Integrated Pest Management for Greenhouses

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INTRODUCTION

The greenhouse environment provides optimum conditions for plant growth; these conditions also favour many plant pests and diseases Pesticides are frequently required to control these problems, but in Australia there is little published information on the safety requirements specific to their use.

The occupational health and safety legislation introduced throughout Australia in recent years highlights the health and safety concerns employers have for their staff. Pesticides when used in greenhouses can undoubtedly pose increased hazards to either the pesticide operator or other staff via exposure factors arising from the confined air space and contact with surfaces associated with greenhouse operations.

This paper outlines key principles of pest management in greenhouses. The main emphasis of these principles is upon occupational health and safety aspects, and the use of integrated pest management to minimise the hazards of pest control. A means is provided for reducing the use of pesticides in greenhouses. The advantages to be gained include reduced public concern about pesticide use, reduced hazards to staff, greater flexibility in staff resources and the potential for reducing costs.

PRINCIPLES FOR SAFE PEST CONTROL IN GREENHOUSES

In the greenhouse environment, if pesticides are necessary, it is important to reduce the potential for pesticide exposure, and to reduce the hazards to all staff who work in the greenhouse.

1) **Integrate Pest Management.** Where possible use biological control agents and other non-chemical control methods in preference to only using pesticides.

2) **Pesticides.** Choose the least toxic pesticide which has proven effectiveness against the pest organisms. Consideration should be given to the possibility of pesticide resistance developing through repeated use of one pesticide.

3) **Safety Procedures and Protective Equipment.** Develop correct safety procedures and use appropriate protective equipment.

4) **Accident Prevention.** Instigate measures to avoid accidental events which could lead to the exposure of staff to pesticides.

5) **Build Safety into the Work Environment.** Provide a work environment that meets suitable safety standards including: pesticide storage, washing and showering facility, and regular medical checks.

6) **Sound Training.** Educate staff in the need for the above measures, and train in the correct procedures.

INTEGRATED PEST MANAGEMENT

Integrated pest management (IPM) is a strategy that has existed in horticulture and agriculture for thousands of years. Today, IPM is proving to be advantageous for park and nursery management organizations. Recently, the ACT Parks and

Conservation Service in Canberra has developed IPM programs for the maintenance of formal gardens and greenhouse plants (Carmody et al., 1981; Nazer and Clark, 1986).

IPM is the compatible use of all means of pest suppression including mechanical, biological, chemical and natural control in a systematic fashion (Rhoads, 1985). It refers to a broad and commonsense approach to pest management.

The IPM approach is not anti-pesticide but uses ecological knowledge of pests and diseases to implement safe and economical control measures. A basic premise of IPM is that broad cover sprays of pesticides not only affect the population level of the pest, but also that of beneficial organisms which provide suppression of pest populations.

The ACT Parks and Conservation Service has developed a system of integrated pest management which is based on three major guidelines

1) The presence of a pest organism does not necessarily indicate a pest problem

2) Consideration should be given to all available pest control strategies

3) The immediate elimination of a pest is not essential, but pest population levels must be kept within acceptable limits.

In following the IPM approach, selective pesticides are used to reduce pest population levels only when non-chemical methods are not achieving the desired result. Non-chemical methods include biological control agents, chromotropic traps and effective hygiene practices The main factors which limit the development of IPM programmes are outlined by Spooner-Hart (1989).

Richardson (1977) considers that sufficient information is available in Australia on the biological control of greenhouse pests for the practice to be commercially developed. At least one Australian firm is investigating the commercialisation of several suitable biological control organisms, but only two are available at present. For example, the Service purchases the predatory mite *Phytoseiulus persimilis* for use in controlling two spotted mite in its glasshouses. Releases are made annually in early summer.

The Service also makes use of several naturally-occurring biological control agents in its IPM program as shown in Table 1. Under the IPM program particular attention is paid to making sure that pesticide applications do not destroy these agents, many of which are easily killed by pesticides.

Every effort is made to choose pesticides which are relatively non-toxic to the predator. Occasionally, it has been necessary to make additional releases of the predator mite if it has been eliminated inadvertently by pesticides or by natural causes. When the use of a pesticide which is toxic to the predator is required, the effects on its population level are minimised by spot treatment of plants, or groups of plants.

Attention is paid to soil sterilisation and plant hygiene practices to reduce pest and diseases occurrence. Outbreaks of soil-borne diseases which can develop during propagation are prevented by regular application of fungicides.

PESTICIDES

Selection of a pesticide for use in a greenhouse should take into account toxicity, residual life, effectiveness, aspects of known pest resistance and compatibility with integrated pest management programs All pesticides approved for general use in greenhouses of the Service are Schedule 5, 6 or Exempt pesticides (AGPS

Canberra, 1982) with short residual life.

Whenever possible, the use of more toxic or long residual life pesticides (e.g. Schedule 7 or fumigant pesticides) is avoided In the case of fumigants, licensed operators may be necessary, and safety measures and training of a higher level required.

The pesticides presently used in the Service greenhouses to control commonly encountered pest problems are shown in Table 1.

Table 1 Pesticides and non-chemical methods used for pest control in ACT Parks and Conservation Service greenhouses

Pest/Disease	Pesticide	Non-chemical control method
Container plants:		
Two-spotted mite *(Tetranychus urticacae)*	Propargite (Omite)	[1]Predatory mite (*Phytoseiulus persimilis*)
Mealybug *(Psuedococcus* spp *)*	Dimethoate (Rogor) or Maldison (Malathion) either alone or combined with White Oil (Albarol) Omethoate (Folimat)	[2]Mealybug ladybird (*Cryptolaemus montrouzieri*)
Scale insects	As per mealybug control	
Aphids (*Myzus* spp)	Pirimicarb (Pirimor) or Dimethoate	[2]Parasitic wasp (*Aphidus colemani*)
Whitefly (*Trialeurodes vaporariorum*)	Dimethoate or Maldison	[2]Parasitic wasp (*Encarsia formosa*) [2]Yellow sticky traps
Caterpillars	Carbaryl (Septene)	[1]Bacteria (*Bacillus thuringiensis*) (Dipel)
Cuttings and Seedlings:		
Grey mould (*Botrytis cinerae*)	Iprodione (Rovral) or Benomyl (Benlate)	
Damping off, stem and crown rots (*Rhizoctonia* and *Sclerotinia* ssp)	Iprodione, Benomyl or Quintozene (Terrachlor)	
Damping off and root rots (*Pythium* and *Phytophthora* ssp)	Propamocarb (Previcur) or Fesetyl (Aliettr)	
General Control:	Polyphenol (Biogram) for periodic disinfestation of greenhouse fixtures	Steam sterilization of soil, hygiene practices, roguing of infected plants, selection of resistant plants

[1]Commercially available

[2]Not commercially available but are utilised whenever possible.

SAFETY PROCEDURES

The use of pesticides in greenhouses presents special problems, and demands great care to ensure their safe use. Ventilation in greenhouses is frequently kept to a minimum to maintain desired temperatures and humidity. As a result any chemical fume, mist or dust may remain in the air for a considerable period of time. It is also difficult for personnel to avoid contact with plants and other pesticide-treated surfaces.

The accompanying procedures of the ACT Parks and Conservation Service are currently followed in the greenhouses. They were developed in consultation with pest control specialists and greenhouse management staff to meet the specific needs of the Service. These procedures are unlikely to be automatically applied but the approaches which have been adopted may assist others in dealing with their own special problems. The need to develop procedures to fit the specific requirements of different operations is stressed, as is the need to accompany the introduction of the procedures with adequate training and a system which enforces them

PROTECTIVE EQUIPMENT

Whilst the directions of a pesticide label must be followed in all cases, there is a surprising lack of product information relating to the safe use of pesticides in confined spaces. The Manual of Safe Practice in the Handling and Use of Pesticides (AGPS Canberra, 1980) strongly recommends protection by either supplied air respirators or canister type respirators when using highly toxic volatile pesticides in greenhouses It otherwise provides only basic guidelines for use of protective equipment in this situation.

The items of protective equipment listed below may be prescribed on pesticide labels, and where this is the case the items must be used. It is important to ensure that clothing and protective devices used conform to the relevant Australian Standards. The Manual of Safe Practice in the Handling and Use of Pesticides explains in detail aspects of the use of the following items: overalls, gloves, aprons, footwear (impervious type), goggles and face shields, and respirators. Correct selection, use and maintenance of protective equipment can eliminate or at least minimise possible hazards.

There are two basic approaches to respiratory protection, air purification through filtration of contaminants, and the supply of uncontaminated air from an external source, such as a compressed-air container. Protection against hazards normally encountered in greenhouse pesticide operations can usually be obtained by using filtration devices. Further discussion of protective equipment is provided by Nazer and Clark (1986).

MODEL FOR GREENHOUSE PESTICIDE PROCEDURES

Pesticides. Only pesticides approved by the greenhouse manager should be used. Refer to the manager if other pesticides are considered necessary.

Label instructions on the pesticide container must be followed in all cases. Do not use unlabelled pesticides.

Application warning. During and for at least 12 hours after pesticide application a **'Warning No Entry - Pesticide Use In This Area'** notice must be displayed at the entrances to the greenhouse.

After large-scale pesticide application the greenhouse must be closed and locked against unauthorised entry for at least a 12-hour period.

If spot spraying or drenching of individual plants or groups of plants is carried out, a notice or coloured label must be placed on treated plants. Where coloured labels are used a notice must be displayed at the greenhouse entrances indicating that these plants have been treated and if necessary the pesticide/s used.

Greenhouse entry

1) **Following large-scale application:**

A) **During 12-hour period:** If entry is necessary before the 12-hour period has expired then appropriate protective clothing including respiratory protection (i.e. the same type of items used when applying the pesticide), must be worn.

B) **After 12-hour period:** Entry is permitted after 12 hours if greenhouse ventilation has been continuous for the 12-hour period following spray application.

Before entry is permitted to a sealed unventilated greenhouse, the greenhouse must be thoroughly ventilated, if possible by forced draught ventilation. The ventilation period should be at least several hours and certainly strong fumes of pesticides should not be noticeable.

2) **Following spot spraying or drenching:**

A) **During 12-hour period:** Entry during this period should be avoided if possible. It is not necessary to wear protective clothing provided treated plants are avoided, and strong fumes of pesticide are not noticeable.

B) **After 12-hour period:** Entry is permitted. If strong fumes of pesticides are noticeable the greenhouse must be ventilated.

Protection of Staff: A thorough washing down of all surfaces with water (including plants and pots) in the vicinity of sprayed plants should be performed prior to allowing people to handle the treated plants.

Protective Clothing and Devices: *Refer to the greenhouse manager for information* on types, uses and change intervals of cannisters and cartridges used in respirators.

When undertaking large-scale pesticide application, it is essential to use a full-face canister respirator or an air-stream hood.

When spot spraying a small number of plants an agricultural respirator hood or face shield and respirator fitted with two cartridges should be used. When drenching with fungicides it may not be necessary to use respiratory protection: however, the breathing of any fumes or spray must be avoided.

Waterproof overalls for large-scale pesticide application. Cotton overalls are suitable for spot spraying and drenching.

Waterproof gloves and footwear should be worn.

Fumigation in greenhouses needs special equipment and training. Contact greenhouse manager.

General precautions. Refer to Pesticide Safety Codes of Practice and the pesticide label.

Special care should be taken to avoid pesticide contamination of ancillary equipment, where such contamination could later be transferred to staff.

LITERATURE CITED

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