectiveness, crop safety and any possible reasons for any poor control seen in order to be able to select the most effective products.

Constraints – Time to keep records and to review them.
Additional work required – Record keeping after each pesticide application and then review of the information at the end of the year.

2.10 Managing unsold stock

- Growers should ensure that unsold stock is either consciously kept and maintained or disposed of to prevent pest, disease and weed spread to new stock.

Constraints – Time to decide which plants to dispose of and the worry that there might still be a future demand for them.
Additional work required – The unwanted plants will need to be moved or disposed of.

2.11 Testing new pest and disease monitoring technologies

- Growers should seek information on new pest and disease monitoring technologies and take time to weigh-up whether any might save them time/money on their nursery.

Constraints – Information from research projects needs to be applied to greater areas of commercial crops and so measures are likely to require periods of testing and evaluation. Investment in new monitoring equipment.
Additional work required – Ongoing interest in new developments such as HDC commissioned research. Records will need to be kept and the measures adapted to suit the cropping systems and crops on the nursery.

2.12 Learning form other crops

- Information on ICM directed at other crops should be examined by HNS growers and their consultants with a view to adoption.

Constraints – Seeking information on ICM in other crops and judgement on whether measures might be utilisable on the nursery.
Additional work required – Awareness of ICM work on other crops, possibly by requesting factsheets or annual summaries of other horticultural sectors from HDC.

2.13 Pest monitoring records

- A crop pest, disease and weed recording form should be utilised by all growers which can be printed off or used on a palm-top for use in the crop to record problems.
- Information should also be noted on the activity of any introduced or natural BCA e.g. the presence of a number of aphid mummies.

Constraints – None except agreement of all to use the same recording method.
Additional work required – Creation of the monitoring form.

2.14 Rapid on site identification

- Smartphones could be used with a magnification application. There could be a photograph of the pest/pathogen next to the magnified image to check identification.
- An "IPM Scope CAM" with a LED-lighted unit to magnify objects 3-25x on the unit display and up to 300x digitally on the computer can be purchased.
- Digital images can be e-mailed to advisors for assistance with identification.

Constraints – Not all growers have Smart phones, and Scope CAMs require funds. Compilation and verification of key pest/disease identification pictures.
Additional work required – Time to set the system up, but then time spent identifying pests and diseases may be saved compared with use of hand lenses and identification guides.

Impact – Low
Importance - Low
Timeframe for implementation – Immediate

2.15 Utilising beneficials

- Growers should consider maintaining some particular areas of crop or wild plants on site to be reservoirs of native biocontrol agents.

Constraints – Knowledge of which plants are most suitable for encouraging native predators and parasitoids but without being weed seed sources or pest hosts. Information on the area and distribution required to ensure significant pest reduction.
Additional work required – Retaining areas of crop plants or sowing wild flower mixes on waste areas or within lawns.

Practical Activities on the nursery
3) Pest control:

Impact - High
Importance – High
Timeframe for implementation – Immediate

3.1 Indicator plants for pest monitoring

- Staff awareness of the different susceptibilities of particular crops to particular pests should be increased to aid monitoring and prompt control of spread.

Constraints – Knowledge of pest host preferences and willingness to learn from observations made on nurseries.
Additional work required – Pest records (if not already done) for different crops and cultivars throughout the year. Once information is available, then staff dispersing BCAs or spot spraying will need to be trained to target their use on specific plant species/cultivars.

3.2 Improving TSSM control

- Growers using only chemicals to control TSSM should try BCAs as good control can be achieved by predatory mites.
- TSSM infestation is usually worse indoors than outside, but nurseries with outdoor infestations should consider BCA use.
- Where BCA use has not given good control, growers should examine the distribution pattern and application density of the predatory mites and determine whether this needs to be improved.

Constraints – Unfamiliarity with the use of BCAs, costs of BCAs (although savings will be

made on pesticides).
Additional work required – Determination of the best BCAs to use and when and how to use theme. Staff time will be required for BCA distribution and monitoring.

3.3 Improving aphid control

- Growers should consider using parasitoid mixtures Aphidsure or Fresa Protect against aphids, particularly if there a mixture of aphid species present, or the identity of those present is uncertain.

Constraints – None, other than growers receiving information on the products.
Additional work required – None, if single parasitoid species are currently being used.

3.4 Multiple biological control agents for improved pest control

- Growers should consider utilising more than one BCA for a pest where they are effective at different stages of the pest lifecycle or have different abilities to attack the pests and so will give complementary control.

Constraints – Unfounded concern that some BCAs may feed on others, lack of information on other BCAs and the need to re-organise the existing programme of BCA introductions.
Additional work required – Growers and consultants should consult BCA producers' websites to determine whether their current BCA purchasing should be amended.

Impact - Medium
Importance - Medium
Timeframe for implementation – Immediate

3.5 Reasons for sub-optimal control with IPM

- If biological control is not as effective on a nursery than reported from others then growers should work with their crop consultants to determine why and to carry out improvements.

Constraints – Knowledge that BCA use on the nursery could be more effective.
Additional work required – Records (if not already done) for different crop areas throughout the seasons for the use of BCAs, with further record keeping as procedures are changed. BCA companies may need to be consulted for advice.

3.6 Managing pesticide resistance

- Management of pesticide resistance (e.g. to Aphox) is improved by the use of bio-controls as this ensures that there is no selective survival of resistant aphid types.

Constraints – None other than lack of confidence in BCA effectiveness if pesticides have only been used previously. If BCA use is adopted, then care will be required in the selection of pesticides for the control of other pests as these might affect BCA survival.
Additional work required – Time required to deploy BCAs

3.7 Use of biological control agents in outdoor crops

- Growers should try out parasitoids and predators against pests in their outdoor crops during the warmer months when the activity of both pests and the control agents are most active.

Constraints – Requirement to set aside an area from pesticide application, availability of consultants, purchase of BCAs, uncertainty of rates and BCA distribution pattern.
Additional work required – Marking out a test area, monitoring of pests and BCAs.

3.8 Learning from biological control on other crops

- Information from BCA use in other crops e.g. glasshouse tomatoes can be utilised by HNS growers.

Constraints – Time to review the information and consider any differences between the crops that could affect the BCAs e.g. a smaller crop canopy in HNS.
Additional work required – Review of BCAs not already used on the nursery, monitoring of any additional/different BCA use.

Practical Activities on the nursery
4) Disease control:

Impact - High
Importance - High
Timeframe for implementation – Immediate

4.1 Reducing conditions that favour disease

- Production staff need to be aware of what environmental conditions favour disease development and to take action to ensure that temperatures, humidity and wetness are as good as possible for each crop type.

Constraints – Possible limited environment manipulation with the current structures and systems and the cost of making changes. Staff will require training on conditions which favour particular diseases. Agreement on staff responsibilities/procedures for e.g. any changing of computer settings.
Additional work required – Training courses. Agreed acceptable environmental conditions for particular crops or growing areas and action to be taken if conditions become unfavourable.

4.2 Treatment of recycled water

- Growers should beware re-using water collected from infected plants without the water being treated for plant pathogens and should install treatment methods.

Constraints – Information required on the best treatment method, finance will be needed for the treatment equipment.
Additional work required – Installation of the treatment facility.

Impact - Medium
Importance - Medium
Timeframe for implementation – Immediate

4.3 Monitoring of irrigation water for pathogens

- Leaf-baiting for *Pythium* and *Phytophthora* pathogens in irrigation water should be more widely adopted by nurseries and could be used to take the place of water sampling for laboratory testing.

Constraints – Knowledge of bait construction and placement and the use of lateral flow devices for diagnosis.
Additional work required - Training in the baiting process, deployment and retrieval of baits

4.4 Biological methods to treat recycled water

- More use should be made by growers of slow sand filters, iris or reed beds to remove pathogens from water collected from contaminated sources.

Constraints – Information required on the types of slow sand filter and/or filter beds.
Additional work required – Installation and then maintenance of the filter.

4.5 Utilising disease forecasting models

- Rose growers should try out the powdery and downy mildew disease forecasting programmes to see if they can make better timed/less frequent fungicide applications.
- Other growers should keep aware of any developments in forecasting for other crops.

Constraints – Potential worry about changing from sprays at regular intervals to spraying according to forecasted risks.
Additional work required – Information to be assimilated, purchase of humidity loggers and use of a decision support system computer programme.

Practical Activities on the nursery
5) Weed control:

Impact - Medium
Importance - Medium
Timeframe for implementation – Immediate

5.1 Growing media composition to reduce liverwort

- Growers should try the inclusion of a proportion of composted woodfibre or sterilised loam in potting mixes to aid liverwort reduction, particularly in short term crops.

Constraints – Some plants may not grow as well in mixes different from their usual mix.
Additional work required – Small-scale test batches potted and observed in comparison with the usual mix over the period of a year.

5.2 Mulches to suppress weeds

- Bark mulches should be used, particularly on larger pots, to suppress weed growth in containers and so eliminate the use of herbicides.

Constraints – Purchase of bark topping machinery or dedication of staff to hand-topping.
Additional work required – Topping with bark will add an extra process but herbicide application will not be necessary. It may be necessary to improve the roadways between the potting area and the beds, otherwise the mulch may shake out during transport.

5.3 Identifying "windows" for herbicide treatment

- Growers not currently determining herbicide programmes based on an awareness of the spray window for both the weed and crop should do so to obtain optimum control.

Constraints – Knowledge of weed biology and herbicide product activity/selectivity.
Additional work required – Information required on the activity of herbicides and yearly spray programmes will then need to be devised.

Knowledge and Technology Transfer

Presentations were given by Erika Wedgwood and John Buxton on disease and pest ICM measures at an HDC growers' meeting held at Bransford Webbs nursery on 28 July 2011.

Knowledge transfer was carried out during visits to participating nurseries as part of the process of assessing what ICM measures were in place or which had, or had not, been considered for use by the growers.