



Spray Check

A Tutorial DVD for Spray Operators Guidance Notes

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Preface

The *Spray Check* tutorial DVD covers small scale sprayers, principally hand-held knapsack and powered trolley sprayers commonly used in the production of a range of ornamental crops. It has been designed as an aid to help train less experienced spray operators and update those who are more proficient. It was not created as an alternative to City & Guilds National Proficiency Test Council (NPTC) training and certification.

The tutorial package consists of three elements:

DVD tutorial

The DVD consists of six modules (each around ten minutes in duration) covering the following key areas:

- Module 1: Introduction (Deciding to spray)
- Module 2: Regulations, record keeping and training
- Module 3: Personal protective equipment and application equipment
- Module 4: Calibration
- Module 5: Spray application
- Module 6: Post spraying

Electronic templates

A number of essential blank templates can also be accessed on the DVD including: a spray application record sheet, a storage inventory, a health and safety risk assessment sheet, a calibration calculator spreadsheet, knapsack calibration checklist and a post-spraying check list.

Guidance notes

These notes support the six training modules on the DVD providing background information and further detail. The notes also contain a useful reference section and a list of suggested questions specific to each module so that the DVD can be used as an interactive training tool with staff members.

Guidance notes

Introduction (Deciding to spray)

In many ways, the application of a pesticide should be a last resort or at least not relied upon entirely for the control of a particular pest, disease or weed problem. Certainly, there should be no blanket decision to spray and any judgement should be based on regular crop monitoring and the need for pest, disease or weed control, particularly in terms



Yellow sticky trap used for monitoring levels of flying pests within the crop

of the likely impact of such problems on crop quality. Environmental considerations and the economics of any application should also be taken into account.

Before deciding to spray, the key points to consider include:

- Has the crop problem been accurately identified, is it for example, a pest or disease capable of causing economic damage to the crop? Could it, for example, be an underlying cultural problem such as water-logging, sun scorch, winter injury or a nutritional issue? Symptoms and causes need to be understood as part of staff training and a regular programme of crop monitoring, and reporting, put in place.
- If it is a pest or disease issue, could it progress to a damaging level? Crop monitoring tools such as sticky traps, pheromone traps and indicator plants are useful for determining pest thresholds and in turn the need for control.
- Are non-target organisms such as beneficial insects at risk by spraying and is biological and / or cultural control an option instead? The use of biological control agents is an important part of integrated crop management and when implemented correctly can significantly reduce the need to spray.
- Is spraying the most cost-effective solution, given the size and value of the crop or can the problem be remedied by less costly and more sustainable measures like good crop husbandry or disposing of affected leaves or plants? Good crop husbandry including weeding, careful water management, balanced and adequate crop nutrition and good control of the growing environment should always be practiced to minimise pest populations and disease and weed pressures thereby reducing the need to spray.
- Is the spray being applied to supplement other measures in place? Spraying and the use of chemical pesticides should only be undertaken by way of support to other 'non-chemical' control measures when they are failing to provide the required level of control. Products which are the least toxic, selective in their spectrum of activity and compatible with biological control agents should always be selected first.
- Are there any environmental risks from the spray application? Is there for example a water course nearby or is the area to be sprayed close to neighbouring houses, farm crops or livestock? Again, can a safer option be used?
- If spraying is close to water courses, is a Local Environmental Risk Assessment for Pesticides (LERAP) required?
- Is the environment the crop is growing in and its impact on spray application being taken

into consideration? For example, if the crop is situated in a glasshouse or polythene tunnel, is it safe to spray in terms of temperatures and crop development stage?

- Are weather conditions suitable for spraying? Windy days or very bright, hot conditions should be avoided.
- Are there staff working in the vicinity? If so, any spray application should be deferred until the area is cleared.
- If spraying is necessary, can the problem be dealt with by spot spraying rather than blanket spraying, to reduce costs and the environmental impact of pesticide use?
- Can the spray application be undertaken automatically (for example using a low volume application machine or a gantry sprayer) rather than via a hand-held sprayer, to reduce potential operator exposure to pesticides?

Following treatment, ensure crop monitoring activities continue to determine the efficacy of the application. Based on the results of crop monitoring, a repeat spray application may be necessary, if so follow label guidance on application intervals and pesticide resistance management strategies as appropriate.

Legislative requirements

Legislation has a distinct hierarchy which encompasses Acts of Parliament, Regulations and Codes of Practice. Acts outline the broad principles of legislation; Regulations introduce more detail to implement the Act whilst practical advice on implementing the actual requirements can be found within Codes of Practice and other guidance notes.

Acts of Parliament

The use of pesticides is governed by a number of key pieces of legislation to help ensure safe, effective and environmentally responsible practice. For reference, the principal Acts of Parliament relating to pesticide use, in chronological order include:

- *The Health and Safety at Work Act (HSW) 1974*
- *The Control of Pollution Act 1974*
- *The Food and Environmental Protection Act (FEPA) 1985*
- *The Environmental Protection Act 1990*
- *The Water Resources Act (WRA) 1991*
- *The Clean Air Act 1993*
- *The Environment Act 1995*

The legislation covers most aspects of pesticide use from storage, mixing and application through to the disposal of washings and containers.

Regulations

More precise detail is provided in the numerous Regulations introduced to implement the Acts of Parliament. The principal Regulations relating to pesticide use include:

- *Control of Pesticides Regulations (COPR) 1986.* These Regulations relate specifically to the approval, supply, storage and use of pesticides and require that users take all reasonable precautions to protect the environment and in particular avoid the pollution of water. Under the Regulations, people using pesticides must be 'competent' and have received proper instruction and training; usually this is obtained by certification from the City & Guilds National Proficiency Tests Council (NPTC).
- *The Groundwater Regulations 1999.* These Regulations aim to protect groundwater from pollution by controlling the discharge or disposal of potentially harmful and polluting materials, including pesticides. They apply to the handling, storage and disposal of listed substances, including agrochemicals, solvents, hydrocarbon-based fuels and other chemicals. Under the Regulations, anyone who disposes of listed substances onto or into land is required to apply and obtain a permit from the Environment Agency to allow them to do this. Further information can be

obtained from the Environment Agency (www.environment-agency.gov.uk).

- *The Control of Substances Hazardous to Health (COSHH) Regulations 2002.* These Regulations require risk assessments to be carried out before using hazardous substances and a record of these assessments to be retained and regularly reviewed. Pesticide dusts, fertilisers, fuels, acid and cleaning materials should all be considered when carrying out a COSHH assessment.

Codes of Practice and other guidance notes

Codes of Practice provide practical advice about the on-site implementation of the detail found in Regulations. Copies of these documents should be held on-site for useful reference. Relevant Codes of Practice and other important guidance notes include:

- *Code of Practice for Using Plant Protection Products.* This Code of Practice covers the day to day use of pesticides in agriculture, horticulture, amenity and forestry. It covers in detail the areas of training and certification, planning and preparing to use pesticides, working with pesticides, disposing of pesticides and record keeping.
- *Protecting our Water, Soil and Air. A code of Good Agricultural Practice for Farmers, Growers and Land Managers.* Pesticide storage and handling



Typical cabinet type pesticide store

forms an element of this Code of Practice, aimed at avoiding pollution of the environment.

- *Local Environmental Risk Assessment for Pesticides (LERAP)*. This relates to pesticide application close to water courses and the need to enforce buffer zones to prevent pollution from spray drift. A Local Environmental Risk Assessment for Pesticides may be required depending upon the product involved and the method of application (principally, using a ground crop sprayer). A best practice guide (The LERAP Scheme – Operator Advice) can be downloaded from the website of the Voluntary Initiative (www.voluntaryinitiative.org.uk).

Pesticide storage and management

The correct storage of pesticides is essential to ensure pesticide containers are not damaged and that product efficacy is maintained for as long as possible.

Storage

A pesticide store should be:

- Suitably sited, away from watercourses and convenient for deliveries
- Secure, lockable and clearly marked with appropriate warning signs
- Of adequate capacity and able to accommodate the necessary amounts of product, particularly during peak periods of use
- Of sound construction using fire resistant materials
- Fitted with accessible non-absorbent shelving

- Dry and frost proof
- Well lit and adequately ventilated
- Capable of containing spillages and leakages
- Kept clean & tidy with a bucket of dry sand, brush and shovel readily to hand to deal with spillages.

Organisation and management

Pesticide stores should be well managed to avoid the storage of revoked pesticides, pesticides in damaged containers or unwanted pesticides. In terms of general guidance:

- Try to purchase only the required number and quantities of pesticides for use in the near future to minimise wastage and lengthy storage periods and date pesticides upon receipt.
- Where only limited quantities of a particular pesticide are used during a year, try to obtain the appropriate horticultural formulation, usually available in smaller, 1 litre or 1 kg containers, as this will also help to minimise wastage.
- Ensure pesticides are clearly labelled and displayed (alphabetically for large amounts).
- Use different areas of the store for different products (for example fungicides, insecticides and herbicides).
- Avoid temperature extremes within store and storing pesticides in direct sunlight.
- Store powders above liquids.
- Do not store fertilisers, workshop materials / tools, paperwork or spray clothing in the pesticide store.



Pesticides neatly stored on shelving within a pesticide store

- Ensure all pesticide containers (boxes, cartons, bottles) are in good condition and regularly checked.
- Where practical, store opened bags in a sealed, clearly labelled container to prevent deterioration, product breakdown or contamination.
- Ensure product labels are legible.
- Clean, puncture and store empty pesticide containers in a secure bin prior to disposal.
- Do not re-use empty pesticide containers for other purposes.
- Ensure appropriate staff members are trained in emergency procedures and have ready access to Product Safety Data Sheets and First Aid equipment.

Storage inventories

A store check should be undertaken at least annually and any relevant pesticide revocations noted so that if necessary, stock can be used up without the need for disposal.

Pesticide store records should include:

- The full product name
- The active ingredient(s)
- The approval (MAPP) number
- The amount held in store
- The date when storage commenced.

A copy of the inventory should be kept in the store and a master version in the main office, so that in the case of fire, the emergency services can be made aware of the store contents.

Spray records

An accurate and up to date record of all pesticide applications should be kept and held in the main office for future reference. The records should be clear, easy to follow, up-to-date and legible; handwritten or computerised records are acceptable.

Each record entry should be signed by the operative involved and show:

- Date and times (starting and finishing) of application
- Total hours involved
- Name of the operator who applied the product(s)
- Site and crops treated
- Reason for treatment (for example aphids, *Botrytis* etc.)
- Name and MAPP approval number of the product used
- Rate of application and water volume used, where applicable
- Total amount of product used (litres or kilograms)
- Total area treated (m² or ha)
- Prevailing weather conditions (for example wind speed and direction).

Personal protective equipment

Appropriate personal protective equipment (PPE) selection is essential to minimise the potential risk to the operator of pesticide contamination. Equipment is needed to prevent the skin coming into contact with pesticides and the inhalation of pesticide dusts, vapours and mists.



Spray operator with protective overalls, gloves, wellington boots and respirator

Guidance on selection of personal protective equipment

For horticultural spray operators, the most likely route of pesticide contamination is absorption through the skin, although fine air-borne droplets or dust could also be inhaled. Both routes of exposure should therefore be carefully assessed to ensure that effective control measures, including PPE are selected and used.

As small scale sprayers are used in different situations to apply a variety of pesticide products, the type and degree of PPE also varies. The product label will list the PPE required for tasks such as measuring out the concentrate, mixing and then applying the dilute solution and these must be followed; otherwise when deciding what PPE is required, the exposure risks involved should be

assessed and a standard of PPE used which will adequately control exposure for the duration of the job.

All protective clothing and respirators must be CE marked and conform to relevant standards.

- **Coveralls** – the choice is between lightweight disposable Type 5 or 6 coveralls supplemented with an impermeable apron when handling concentrates, and reusable Type 3 or 4 coveralls. The reusable coveralls are more expensive and may be uncomfortable under warm conditions.
- **Gloves** – unless the product label or COSHH assessment states otherwise, gloves should be nitrile rubber, at least 0.5mm thick, 300mm long and unlined or flocked lined (not cotton).

Suitable levels of personal protective equipment for situations not covered on the label

Activity	Coveralls	Gloves	Boots	Faceshield	Apron	Hood	RPE	Ear protection	Comments
Handling unopened packs	✓	✓	✓	(✓)					Wear safety footwear
Mix, fill - unclassified products	✓	✓	✓	✓	(✓)				Fill well away from water-courses, ditches, drains
Mix, fill - harmful, irritant products	✓	✓	✓	✓	✓	(✓)			Fill well away from water-courses, ditches, drains
Mix, fill - toxic, very toxic products	✓	✓	✓	✓	✓	✓	✓		Use full-face type RPE
Handling contaminated equipment and packs	✓	✓	✓	✓		✓	(✓)		Use full-face RPE for every toxic product
Cleaning packs	✓	✓	✓	✓					Dispose of wastes safely
Hand-held spray downwards	✓	✓	✓						Beware leg contamination - use waterproof leggings
Hand-held spray upwards i.e. above waist height	✓	✓	✓	✓		✓	(✓)		Beware face and arm contamination
Applying indoors (eg to protected crops)	✓	✓	✓	✓					Avoid working in spray mist
Reduced volume spray - indoors	✓	✓	✓	✓	(✓)	✓	✓		Due to higher spray droplet concentration
Reduced volume spray - outdoors	✓	✓	✓	✓		(✓)			Hood for harmful or irritant products
Applying dusts, granules, fogs, smokes or gases	✓	✓	✓	✓		(✓)	✓		Use full-face type RPE for very toxic products
Using mist blowers and fogging machines	✓	✓	✓	✓	(✓)	✓	✓	✓	Work for short periods only
Seed treatment	✓	✓					✓		May need hat, safety boots, eye protection
Changing nozzles and other parts	✓	✓		✓	(✓)				Keep clean spares handy
Cleaning PPE, RPE, application equipment	✓	✓	✓	✓	(✓)				Dispose of wastes safely

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Notes: (✓) Indicates optional but recommended. Unclassified indicates products with no hazard symbol (e.g. harmful, etc.). Coveralls assumed to be disposable Type 5/6.

- **Boots** – full length water-proof rubber boots / wellingtons should be worn, preferably with steel toe-caps.
- **Face-shield** – a face-shield that provides all round protection should be worn.
- **Respiratory protective equipment (RPE)** – RPE ranges from disposable masks to full face-piece powered respirators. The choice depends upon the product label and COSHH assessment. All RPE should be suitable for the wearer and provide adequate protection against the particular contaminant. Note the date when first used on the cartridge. Simple nuisance dust masks should not be used.

A simple guidance sheet (PPE for situations not covered on the label) can be found in the BCPC Booklet *Small Scale Spraying* and is reproduced on the page opposite. Checking this guidance list against label recommendations is a sensible approach when making the necessary judgements on PPE selection.

The BCPC publication *Safety Equipment Handbook* provides more detail and is a useful source of reference. Further detail on the appropriateness of PPE products to particular situations should be available from the PPE manufacturers.

Spraying protected crops

Spray operators in protected crops are in close or even direct contact with the spray cloud and so PPE is very important, especially when application is carried out for long periods of time. When spraying in protected structures, the minimum PPE required includes a coverall with hood (full protective suit), gloves, boots and face-shield.

General points on personal protective equipment

Other points for consideration include:

- PPE should be personal and not shared with other staff members, it should be stored away from pesticides in a safe, secure location and should be cleaned promptly after use and a record kept of respirator cartridge usage.
- Ensure that the correct respirator cartridge is selected, according to the type of product used. The categories of product that each cartridge type

will protect against are listed on the pack.

- ‘Air-flow’ systems, whereby a special face mask is worn with a cartridge and battery on a belt around the operators waist, and which creates a positive air flow down around the operators face, are more comfortable than respirator masks. This is particularly so with the high temperatures often encountered in glasshouses and polythene tunnels.

Nozzle types and uses

Correct nozzle selection is fundamental to determining how effective the spray application process will be, the nozzle type will dictate droplet size and output which in turn will determine the level of spray drift and coverage.

Nozzle selection

As a result of the various leaf types and crop growth habits associated with the range of ornamental crops commercially produced, an appropriate spray droplet size needs to be selected to optimise retention of the spray liquid on the plant or target weed. Of the five British Crop Production Council (BCPC) spray classifications only three apply and these are fine, medium and coarse. These descriptions relate to the droplet sizes within each classification and the table below indicates the most appropriate use of each.

There are really only three main nozzle types applicable for use with knapsacks or powered trolley sprayers these include: deflector, cone and flat fan nozzles. Dependent upon size, flow rate and pressure all the nozzles can produce a range of spray qualities though each type has specific qualities as outlined below.

Deflector nozzles are most usually associated with coarse droplet production, minimising the potential for spray drift. They are generally used for herbicide applications.

Cone nozzles produce either solid or hollow cone spray patterns. They generally produce a fine droplet size and may suit dense leaf canopies with multi-directional leaves, where good penetration of the spray is required with possible improved under-leaf deposition. In protected cropping, they may suit single nozzle sprayers where hand movement of a spray lance will create multi-directional trajectories

Spray quality suitability by droplet size

Spray quality	Size of droplets	Retention on difficult leaf surfaces	Used for	Potential drift hazard
Very fine		Good	Exceptional circumstances	
Fine		Good	Good cover	
Medium		Good	Most products and uses	
Coarse		Moderate	Soil herbicides	
Very coarse		Poor	Liquid fertilisers	

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to the spray pattern. They can also be fitted on to a boom.

Flat fan nozzles generally produce a triangular spray pattern according to the angle of the nozzle orifice. They are the most common nozzles in use and suitable for use on a knapsack sprayer or multi-headed boom applicator. Flat fan nozzles may not produce the penetration desired with very dense multi angular leaves, but are best suited to low profile plant species with horizontal foliage.

Generally, nozzle manufacturers will offer spray quality information for a flow rate at a particular pressure. The table below is an example of spray quality variation with pressure over a range of flat fan nozzle sizes.

From the table, a fine quality spray may be produced with orange, green, yellow or lilac nozzles operating at 2 bar pressure. Note that the flow rate changes from 0.327 l/min up to 0.816 l/min over the nozzle range. Selection will be dependent on the application rate required per area linked to walking speed.

Flow rate at different pressures for a range of flat fan nozzle types

	Press. BAR	Flow l/min		Press. BAR	Flow l/min
Orange	2.0	0.327	Brown	2.0	1.633
	3.0	0.400		3.0	2.000
	4.0	0.462		4.0	2.309
Green	2.0	0.490	Grey	2.0	1.960
	3.0	0.600		3.0	2.400
	4.0	0.693		4.0	2.771
Yellow	2.0	0.653	White	2.0	2.613
	3.0	0.800		3.0	3.200
	4.0	0.924		4.0	3.695
Lilac	2.0	0.816	Light Blue	2.0	3.266
	3.0	1.000		3.0	4.000
	4.0	1.155		4.0	4.619
Blue	2.0	0.980	Light Green	2.0	4.899
	3.0	1.200		3.0	6.000
	4.0	1.386		4.0	6.928
Red	2.0	1.306	Black	2.0	6.532
	3.0	1.600		3.0	8.000
	4.0	1.848		4.0	9.238

BCPC coding: Fine Medium Coarse

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From the table a medium spray quality is available from blue, red, brown or grey nozzles at 2 bar pressure.

The nozzle flow rate required (in l/min) can be calculated by the following formula:

$$l/min = \frac{\text{Application rate (l/ha)} \times \text{Speed (km/h)} \times \text{Nozzle spacing (m)}}{600}$$

By careful selection, an operator can choose the appropriate nozzle for the flow rate required to generate the spray quality most suited for the

target crop and leaf type under consideration. For further information on nozzle selection and maintenance visit the Voluntary Initiative website at www.voluntaryinitiative.org.uk/_Attachments/Resources/1094_S4.pdf.

Crop considerations

Spray application over uniform, low growing crops (like bedding plants) should be relatively straightforward to achieve. However, over other crops with dense canopies and waxy leaves (for example *Phormium*), good spray penetration may be more difficult to achieve and a fine droplet size will be required. Other difficult subjects include hedging plants, for example *X C. leylandii*, *Prunus*, *Ligustrum* and evergreen subjects such as *Choisya*, *Elaeagnus*, *Daphne* and *Skimmia*. These, along with any specimen plants where the total amount of foliage is significant, may require air assisted sprayers which produce a certain level of air movement to allow small droplets to be intercepted by the dense leaf growth.

'Variable nozzle spray guns'

No information is available as to the droplet sizes produced by these types of applicators, which are often used to treat a range of crop species. It is likely that the small droplets created with the wider spray pattern would be more appropriate to attain good leaf deposition and retention on both the upper and lower leaf surfaces. However, the use of such equipment on low profile, flat leaf crops may give rise to higher levels of run-off from the plants.

Calibration

Calibration is important to ensure that the correct amounts of pesticide and water are being applied to the required unit area. Under-application can result in reduced levels of pest, disease or weed control, whilst over-application can result in pollution and waste spray solution.

Key elements of calibration

Accurate calibration is an essential part of effective pesticide spray application as it ensures that the pesticide product is applied at the correct rate. The principal objective is to measure and adjust the liquid output from the sprayer over the area covered so that it matches the product label recommendation.

The calibration of hand-held sprayers is usually specific to an individual operator and the nozzle selected. The standard method involves simple measurement of the amount of spray solution that the sprayer to be used emits over a set time (the flow rate). This is then combined with a calculation of the time taken to cover a set distance at walking speed with the width sprayed to give the area treated.

Plain water should always be used, unless pre-formulated or concentrated ready-to-use products are involved, in which case these must be used for the calibration. However, avoid contamination of non-

target areas when using such products.

Detailed guidance on calibration is available from several sources, including sprayer manufacturers and the BCPC. The Voluntary Initiative is also a useful source of reference and the standard method for calibrating a knapsack sprayer can be found on their website (www.voluntaryinitiative.org.uk). A knapsack calibration calculator spreadsheet and calibration checklist can also be found on the DVD.

High volume rates

The label recommendation of some pesticide products may state a high volume rate, in which case the application rate is detailed as the volume to be applied to reach the point at which the crop foliage is thoroughly covered and the solution starts to drip, this is often referred to as the 'point of run-off'. In such cases, the label dose rate will usually be shown as millilitres or grams of product per litre of water. This is particularly useful when treating relatively small crop areas, or spot spraying problem areas to control pest or disease outbreaks.

There is an important difference between excess run-off and achieving adequate spray coverage, and operators should practice with plain water until the 'point of run-off' is safely accomplished.

Coarse quality droplet sizes should not be used as adhesion of the spray solution to the crop foliage will be compromised. Over-application to the point where the spray collects in leaf depressions or drips onto lower parts of the plants should also be avoided. Over-application is wasteful of the product and may cause phytotoxicity or leave visible pesticide residues.

To determine spray application efficacy and help improve spray application technique, water sensitive paper can be attached to a selection of plants during the calibration process.

Spray application

This section summarises the key points for consideration prior to spraying and during the application process. The list is not meant to be exhaustive, but highlights areas of good practice.

Prior to spraying

- Think carefully about the safety of the public, wildlife, livestock and domestic pets in and around the areas to be sprayed, especially when working close to residential areas, areas of general public access, office buildings, shops and farmland / neighbouring crops. It is good practice to inform neighbours of any work involving the application of pesticides – this may in due course become a legal requirement.
- Use warning signs to inform staff, visitors and (where appropriate) the general public of spraying activities. Ensure the signs are clearly visible in a prominent position at or near to the point(s) of entry to sprayed areas / production beds / polythene tunnels.
- Ensure weather conditions are suitable for spray application.
- Notify a suitable member of staff when planning to spray in the event of accidents or the need for assistance.

Preparation

- Ensure the appropriate PPE is to hand and is used correctly.
- Ensure the sprayer has been thoroughly washed out before using it.



Spray application warning sign providing detail of treatment

- Use clean water to check sprayers for leaks.
- Ensure the spray pattern is correct and the nozzle flow rate is within 5% of the manufacturers stated output at the pressure selected.
- Check that the nozzles and the operating pressures are appropriate for the task.
- Read the product label carefully before use, to become familiar with the product and its label requirements, including application rates, water volumes and safety precautions.
- Ensure the product being used has a current and appropriate approval status for the work to be undertaken; ensure the appropriate Specific Off-Label Approval (SOLA) is obtained as required.

Measuring

- Use a dedicated area for measuring, mixing and filling, well away from watercourses or other environmentally sensitive areas. As a result this may involve some transport of the filled sprayer to the area to be treated – ensure this is done safely and securely to prevent spillages.
- Ensure that the correct equipment is used for measuring out concentrated pesticides including using disposable syringes and accurate scales.



A number of syringes suitable for measuring out small amounts of liquid

- Ensure measuring devices are calibrated as appropriate.
- Stand up rather than crouch down when measuring; it is safer and more accurate to do it this way.

Mixing and filling

- Always open concentrate containers and use measuring equipment over a drip-tray to prevent contamination of the ground.
- Ensure the main sprayer filter is in place on top of the tank, so that large particles do not enter the spray solution, possibly causing nozzle blockages.
- Add the pesticide concentrate to the tank after quarter filling with water, and agitate to make sure the product remains in suspension and is well mixed in the tank.
- Triple rinse measuring vessels (and, if it has been emptied, the product container too) and pour the solution into the tank.
- If mixing two products check to see if the proposed tank mix is permitted.
- Get one product into solution first, before adding the second and agitate again to ensure both products are well mixed. Check whether guidance exists as to which order products should be mixed in.
- Fit the tank lid and gently shake the knapsack or agitate the sprayer to ensure thorough mixing.
- Remove the lid, complete the filling process as required, replace the tank lid and gently shake or agitate to ensure thorough mixing.
- Ensure the tank is not over-filled and is clean and dry before handling.

Containers and spray mixture

- Return the concentrate container to the pesticide store; do not re-use empty containers for any other purpose unless it is specifically designed to be returned and refilled or, an identical pesticide product is being transferred into it from a damaged container.
- Empty containers must be disposed of safely in accordance with current Waste Regulations.
- Never leave a spray mixture in a spray tank overnight as the product may settle out or degrade, it also represents a hazard to others.

During application

- Where crops are grown on a bed system, walk down the bed, spraying along one side before spraying the other side when returning.

- Be careful to avoid spray drift at all times; lower nozzle heights, reduce spray pressures, fit drift reducing nozzles or fit a spray guard.
- In the case of hand pumped knapsacks, pump consistently and evenly, and / or fit a constant pressure valve to regularise spray output.
- Maintain a consistent walking speed, spray pressure and spray height above the crop.
- Adopt a consistent spraying action maintaining an appropriate nozzle height.
- If using a spray boom with separate nozzles, ensure the height of the boom above the crop is correct to achieve the necessary double overlap. Keep the boom steady when walking through the crop.
- If using a variable nozzle spray gun, ensure the setting on the twist grip is correct for the job in hand, test settings beforehand using plain water.
- Make sure that the 'throw' of the nozzle reaches far areas of the bench or bed, particularly if applying a treatment to crops grown on rolling benches.
- Do not apply any pesticides during hot weather or when bright sunshine is likely, unless effective shade screens are in place. During the summer months, aim to apply sprays in the early morning or early evening when temperatures are cooler and evaporation rates lower.

- Use water sensitive paper to help check the effectiveness of spray coverage.
- Remove warning signs promptly when it is safe to re-enter treated areas.

Post spraying

To prevent contamination and potential pollution, consideration should be given to dealing with concentrate and dilute pesticides (particularly washings), pesticide containers and contaminated personal protective equipment.

Disposal of pesticide wastes

Pesticide waste usually comprises of four types:

- Concentrated products and ready-to-use formulations
- Diluted pesticides including washings
- Empty pesticide containers
- Contaminated clothing and other materials.

The amount of waste generated can be kept to a minimum by:

- Only using pesticides when necessary
- Not ordering new products if there is sufficient in stock
- Ensuring the most suitable pack size is selected



Spray application via knapsack

- Mixing slightly less than is needed so as to leave an untreated area for the disposal of washings
- Reducing packaging waste by using returnable containers, soluble packs and closed transfer systems.

Careful planning and good practice will help to reduce or even eliminate unused spray liquids and so in turn the need for disposal. Such practice includes the careful measurement and estimation of work to be done, and the careful calculation of the amounts of spray product required, particularly when treating a specific area.

Concentrates - The quantities requiring disposal can be minimised by giving careful consideration to the amount of concentrate (product) and the pack sizes that need to be purchased. For example, by matching the area to be treated (and, the need for repeat applications) with the sizes of packs available for purchase, surpluses can be kept to a minimum.

If there is no opportunity to use a product for its approved purpose, it may be possible to return packs to the supplier provided they are in good condition, unopened and fit for re-sale. Otherwise, because pesticide concentrates are likely to be regarded as hazardous waste, a licensed waste contractor will be required for their safe and legal disposal. Contact details for licensed operators can be found through the Environmental Services Association (www.esauk.org).

Concentrates for disposal must be safe to transport. They must be sealed in suitable containers and clearly labelled. Further information on dealing with hazardous waste is available from the Chartered Institute of Waste Management (www.ciwm.co.uk).

Dealing with dilute pesticides - Unused spray mixtures and tank washings are the main source of dilute pesticides, the disposal quantities of which can be reduced by careful planning. Calculate the area to be treated accurately and only prepare the amount of diluted spray solution required.

Dilute pesticide waste must be disposed of safely and legally to protect people, wildlife and the wider environment, particularly ground and surface waters. The best practice is to spray the dilute waste onto the area just treated, provided this does not exceed the maximum dose permitted on the label; leaving a small area untreated or under-dosed during spray application helps to achieve this. Other options include:

- Storing the waste until a licensed waste contractor can collect it.
- Disposal via a lined bio-bed or bio-filter or an effluent treatment system in which wastes are treated via a carbon filter. Both of these options require an appropriate waste management licence or exemption.
- Disposal onto a non-cropped, grassed area of



Bio-filters can be a useful system to treat pesticide washings where space is a limiting factor

minimal wildlife value, ensuring the area is away from waterways, ditches and ponds, drains and environmentally sensitive areas and that it is not liable to surface run-off or leaching. Such sites require an Authorisation under the Groundwater Regulations and may only be used following approval by the local Environment Agency.

Pesticide containers - Unless prohibited by the product label, empty containers should be triple rinsed and thoroughly drained before disposal. This should be undertaken immediately after emptying and the washings added to the spray solution. Store the clean, punctured containers safely and securely prior to disposal; usually, either boxed or bagged-up pending disposal by a licensed waste contractor. Alternatively, they can be taken to a licensed disposal or waste recovery site directly, but it is advisable to check that the site will accept rinsed pesticide containers beforehand.

Containers which cannot be rinsed out, such as paper sacks, cardboard cartons or ready-to-use containers should be emptied as completely as possible and stored as if they still contained the pesticide product, until disposal by a licensed waste contractor.

Never burn pesticide containers and never use

them for any other purpose (except to hold the contents of an identical container which has been damaged). Further guidance on cleaning pesticide containers can be found via the Voluntary Initiative (www.voluntaryinitiative.org.uk). Details of local waste disposal or recovery sites can be found via the National Recycling Directory at www.wasterecycling.org.uk.

Decontamination of spray equipment

Thorough decontamination of spray equipment after use will avoid damage to other crops treated subsequently. It will also prevent damage to the sprayer from corrosive or abrasive residues and reduce the risk of blockages. Regular maintenance helps to prolong the life of equipment and ensures accurate and trouble-free operations.

Always keep spray equipment used for herbicide applications separate to that used for the application of other pesticides to prevent cross-contamination, and ensure spray equipment used for weed control is clearly labelled.

Before decontamination check and follow the label recommendations of the pesticide products used and ensure the appropriate PPE is worn.

All decontamination processes post spraying will produce liquids which may in some way be hazardous. Therefore the disposal routes for such liquids must be carefully considered to safeguard the environment and others.

All sprayers after use should be sprayed-out to a point of no-flow. This should ideally be within a crop area especially left and not sprayed to full dose previously. The sprayer should then be cleaned out using a repeated wash-out approach rather than just a single wash-out with a large volume of water. It is more efficient to use a volume reduced to one third and repeat the operation three times.

Contaminated personal protective equipment

Heavily contaminated or old PPE and any materials used to deal with spillages should be disposed of through a licensed waste contractor. Some of these items may in fact be classified as hazardous waste.

Further information on waste disposal can be found on the Defra website, www.defra.gov.uk/environment/waste/topics/index.htm and from the Environment Agency at www.environment-agency.gov.uk.

References

A list of relevant publications is presented by module section in the DVD and the web addresses of appropriate organisations are also provided for further information.

Module 1: Introduction – Deciding to spray

- HDC Crop Walkers Guide: Pot and bedding plants.
- HDC Factsheet 10/07: Guidelines on nursery

hygiene for outdoor and protected ornamental crops.

- Various HDC Factsheets on pests and diseases, including whiteflies, vine weevil, downy mildew and *Botrytis* – see www.hdc.org.uk.

Module 2: Regulations, record keeping and training

- BCPC Guide, Small Scale Spraying.
- Defra Code of Practice for Using Plant Protection Products (Ref PB11090).
- HSE Information Sheet No 16: Guidance on storing pesticides for farmers and other professional users.
- The UK Pesticide Guide.
- VI Leaflet, Pesticide Storage.
- VI Leaflet, Crop Protection Management Plan.
- VI Leaflet, The LERAP Scheme – Operator Advice.

Module 3: Personal protective equipment and application equipment

- BCPC Guide, Small Scale Spraying.
- BCPC Guide, Safety Equipment Handbook.
- BCPC Guide, Using Pesticides.
- BCPC Guide, Field Scale Spraying.
- Defra Code of Practice for Using Plant Protection Products (Ref PB11090).
- HDC Factsheet 14/06 (revised): Guidelines and best practice for pesticide spray application in protected ornamentals crops.
- VI Leaflet, Efficient Spraying.
- VI Leaflet, H2OK? – Best Practice Advice Booklet.
- VI Leaflet, Pesticide Handling Areas.
- VI Leaflet, Safe Application of Slug Pellets.
- VI Leaflet, Spray Operator Training.

Module 4: Calibration

- BCPC Guide, Small Scale Spraying.
- VI Leaflet, Knapsack Checklist with Calibration Aide Memoir.

Module 5: Spray application

- BCPC Guide, Small Scale Spraying.
- Defra Code of Practice for Using Plant Protection Products (Ref PB11090).

- HDC Factsheet 14/06 (revised): Guidelines and best practice for pesticide spray application in protected ornamental crops.
- VI Leaflet, Avoiding Drift.
- VI Leaflet, H2OK? Think Water, Knapsack Do's and Don'ts.
- VI Leaflet, Nozzle Selection and Maintenance.
- VI Leaflet, The LERAP Scheme – Operator Advice.

Module 6: Post spraying

- BCPC Guide, Small Scale Spraying.
- Defra Code of Practice for Using Plant Protection Products (Ref PB11090).
- Defra, Saving money by reducing waste (Waste minimisation manual: a practical guide for farmers and growers).
- Environment Agency Waste Regulations Pack (via VI website).
- HDC Factsheet 03/09: Bio-beds for treatment of pesticide waste and washings.
- VI Leaflet, Follow Best Practice to Protect Water.
- VI Leaflet, Lined Bio-beds.
- VI Leaflet, Pesticide Disposal, FAQ's.
- VI Leaflet, Pesticide Disposal.
- VI Leaflet, Pesticide Container Disposal.
- VI Leaflet, Sprayer Cleaning.

Organisations

- BASIS
www.basis-reg.co.uk
- British Crop Production Council (BCPC)
www.bcpc.org.uk
- City & Guilds National Proficiency Test Council
www.nptc.org.uk
- Defra
www.defra.gov.uk
- Defra Chemicals Regulations Directorate
www.pesticides.gov.uk
- Fera Liaison pesticides website
www.liaison.fera.gov.uk
- HDC
www.hdc.org.uk
- HTA
www.the-hta.org.uk

- The Environment Agency
www.environment-agency.gov.uk
- The Health and Safety Executive (HSE)
www.hse.gov.uk
- The National Register of Spray Operators
www.nroso.org.uk
- The National Sprayer Testing Scheme
www.nsts.org.uk
- The Scottish Environmental Protection Agency
www.sepa.org.uk
- The Voluntary Initiative (VI)
www.voluntaryinitiative.org.uk

Suggested questions

A number of questions relating to each module have been created to aid discussion with staff members on certain aspects of the DVD and accompanying guidance notes.

These can be adopted as part of any in-house training programme.

Module 1: Introduction – Deciding to spray

- Which City & Guilds NPTC modules must you have passed to be allowed to apply pesticides via a knapsack or powered trolley sprayer?
- Name the four principal modes of action of insecticides?
- Name and briefly describe three different formulations of pesticides?
- How do you decide if a crop needs spraying?
- List three non-chemical methods of crop protection as alternatives to pesticides?

Module 2: Regulations, record keeping and training

- What is the main reference guide for using plant protection products, and where can it be obtained from?
- What is the Voluntary Initiative (VI) and where can you find out more about it?
- What do the initials COSHH stand for and what is a COSHH assessment?
- Which details should be included in the spray record book, and why must these records be kept?
- The pesticide label lists all approved crops and rates of use, but where would you find information about Specific Off-Label Approvals (SOLAs) and what are they?

Module 3: Personal protective equipment and application equipment

- Where can I find more information about the personal protective equipment (PPE) I may need?
- Which are the three most common types of hand-held sprayers used in ornamental plant production?
- Name three different spray qualities?
- Which nozzles can produce:
 - a) Fine sprays?
 - b) Medium sprays?
- Which type of nozzle and spray pattern is generally more suitable for fungicide and insecticide applications to ornamental crops and why?

Module 4: Calibration

- What is calibration, why and when is it necessary?
- What equipment might you need to assist calibration?
- Where would you find further information about calibration techniques?
- What should you do with calibration results?
- What happens if pesticide spray is applied too heavily to crop foliage and why should this be avoided?

Module 5: Spray application

- How do you measure out small quantities of liquid pesticides accurately?
- When applying an insecticide or fungicide product to crop foliage, what is the level of cover that should be aimed for?
- Why should very fine or very coarse droplets be avoided?
- How do you check the effectiveness of spray coverage?
- During the summer months, when is the best time of the day to spray?

Module 6: Post spraying

- After spraying, what are the two principal areas of work requiring attention?
- What can be done to reduce or even eliminate unused spray liquids and so in turn the need for disposal?
- If you have diluted spray liquid left over, what should you do with it?
- How do you safely dispose of pesticide washings?
- How do you safely dispose of empty pesticide product containers?

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