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Compilation of guidelines for a proposed national nursery accreditation scheme

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Know-how for Horticulture™

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Using the working paper

The working paper consists essentially of three sections.

The first (pp 1-11) gives a broad overview of the current situation of nursery accreditation in Australia.

The second (pp 12-28) presents the range of factors which have to be discussed and refined prior to the compilation and publication of a more compact and widely circulated document, the 'Draft National Nursery Accreditation Guidelines'.

The third section consists of eight appendices, which, together with discussions with state nursery industry association representatives and interested technical authorities, acted as a source for the first two sections.

At the meeting in August 1992, it is essential that section two is fully discussed and a firm set of draft guidelines which is suitable for general publication, is arrived at.

Your participation, as representatives of state nursery industries is absolutely essential.

Acknowledgement

This study was financed by the Horticultural Research and Development Corporation (HRDC).

It was conducted under the auspices of the Nursery Industry Marketing Forum (NIMF) and the Australian Horticultural Corporation (AHC).

It fulfils part of Goal 3 of the Nursery Industry Association of Australia (NIAA), that is, to prepare a draft set of guidelines for national nursery accreditation, suited to the needs of a reviewing body dedicated to preparing a more complete document.

The study was completed with considerable support from the following persons and organisation:

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Contents

A WORKING PAPER ON NATIONAL NURSERY ACCREDITATION IN AUSTRALIA

Introduction

The main purpose of this paper is to satisfy part of Goal 3 of the Nursery Industry Association of Australia, namely, to draft a set of guidelines for a national system of accreditation of nursery plant-growing practices. While it was not our responsibility to comment on the much broader aspect of nursery quality management systems for national quality certification, because accreditation may play an integral part of such a scheme, it has occasionally been mentioned here.

The paper is, as titled, a working paper. As such, it was intended that it be both a statement of each state nursery industry association's stance on nursery accreditation, and the presentation of a set of preliminary guidelines for further debate and resolution at a national meeting of state chairpersons, in August 1992.

We are therefore interested in receiving your opinions on the information presented, as quickly as possible.

Much of the paper is based on information and opinions obtained from representatives of nursery associations and also from independent technical sources, so if there is any strong disagreement please direct it to us, for recording, but not at us.

If a national scheme eventually develops it will only be after some compromises are made. However if it does develop, it will be a major achievement and of international interest.

A brief description of nursery accreditation in Australia

The nursery industry associations of the Northern Territory, Victoria, Western Australia and much more recently, Queensland, have introduced nursery accreditation schemes. New South Wales and Tasmania have produced accreditation scheme outlines. The South Australian association is awaiting the further development of other schemes in order to more effectively frame its own.

All of the functioning schemes have accreditation guidelines which are predominantly concerned with the prevention of either specified or unspecified root diseases. However the Victorian, New South Wales, Queensland and Tasmanian schemes also involve elements of, and a variable emphasis on, a wider range of quality management criteria. The philosophy in these cases is to guarantee that scheme plants are of a good overall standard, in addition to being essentially free of root rots. Disease-free plants can, if produced under unfavourable nutritional and environmental regimes, compare unfavourably with diseased plants where the disease is managed well and the plants are given good growing conditions.

These plants can and usually do decline however, when removed from remedial treatments, that is, when sold. Post-sale deaths or poor plant performances due to Phytophthora root rots are the best example of this.

There has been some confusion between nursery accreditation and quality management. It cannot be argued that any of the existing schemes are implementing quality management systems. It can be argued however that their involvement with disease prevention is a very effective start to and a very important part of a quality management system, as defined by the Australian Horticultural Corporation (AHC) administered Australian Horticulture Quality Certification Scheme (AHQCS).

The commonality of interest in disease prevention in Australian nursery accreditation schemes may enable the development of a national accreditation scheme focussed on disease prevention. Nationalisation of accreditation would give the process far greater critical mass, ensuring longer term survival, improved recognition, and promotional opportunities.

At the moment there is no generally accepted set of quality control criteria within the Australian nursery industry. The development of this would require large scale and extended debate within the industry. In fact, there may never be any resolution of this because of the great diversity of product - not only of the species or cultivars produced but also of the numerous ways in which each may be presented for sale. We would value each of your opinions on this as it is pivotal in determining the scope of this examination of national accreditation. However, if you disagree, it is incumbent on you to produce a list of quality control criteria (additional to specified plant disease prevention criteria) that you feel will meet national acceptance.

There may be some disagreement about the relevance of a national scheme based initially on the prevention of root disease. We believe that there is more than enough proof that root diseases are the most serious and common disorders found in nursery stock Australia-wide, but would welcome evidence to the contrary.

Thus it would appear that national nursery accreditation may be possible through a shared interest in the prevention of specified plant diseases. Other aspects of crop protection such as effective pest control and the effective control of lesser disease problems and weeds could be incorporated into this.

Other aspects of quality management should, in time, be built into a national scheme after suitable debate.

As many nursery operators consider that the current disease prevention requirements built into state accreditation scheme guidelines are already too restrictive, it is difficult to imagine that guidelines based on a wider range of quality control criteria, even if commonly agreed upon, would be suitable for initiating and sustaining national nursery accreditation.

What is nursery accreditation?

On a state by state basis it is the recognition of any type of nursery business which meets a set of standards determined by the nursery industry association in that state. The standards essentially deal with the prevention of a number of common diseases which, once the plants are infected, cannot be satisfactorily or easily controlled for an indefinite period of time. In addition to disease prevention there is an emphasis on good pest and disease control and an expectation that the crops will be well managed nutritionally and environmentally. There are not however, any firm guidelines on the nutritional and nursery environmental aspects.

In terms of broader environmental issues, there are proposals by some state nursery industry associations to incorporate state government regulations into nursery accreditation guidelines. Examples of this are requirements under the Clean Waters Act (NSW), the future amendments to the Chemical Usage Act (Qld) and changes to the schedules of the WA Diseases in Plants Act. While there are different regulatory requirements in each of the states there is a degree of commonality, and issues such as pesticide use, effluent control and plant disease spread should be discussed as they are only going to become more prominent in the future.

There is some concensus amongst industry associations that these issues should be dealt with now, to gain favourable government recognition and a place in the consultative process when future policies related to these factors are being determined.

It is therefore generally accepted that a national nursery accreditation scheme addressing these issues would assist in gaining that recognition.

The various state accreditation guidelines which are already in operation can be divided into administrative and technical categories. These are summarised in Tables 1 and 2 on a state by state basis.

Table 1. The commonality of administrative criteria in state nursery accreditation schemes.

Administrative	Criteria	NT	VIC	WA	QLD	NSW	TAS	SA
Eligibility	Nursery association members only		✓	✓		Initially	Initially	?
	Members and non members	✓			✓	Eventually	Eventually	?
Administration	Nursery association entirely		✓	✓	✓	✓	Initially	
	Nursery association and state government	✓					Eventually	✓
Inspectors	Nursery Association consultants		✓	✓			?	?
	State government employees	✓			✓	✓	?	?
Funding	User pay				✓	✓	?	?
	User pay with association subsidy		✓	✓		?	?	?
	Costs borne by state government	✓						
Governing body	Nursery association accreditation committee			✓	✓	?	?	?
	Nursery association executive		✓			?	?	?
	State Government/Nursery Association	✓					?	?

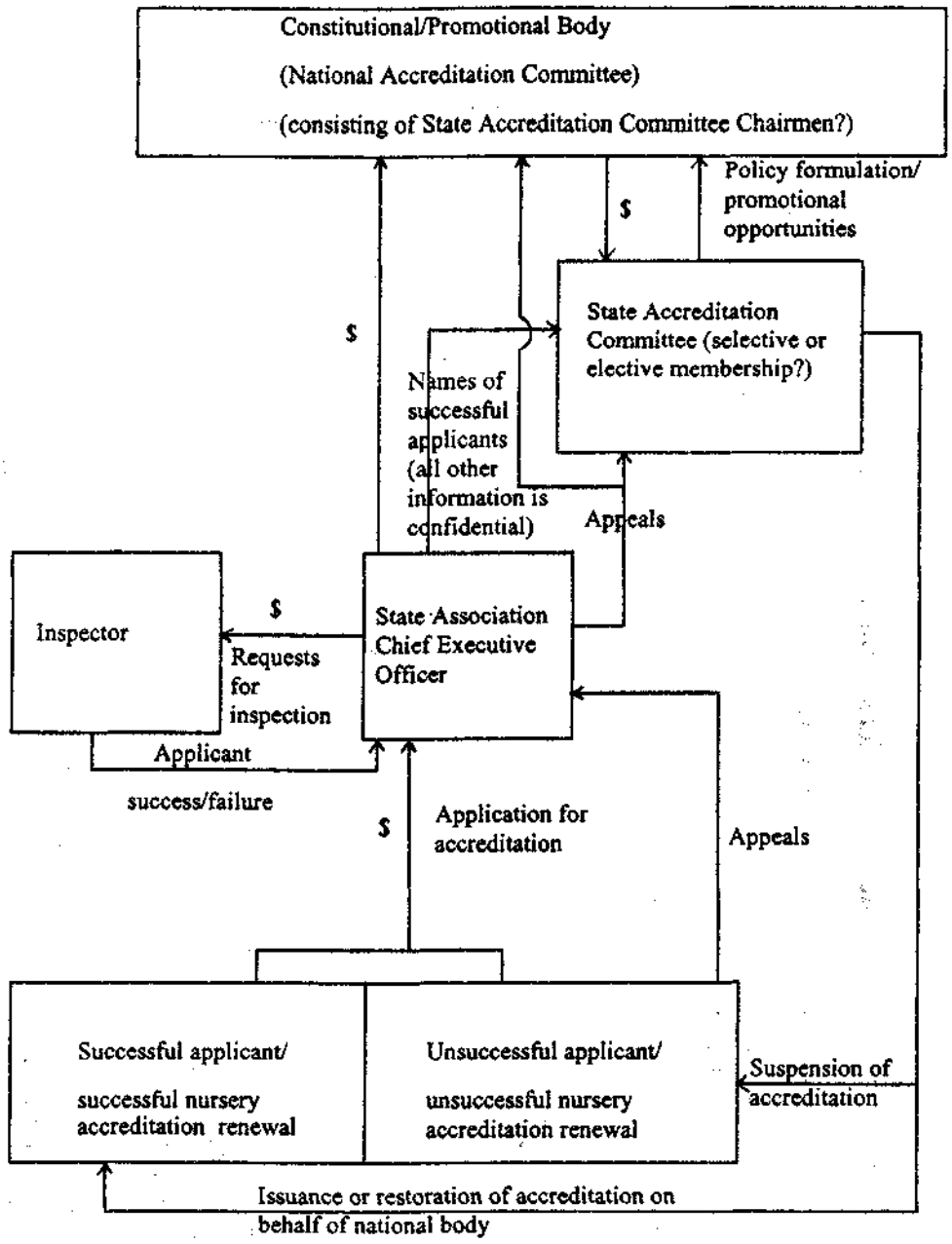
Administrative	Criteria	NT	VIC	WA	QLD	NSW	TAS	SA
Membership	Obligatory for members			✓		Eventually	Eventually	Eventually
	Voluntary	✓	✓		✓	Initially	Initially	Initially
Types of nursery granted eligibility	Retail	?	✓	✓	✓	✓	?	?
	Wholesale, container production	✓	✓	✓	✓	✓	✓	✓
	Wholesale, in-ground production	?	?	?	✓	?	?	?
Assessments (inspectorial involvement)	Annually	✓		✓		✓	?	?
	Six monthly		✓		✓			
	Routine sampling				✓			
Appeals	Association executive		✓			?	?	?
	Accreditation committee			✓	✓	?	?	?
	State government	✓						

On an administrative basis, it is apparent from Table 1 that, for a national scheme to develop, there must be interstate agreement on:

- the short term and long term aims of the scheme,
- the eligibility of applicants and nursery type (for instance voluntary or obligatory accreditation for association members, acceptance of non-members, acceptance of in-ground producers and retailers),
- the degree, if any, of government involvement in the scheme, other than as an on-demand technical service or to provide inspectors whose responsibilities are governed by the scheme guidelines but retain impartiality. Some states are seeking eventual regulatory inputs by government (WA, NSW, SA and Tas.). Other states are relatively antagonistic towards this (Vic. and Qld).
- the constitution, selection and powers of a national accreditation committee,
- the responsibilities of and/or the retention of state accreditation committees,
- a protocol for the termination or suspension of accreditation, and restoration of accreditation after suspension,
- avenues of appeal for participants,
- participant privileges and incentives,
- methods of promoting the scheme,
- fees,
- participant responsibilities (for example, giving freedom of information to inspectors, unimpeded access of inspector to property and in sampling materials, participants must not promote plants as disease free, but as plants grown under scheme guidelines which are conducive to disease freedom, etc),
- funding (completely user-pay or user-pay plus association subsidy),
- the eligibility and training of inspectors,
- methods guaranteeing confidentiality to applicants and participants.

Keeping in mind the fact that this is a working paper which is in no way intended as a finished document, a possible scenario (based on a broad concensus of existing nursery accreditation processes) for the administration of a national nursery accreditation scheme is schematically represented below in Figure 1.

Figure 1. Schematic representation of one possible set of national nursery accreditation dynamics.



The technical guidelines employed by all of the operating state nursery accreditation schemes are, as mentioned, concerned mainly with crop hygiene. The criteria used are summarised in Table 2.

Table 2. The commonality of the technical guidelines employed by the state nursery accreditation schemes.

Technical criteria	NT	VIC	WA	QLD	NSW	TAS	SA
Almost completely concerned with disease prevention	✓		✓	✓		?	?
Mainly concerned with disease prevention with some other significant aspects of quality control		✓			✓	?	?
Major concern with root disease prevention	✓	✓	✓	✓	✓	?	?
Common requirements for irrigation water hygiene	✓	✓	✓	✓	✓	?	?
Common requirements for media/soil sanitation and storage	greater controls than in other schemes	✓	greater controls than in other schemes	✓	✓	?	?
Common requirements for hygiene in growing areas	✓	✓	✓	✓	✓	?	?
Common requirements for hygiene in propagation houses	✓	✓	✓	✓	✓	?	?
Common requirements for hygiene in disinfestation of working surfaces and tools	✓	✓	✓	✓	✓	?	?
Common requirements for introduction of stock from unaccredited nurseries	✓	✓	✓	✓	✓	?	?
Common requirements for drainage and runoff mitigation	✓	✓	✓	✓	✓	?	?

There are significant differences in the technical guidelines in terms of the stress given to different components of them. These were found, however, in an independent study of the WA and Victorian schemes (funded by the QNIA) to be reduced somewhat by the inspection techniques used in the two states. That is, the experience of the inspectors allowed some exceptions to the rule where there were clearly mitigating circumstances and consequently, significantly reduced chances of likely risk. This certainly underlines the need for inspectors with a high level of technical competence and nursery crop experience. In a national accreditation scheme this allowance of informed decision making would involve some agreement between the states.

In the attached summaries of each states' accreditation guidelines (Appendices II to VIII) it can be seen that there are, if a national scheme is to develop, some differences in the technical requirements that will have to be reconciled.

These are briefly:

- the need to sanitise media,
- the approved procedures for water disinfestation,
- the importance of effluent controls in the national accreditation guidelines,
- the importance of pesticide use, safety issues and regulations in the national accreditation guidelines,
- agreement on the importance of mealybug, scale insect and soilborne insect freedom in national scheme plants,
- the importance of weed freedom, pest and incidental disease control procedures, nutrition, the general presentation of the nursery, and the effectiveness of environment control (where used).

It is our experience however that a nursery business that has progressed to effective hygiene procedures has also utilised good overall management practices.

The need for stressing effective hygiene procedures

As can be seen in the attached state accreditation guidelines (Appendices II to VIII), there is a large degree of similarity in requirements and aims with regard to disease prevention (and mainly the prevention of root diseases).

This is undoubtedly a recognition by industry of the importance of these diseases in nurseries Australia-wide. The most significant of these diseases are described in Appendix I. In terms of disease prevention, the same methods of eliminating infection are largely common to all root rots. Appendix I, as well as being an argument for root disease prevention, (rather than chemical control), contains information on the biology of root rot organisms and this is required to better appreciate the recommendations in the technical guidelines. This information

is not for further dissemination as the authors intend to use it in another, more comprehensive, publication on nursery crop diseases.

Various state government and university research programmes have also investigated the status of root rots in nurseries. Few of these have been published or published widely, but it is only a matter of time before reports similar to that of Drs Hardy and Sivasithamparam reach wider attention.

Phytophthora was unanimously recognised at the Standing Committee on Agriculture sponsored National Workshop on Pest and Disease Control in Ornamental Crops (Sydney 1988), as being the major disease organism of ornamental crops.

We have carried out, over the last 12 years, extensive testing for *Phytophthora* in nursery crops from many parts of Australia. There is no indication to suggest, that apart from a few situations, that there has been any significant reduction in the problem over that period. In fact, chemical controls adopted by the industry are so effective at suppressing disease, that prevention techniques have demonstrably become less widely used than they were in previous decades.

The long term dependence on chemicals used to suppress serious pathogens such as *Phytophthora* must be discouraged. The use of these chemicals on accredited nurseries should be discussed.

Other quality management criteria

In other quality management systems in horticultural crops (such as the AHQCS), a very wide range of criteria are established. In all cases the participants, if acting in groups or co-operatives, are dealing with one or at most several commodities (for instance citrus, mangos, avocados, lychees). The commodity focus is therefore much narrower than would be possible with most nursery operators who wished to act together. An exception would be an export venture where there are reduced numbers of commodity lines and a narrower focus on the market requirements.

It was our observation on speaking with members of accreditation committees and accredited nursery participants in Victoria, Western Australia and Queensland that there was a general reluctance to accept a broad range of quality management criteria in accreditation schemes because of either a lack of applicability or the additional constraints this placed on scheme participation or lack of agreement on the criteria to be used.

Another problem would be the lack of availability of disinterested inspectors with broad nursery technical skills.

It is apparent however that there is a need for scheme produce to meet a broader range of consumer requirements than disease freedom alone.

In terms of formulating the technical requirements of a national nursery accreditation scheme, the following points must therefore be discussed.

Weed freedom is a requirement of several schemes (for instance, in Victoria, New South Wales, Queensland) and consideration must be given to this in debating the content of national accreditation guidelines.

The effective control of particularly injurious insect pests may also be considered of importance, particularly the control of mealybug, scale and soilborne insects.

It should be necessary that the nursery practises a broadly effective crop protection programme, incorporating diagnostic skills, a knowledge of efficacious controls, and pesticide application safety and regulations.

All nursery operators who consign interstate are aware of (perhaps sometimes illegally under the Australian Constitution) state government restrictions on the movement of specified weeds, and the hosts of specified inspect pests and diseases (for instance palm leaf beetle, phylloxera, certain weeds to Tasmania, and chrysanthemum white rust). Consideration could be given to the scheduling of these in the industry accreditation guidelines. This may eventually avoid the necessity for the separate state government accreditation of properties which consign interstate.

As mentioned on page 3, in several states there is some thought on incorporating a number of relevant state government regulations into accreditation scheme guidelines. Of course, it may possible to operate a national accreditation scheme based on a core of commonly accepted criteria and separately incorporate compliance with government regulations into association membership qualifications or as a state accreditation requirement, however this subject requires debate.

In Victoria, Queensland and NSW, the NAV, QNIA and NIAN have placed varying degrees of emphasis on the environment of the plants and how suited it is to the range of stock grown, and its general vigour and nutrition. In Victoria the general appearance of the nursery is also important.

Should these factors be included in a national scheme? If so, to what extent?

Water quality can affect the production of nursery plants in some areas. There is a requirement by the QNIA accreditation scheme that water be of a suitable quality. Is there any objection to this being incorporated into the technical guidelines? If so, what should be the water quality criteria used, and what authority would be acceptable.

It is with these factors in mind, that the following is presented.

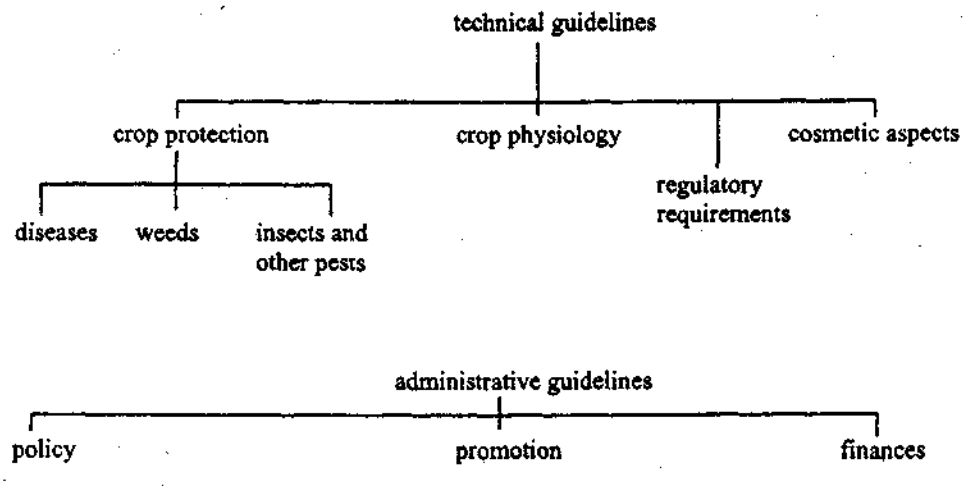
Proposed guidelines for a national nursery accreditation scheme

These suggestions are based on factors falling within two broad categories:

- the technical guidelines, and
- the administrative guidelines.

These are further divisible and can be represented as in Figure 2.

Figure 2. Factors to be considered in developing national nursery accreditation guidelines.



1. Technical guidelines

1.1 Crop protection

1.1.2 Disease prevention and control

A list of pathogens ('the specified pathogens') considered to be of general concern to the nursery industry in all states needs to be generated, for the purposes of a national accreditation scheme. *Phytophthora spp.* would appear to be an obvious inclusion, but please also consider *Rhizoctonia solani*, plant parasitic nematodes, *Cylindrocladium scoparium* and *C. spathiphylli* and bacterial diseases such as crown gall. The prevention of root diseases is a major consideration as, once contracted, most cannot be eradicated in a commercial or end use situation. Root rot prevention relies on a complete package of strategies which is successfully operated only when the life cycles of the pathogen are fully understood. Where a root rot outbreak occurs in a nursery set up with what appears to be the full complement of cultural and physical barriers to the completion of pathogen life cycles, the cause is almost invariably due to a lack of staff or operator training. Consequently the chairpersons of state accreditation committees which are not currently offering an educational component in their accreditation process may wish to consider one.

An outline of a hygiene guideline is given below. It is essentially a blend of state accreditation scheme guidelines already in operation. It is intended that this be the basis for further discussion on root rot prevention strategies adopted by a possible national process.

1.1.2.1 Water

Reticulated (town) water and water from bores and clean roof catchments do not require treatment.

Water from surface supplies, effluents, or water testing positive for the presence of root-rot organisms must be disinfested by an approved method (chlorination, bromination, microfiltration). Some resolution needs to be made regarding required contact times between the biocide used (for example chlorine) and the pathogen. For instance, in-line treatment is accepted in some situations by accrediting authorities but tank treatments (hence possibly longer contact times) may be required by others. There is no doubt that in-line injection followed by tank storage offers a greater degree of confidence in controlling a wide range of pathogens (excluding nematode eggs), but there is limited evidence that in-line injection is not effective in controlling zoospores of *Pythium* and *Phytophthora*, in all situations. Ultraviolet irradiation may be considered where testing proves its efficacy. Disinfestation systems must be regularly monitored by the operator.

The subsequent storage of treated water requires facilities and procedures that do not allow for recontamination by untreated water, soil, plant debris, dust and animal movement.

1.1.2.2 Growing media/propagating media

Disinfestation of media. Media or media components must be treated by an approved method (steam /air or other heating methods capable of elevating suitable volumes of medium to 60°C and maintaining that temperature for 30 minutes, or by an approved chemical biocidal drench or an approved fumigant (methyl bromide, methyl bromide plus chloropicrin, or dazomet) using concentrations and contact periods which must be agreed upon nationally. Note that methyl bromide is most likely to be withdrawn from use from 1994.

Both WA and the NT require that propagating media are treated, and the NT requires that growing media are also treated.

Treatment need not apply to media or media components which are properly stored and are generally recognised as being free of major root pathogens, or are from a source tested free of specified root pathogens.

Storage of media. Media need to be stored in facilities which effectively prevent infestation or reinfestation by root rot organisms.

As such, all media and media components which are already treated, or do not need treatment are to be stored on surfaces and in areas which both shed and exclude runoff water and exclude contamination by soil and other possibly contaminated materials. Alternatively, media can be stored in bins, trailers and trolleys.

Different batches of media should be stored separately to avoid possible cross contamination.

All storage surfaces must be suited to easy cleaning and disinfestation between batches.

Mixing of media. Media mixing areas (where media are not to be subsequently treated) are to be constructed with sealed and well drained surfaces.

Storage areas for approved and/or treated media must be effectively separated from areas used to store possibly contaminated media.

Transport of media. Treated media and media determined as being free of specified pathogens must not be contaminated during handling and transport.

Equipment used to transport media must be washed and sanitised between loads, if the vehicle is also exposed to unapproved media or media components.

Approved media suppliers. Media components other than those generally accepted as being pathogen-free (for instance imported peatmoss, perlite, vermiculite, expanded polystyrene) and those which are routinely disinfested by any of the approved methods already described, must be from an approved source. An approved source is an accredited supplier of materials from specified pathogen-tested extraction, storage and mixing sites.

Reuse of media. In several schemes, reuse of media, even after the application of an approved disinfestation process is not allowed. This needs debate on a national basis.

Routine disinfestation of propagating media. This is currently a requirement in some states and not others, and requires debate.

Experience indicates that peatmoss, perlite, vermiculite and properly composted pine barks prepared on clean surfaces, are most often free of the most common pathogens occurring in propagating facilities, (*Pythium spp, Rhizoctonia solani, Fusarium spp, Cylindrocladium scoparium, Phytophthora spp* and *Botrytis cinerea*). Experience also indicates that contaminated propagules, tools, containers, preparation surfaces, water and dust and splashed or windborne inoculum present a much greater risk.

Sand, particularly river sand, presents a significant risk of carrying *Pythium, Rhizoctonia*, nematodes and *Phytophthora* however.

1.1.2.3 Motherstock plants

Stock plants must be free of specified pathogens.

Seeds must either be collected from the plants or if collected from the ground, treated in an approved manner. This could include the use of a suitable heat disinfestation procedure or chemical treatment, depending on the nature of the material.

Cuttings must be obtained from pathogen-free plants, and where possible, from parts of the plant not subjected to contamination by soil. Motherstock should be treated regularly with fungicides to decrease the possibility of diseases entering propagation facilities.

Where motherstock is inground, good drainage is essential.

1.1.2.4 Working surfaces

Benches used to plant or prepare plant propagules need to be constructed of non-porous materials or covered with non-porous materials which are cleaned at least daily but preferably between batches of media or propagules.

Approved methods of disinfestation of surfaces need to be discussed, however cleaning the surfaces prior to disinfestation is essential. Disinfestants currently in use are chlorine solutions (2 500 - 5 000 ppm chlorine, methylated spirits, quaternary ammonium chlorides (for example, Biogram at 2%) or other unspecified disinfectants approved by the inspector.

1.1.2.5 Tools

All tools need to be treated between batches of media or after use, by first removing any adherent materials and then either using heat (as specified previously) or by dipping or swabbing with any of the chemicals listed in Section 1.1.2.4. An additional disinfectant for tools is formalin.

1.1.2.6 Footwear

Where contamination of footwear is possible either it should first be cleaned and then disinfected, or changed at different work stations. Methods of disinfestation should be in compliance with health regulations in each state. Waterproof footwear is required. Regularly replenished and cleaned footbaths may be essential in some situations (for instance at entries to in-ground sites).

1.1.2.7 Vehicles

Vehicles from possibly contaminated sites which enter clean nursery sites should be first cleaned of any adherent soil or detritus and then disinfected using any of the approved surface sterilants. It is ideal however, to restrict the passage of possibly contaminated or regularly contaminated vehicles into production or media preparation sites.

1.1.2.8 Access

Access to in-ground stock areas and propagation facilities must be restricted.

Propagation areas must not be thoroughfares for staff or materials involved in materials and plant handling operations unrelated to propagation.

1.1.2.9 Removal of plant and media wastes

Discarded and diseased plants and spilt media are to be accumulated in specially allocated containers and disposed of on a frequent basis. It is unsure at this stage if used media can, for the purposes of accreditation, be reused. It is far more likely that used media, with potentially much higher levels of disease inoculum and possibly detrimentally changed physical and chemical properties, is going to present future problems.

1.1.2.10 Floors and pathways

Propagating facilities. Paths should be sealed in propagating areas. Gravel is permitted under benches where beds or benches are raised, and the floors are well drained and the aggregate coarse (10-25 mm diameter) and at least 75 mm deep. However disease organisms such as *Botrytis cinerea* can become a problem in older facilities where gravel is used. Floors should be washed and treated with sanitising solutions on a frequent basis. Plant debris must not be placed on the floor. Dead and diseased plants and propagules should be placed directly into specially allocated containers (Section 1.1.2.9).

Production facilities. Pathways adjacent to production facilities should be sealed using bitumen or concrete or by the use of coarse gravel (10 mm - 25 mm diameter) on a consolidated graded surface at a depth of at least 75 mm. All pathways must shed water. That is pooling is as unacceptable on pathways as it is on surfaces used for plant production.

Roadways adjacent to production facilities must be properly drained and consolidated, and preferably sealed. Dust from roads should not enter production or propagating areas.

1.1.2.11 Quarantine areas

Plants or propagules entering the nursery from unaccredited sources need to be placed in a specially designated quarantine area. If they need to be repotted this is permissible but they may not be treated with fungicides or nematicides which mask disease symptoms. The period of quarantine is dependent on whether the plants are to be disease tested or not. If not disease tested, the plants must not be removed from quarantine for at least six weeks. It is especially important that the specially designated quarantine area is such that drainage water from it is not allowed to enter other propagation or production sites on the nursery.

1.1.2.12 Potting facilities

Containers, plants to be potted, and the growing medium and the newly potted plants must not come into contact with possibly contaminated materials or surfaces during potting operations.

1.1.2.13 Plant handling

Plants and/or their containers must not come into contact with possibly contaminated plants or materials, during handling operations on the nursery.

1.1.2.14 Washing facilities

The importance of removing disease inoculum from nursery workers is underrated. *Pythium, Rhizoctonia, Phytophthora* and *Cylindrocladium* can be transmitted to benched plants by the use of soiled hands. Good access to hand washing facilities and their routine use is essential in a disease prevention programme. While a hand washing biocide recommended by State Health Departments may be necessary in some situations, soap and water used with a brush is usually suitable.

1.1.2.15 Containers

Where new containers can be stored free of soil, plant debris and drainage water contamination, they need not be sanitised. Clean and sanitised containers must be stored above floor level. Sanitising chemicals are dangerous and the nursery must be equipped to use them safely.

Used containers must have all detritus removed prior to disinfecting. This means that plant containers must be washed thoroughly prior to treatment. Methods of treatment include treating with steam/air (as for media), chlorine solutions (2 500-5 000 ppm available chlorine for at least five minutes) fumigants (for instance methyl bromide at manufacturer's recommended rates) or formalin. (Note that formalin must not be used on polystyrene containers such as Speedling® trays. Sanitising chemicals are dangerous and the nursery must be equipped to use them safely. They must then be handled and stored as recommended.

1.1.2.16 Beds and benching

The pathogens that a national nursery accreditation scheme should be most concerned with are those that are soil and waterborne. As described in Appendix I, contaminated water, growing media (including soil), surfaces and infected plants are the elements which allow the continuity of pathogen lifecycles. In nursery propagation and production sites, the water most likely to be contaminated is drainage

water, and the growing media most likely to be contaminated is that prepared at the nursery or residual on used pots, tools and surfaces on which plants and new media are placed. Also bear in mind that water splash is a marvellous way of spreading these diseases and many other diseases as well.

A suitable surface for the handling, propagation and growing of plants is therefore one which isolates them from the above sources of contamination, and it is this that accreditation schemes are attempting to define.

There are elements of risk of contamination in different situations and it is therefore difficult to be didactic about bench and bed specifications, but for the purposes of disease prevention the following recommendations have proved useful.

In many situations however, the inspector should be given some discretion in the interpretation of these guidelines, as long as he/she has the necessary technical background.

Propagating beds for inground plants. Beds must be raised above surrounding surfaces (preferably a minimum of 30 cms) and freely draining. Footbaths containing specified and regularly replenished solutions are necessary at entrances to areas where beds, rather than benches are used. There must be limited access and strictly defined entry points for both vehicular and foot traffic.

Motherstock beds. See Section 1.1.2.3 Motherstock plants.

Production beds for containerised stock. The surface of the bed and the pathways adjacent to it must prevent contact of the plant, the plant roots or the container, with soil or water contaminated by soil (or media) or water draining from containers or from any other possibly contaminated sources.

Weedmat alone is insufficient. Polythene on soil is not permitted. Concrete or bitumen surfaced beds are permitted only where exceptionally good drainage occurs and all other hygiene practices are excellent. Beds with these surfaces must not pool water and must be separated as much as possible from adjacent production sites in terms of effluent runoff.

Experience indicates that aggregate (screenings of 10 mm and preferably higher diameters) covered surfaces are effective where the surfaces are consolidated, well drained and the aggregate is 75 mm deep (preferably deeper). Puddling is definitely not permitted. Weedmat over aggregate is preferred, as it keeps the material free of crop debris and potting mix spill, and reduces root escape. Fumigation of the soil with methyl bromide and chloropicrin mixtures is recommended prior to surfacing on contaminated nursery sites where

aggregate is not being place over an imported roadbase, and where care is taken in preventing recontamination.

Benches. Where benches are used, the suitability of the height is dependent on the type of surface underneath. Benches over either properly sealed or aggregate surfaced floors and paths and grown in polyhouses/glasshouses with low precipitation rate irrigation outlets, need not be higher than 30 cm.

However, where splash and other methods of contamination are likely to occur, a suitable bench height is 75 cms or higher.

The bench surface should preferably be free draining (for example galvanised mesh) and easily disinfested. Solid surfaces or benches, such as those used for capillary watering systems are permitted only where all other hygiene practices are sound.

Hanging baskets and double benches are allowed in growing areas providing all other hygiene requirements are met.

1.1.2.17 In-ground production

Accreditation of in-ground production sites is permissible, where the production sites have tested free of the specified pathogens. Long term disease freedom of in-ground sites has been proven possible but only where great care has been taken to quarantine these sites effectively. This can be expensive but has been very cost effective where the aim has been the supply of specified disease free plants (such as those used in timber production).

The accreditation of in-ground production sites is very dependent on comprehensive site sampling and this may be expensive.

Previously disease contaminated sites may be adequately disinfected with properly applied fumigants (methyl bromide). This has been very effective in the long term eradication of *Phytophthora spp* in Queensland, but less effective with *Fusarium spp.* in many situations. Again, success will depend on effective quarantine after treatment.

In all cases, the area must be well drained. Where the soil type is heavy and consequently, internal drainage is restricted, a raised bed system must be developed.

All water from adjacent areas must be deflected from the production area and roadways. The production site needs to be broken up into as many discretely drained blocks as possible. In this manner, if infection does occur, it can be restricted to a limited part of the nursery.

Surface drains need to be properly stabilised.

Vehicle access to production sites needs to be as limited as possible.

The growing area needs to be fenced to prevent the access of large animals and vehicles, which may carry soil infested with weeds and disease organisms.

1.1.3 Weed Control

Growing media

Growing media supplied to the nursery must be free of weeds and weed propagules. This includes cryptogams such as ferns and liverworts.

Storage and mixing areas must be free of weeds and weed propagules.

Propagation areas and production areas must be free of weeds. Weeds which produce windborne seed must be suppressed on the nursery site, even when outside of the immediate production area.

1.1.4 The prevention and control of insects and other invertebrate pests

There have yet to be any firm guidelines on absolute levels of insect control in Australian nursery accreditation systems. While it would be prohibitive to rule on levels of pest freedom equivalent to export phytosanitary requirements, particularly in an era of minimised pesticide usage, some consideration should be given to this subject. Freedom from a number of specified insects may be contemplated, including those already covered in interstate quarantine guidelines.

As with the control of unspecified diseases, it must be expected that the control of insects and mites on accredited nursery sites is also of a high level.

1.1.5 Crop protection programmes in general

1.1.5.1 Equipment

Application equipment must be suited to the task, be calibrated regularly and kept in good working order. The personnel operating the equipment must have access to adequate and properly used measuring devices and safety equipment.

1.1.5.2 Personnel

Persons responsible for crop protection procedures must demonstrate an adequate knowledge of pest and disease diagnosis, pest and disease control procedures, crop hygiene, and the safe use of pesticides.

1.1.5.3 Pesticide storage and mixing facilities

These must meet the minimum requirements of the relevant government regulations.

1.1.5.4 Pest and disease control programmes

These must be capable of controlling correctly diagnosed or identified target organisms without causing significant damage due to pesticide induced phytotoxicities.

1.1.6 Records

Complete records of the chemicals used, the rates, the dates of application, the approximate volumes (or weights) applied, the section of the nursery sprayed and/or the crops treated, and the name of the spray operator, must be maintained.

1.2 Regulatory requirements

A number of nursery industry associations have expressed an interest in including state government regulations in their accreditation schemes.

Other have expressed some antipathy to this and wish to keep their schemes separate from government regulatory processes, as discussed on page 3.

Thus, some debate is required. Of course, it may be possible for a national scheme concentrating on a core group of issues to develop, with adjuncts required by state nursery associations administered at that level.

1.3 Cosmetic requirements

While it is expected that scheme plants will be produced by a system that ensures a superior degree of disease freedom there are varying levels of requirements in the various state accreditation schemes, with regard to their other attributes.

Physiological aspects are discussed in the following section (1.4).

Apart from plants which have the attributes of being raised under improved crop protection and cultural programmes however, there are other properties that need to be defined for nursery crops sold mainly on their cosmetic appeal. These include shape, foliage density etc. Whether or not these are considered in an accreditation process is largely philosophical and only resolved by debate.

However, the general appearance of the nursery itself is of importance in at least one state scheme (Victoria), and if a national scheme is to eventuate, this needs to be considered.

1.4 Crop physiology

The inclusion of the following factors in a national scheme, and if included, their scope, will require discussion. However there are guidelines already utilised in some state schemes and a number of these are included here.

1.4.1 Water

1.4.1.1 Quality

The quality of the various supplies of irrigation water available to the nursery must be of a known analysis, to determine the degree of mineral content and its possible effects on the quality of stock produced. Where previous analyses indicate that salinity levels are borderline or likely to fluctuate, analyses should be conducted on at least an annual basis. Analyses are currently conducted free by government laboratories in most states. Where irrigation water is deemed of borderline quality, salinity mitigation procedures should be employed, as should methods of water treatment such as iron precipitation.

1.4.1.2 Irrigation

Irrigation equipment and practice must suit the needs of the crop in terms of the uniform distribution of water and effective irrigation scheduling. Waste water, particularly that containing fertilisers and/or pesticides should be minimal in volume and preferably disposed of by the use of an approved discharge system or recirculated. Growing media should have a suitable range of physical properties in terms of water holding capacity, aeration and drainage. Plants requiring a hardening-off period should be able to be placed under a modified watering regime.

1.4.1.3 Humidity

The humidity of atmospheres maintained in nursery structures should not continually exceed levels beyond which plant health becomes a persistent problem, or the plant is poorly adapted to its new environment.

1.4.2 Wind control

The physiological and physical damage sustained by plants should be, where necessary, minimised by the use of suitably constructed

windbreaks. Windbreaks and other methods of dust control must be employed **where applicable**.

1.4.3 Light

The crops should be grown under light regimes suited to the needs of the species. Where necessary, facilities should exist to acclimatise plants to light levels used by the purchaser. Light levels in the dispatch area and in the transport process should not exceed the tolerance of indoor plants. Light levels in retail sites must be sufficient to sustain growth of both indoor and outdoor nursery crops.

1.4.4 Temperature

Modified temperature regimes should not be outside the tolerance range of the majority of crops grown. In the event of an environmental control failure (for example, with low precipitation frost mitigation, greenhouse cooling or greenhouse heating), the nursery operator must be prepared to grow-on the damaged plants for a period sufficient to guarantee both quality and continued plant vitality.

1.4.5 Nutrition

The nursery operator should demonstrate a thorough knowledge and control of crop nutrition. In addition, enough information on the nutritional practice of the nursery should be relayed to the inspector to assure him/her that the operator consistently uses an effective programme. The operator needs to supply the outgoing plants with the nutritional reserves required to maintain the plants for long enough to meet the needs of the purchaser.

1.4.6 Structures

Structures should be adequately maintained, comfortable to work in during periods of peak staff activity, and suited to their design purposes.

1.4.7 Root binding

This subject has been discussed by several state nursery associations, particularly with regard to tubestock and stock destined for landscape purposes (mainly home garden but also professional landscapes). The subject requires a decision on whether or not it is incorporated into national accreditation guidelines and if so, how it is to be evaluated.

2. Administrative guidelines

2.1. Policy

2.1.1 Aims of the scheme

Under NIAA Goal 3 - National Quality Assurance and Accreditation Objective, the aims of accreditation and quality management are:

- enhancement of domestic and export market performance,
- improved consumer confidence,
- improved quality,
- increased profit.

However a national accreditation scheme also offers a number of other desirable outcomes. These are:

- acting in sympathy with environmental concerns related to safe pesticide use and the reduced spread of diseases such as *Phytophthora*, and
- benefiting the consumer.

2.1.2 Eligibility

This is one of two matters of policy which are most likely to cause disharmony, should participation in a national accreditation scheme be:

- obligatory for nursery association members,
- voluntary for nursery association members,
- voluntary for all nursery operators and relevant allied industry concerns,
- obligatory for all nursery operators as part of government regulations?

Obligatory participation is seen by some industry representatives as being necessary in guaranteeing that the aims of accreditation, particularly with regard to the environmental and regulatory aspects, are met.

Voluntary participation is viewed by others as being an opportunity to display to commercial advantage, that their nurseries operate according to a recognised set of guidelines.

An argument for voluntary participation is that it attracts participation and perhaps increases association membership without alienating existing members.

The existence of accreditation schemes is considered by associations which offer voluntary participation, as being enough of a competitive incentive for non-participants to upgrade their facilities and practices.

2.1.3 Involvement with government regulatory processes

This is the second policy consideration that will provoke argument.

To date, all of the schemes have had an involvement with state government technical officers, and almost invariably those with a plant protection background or nursery industry training.

The state governments have been quick to support and endorse the schemes because of their aims, particularly those related to disease freedom, the move towards quality management and upgraded technology and the environmental aspects.

Attempts, mostly successful, have been made to involve government officers as inspectors, for the purpose of guaranteeing impartiality in the certification process.

While there have been few significant objections to the above involvement of public institutions with accreditation schemes, there have been worries that a further involvement may lead to regulatory authorities gaining control of the accreditation process. It has been necessary in both Queensland and Victoria, for instance, for the industry associations to repeatedly underline the fact that they, and not government, are in total control of accreditation.

2.1.4 Administration

There are options on how a national accreditation scheme may be administered. One possible operation could be that described by Figure 1 (page 7).

All existing state schemes are overseen by accreditation committees. It should therefore be possible to select delegates representing the interests of each state's industry when constituting a national committee.

It would appear that the continuation of state accreditation committees would be necessary should a national process arise, both to ensure the above, and to administer the day to day mechanics of accreditation (allocating and collecting finances, granting and rescinding accreditation, selecting inspectors, and further updating and developing the scope of accreditation).

Promoting accreditation on a national basis and determining national accreditation policy would appear to be the responsibility of a national body.

2.1.5 Privileges

Accredited nurseries may state so in advertising and in displaying the approved logo.

2.1.6 Responsibilities

An accredited nursery may not guarantee plants as being disease, pest or problem-free as a consequence of gaining accreditation, nor shall any warranty be implied by the state or national accrediting authorities, cooperating organisations (state governments) or their personnel.

An applicant or accredited operator shall agree on request to allow an inspector under the Scheme to make inspections and/or take samples for assay, or analysis, where these have relevance to the successful operation of the Scheme.

A nursery operator shall agree to refrain from using the logo and advertising as an accredited source of plants, if eligibility for accreditation lapses, and do so until accreditation is restored.

2.1.7 Termination or suspension of accreditation

Accreditation shall be suspended if, in the opinion of the state accreditation authority:

- satisfactory standards as dictated by the guidelines are not maintained, or
- the business does not abide by the schedule of fees,
- the nursery misrepresents unaccredited plants.

The period of suspension is reliant on the time taken to implement remedial action.

2.1.8 Restoration of accreditation

The Accreditation Committee retains ownership of the annual and dated certificate of accreditation and requires its return if accreditation is suspended or terminated. The Accreditation Committee will restore accreditation upon the nursery or relevant allied business once all of the necessary guidelines are again successfully met.

Additional costs due to extraordinary inspections and/or sample processing will be borne by the nursery or allied business operator.

2.1.9 Site accreditation

If a nursery or relevant allied business operates at two or more sites, each relevant site must be separately accredited if produce from each site is to be marketed as accredited produce.

2.1.10 Fees

To be determined.

Fee structures have been determined for the Western Australian, Victorian and Queensland schemes (Appendices II, IV, VIII), and these may act as a guide.

2.2. Promotion

One of the major advantages in nationalising accreditation is the enhanced promotional opportunities, both domestically and offshore. It is obvious that a national accreditation committee in conjunction with a national promoting body would best ensure success.

2.3 Financing

As accreditation is a user-pay process and state associations are best suited to collect fees it is also suitable that these should administer fees but in turn also finance the activities of the national body.

APPENDIX I

Major plant pathogens of relevance to nursery accreditation

Major disease problems in nursery plant production

Root rot and other diseases are serious problems to contend with in nursery production of many plants. Major diseases are caused by the fungi, *Phytophthora, Pythium, Cylindrocladium, Rhizoctonia* and *Fusarium.* Other fungi, such as *Sclerotinia, Sclerotium* and *Verticillium*, nematodes and bacterial plant pathogens are also important.

The consequence of disease in potted plants is, or has been:

- hampering of efficient nursery production
- losses, often devastating, of valuable nursery stock
- reduced lifespan of potted plants leading to lack of consumer confidence and decreased sales
- the spread of dangerous plant pathogens such as *Phytophthora* into native vegetation
- infestation of new growing areas in nurseries with pathogens not previously present
- losses of fruit, vegetable, timber or flower crops or yield reductions because of infected planting stock
- failure of landscape and interiorscape projects using diseased but initially symptomless plants
- possible interstate movement of serious pathogens such as *Phytophthora*

Large scale destruction by disease (usually caused by *Phytophthora*) in nurseries has occurred in plants such as African violets, anthuriums, azaleas, citrus, carnations, camellias, casuarinas, conifers, fuschias, Geraldton wax, grevilleas, impatiens, proteas, pothos, spathiphyllums, cinererea, dipladenias, hibiscus and orchids to name a very few.

Some examples of field plantings lost because of infected planting stock include: carnations from Fusarium wilt; Geraldton wax, casuarina, aster, protea, avocado and citrus from Phytophthora root or collar rot; capsicum, tomatoes and lettuce from Pythium root rot and Geraldton wax from Cylindrocladium disease.

Recent interiorscaping with spathiphyllums has been spoilt by Cylindrocladium root rot, and valuable potted and landscape palms have been lost because of *Phyphthora.*

Root rot diseases occur in nurseries wherever susceptible plants are grown. There is a very wide range of susceptible nursery plants and the problem is both national and worldwide. Australian nursery production sites are too often not designed to prevent these diseases.

Phytophthora

The most important, most widespread and most destructive fungus causing root rot is *Phytophthora.* Species of this fungus are important pathogens locally, nationally and globally. They cause diseases of a very wide range of nursery-grown plants, as well as affecting many timber, pasture, vine, fruit tree and flower crops.

Life cycle

Phytophthora species are soil-borne; they survive multiply and spread in soil and soil water; infested soil is usually the initial source of contamination.

Phytophthora produces a number of different spore stages. When soil, or potting mixes, are at or near saturation, and at favourable temperatures, the fungus rapidly produces large numbers of microscopic sac-like structures called sporangia. Within these are produced and released many minute spores called zoospores. Each of these spores have 2 tiny tail-like structures called flagella which enable them to swim short distances through water. However, most significant spread is in running or splashing water. Chemicals naturally exuding from roots attract swimming spores and any root injury which increases this exudation will enhance infection. Zoospores encyst on root surfaces then germinate to grow infect and destroy invaded plant tissue via fine thread-like growth. Zoospores in surface puddles may be splashed onto foliage to initiate infection. *Phytophthora* as well as *Pythium* species are often referred to as water-moulds because they depend on free water to complete their life cycle.

Phytophthora is a very successful pathogen because of its ability to rapidly build up large numbers of zoospores from very little initial inoculum. During harsh times the fungus can survive protected from complete drying out within organic particles or inside roots it has invaded. Deep seated infections are also protected against chemical treatments that may be applied. Resistant thick-walled spores, the oospores or chlamydospores enhance this survival. *Phytophthora cinnamomi* is a particularly resilient fungus; it is able to survive in soil for many years in the absence of host plants. It can act as a saprophyte, living on and surviving in organic material in the soil.

Environmental factors

Soil moisture and temperature are the major factors affecting *Phytophthora* activity. Rapid build-up of zoospores occurs in free standing water in soil and

in surface waters. *Phytophthora* species have been detected and commonly occur in puddles, in rivers, in streams and in dams. High numbers of zoospores are present following prolonged rainfall when spores in run-off from saturated soils are carried into dams or other catchments. Zoospores are delicate and short lived, surviving only a number of days to a few weeks after their production. Storing water for over 3 weeks greatly reduces zoospore numbers.

Optimum temperatures for fungal activity depends on species but usually is within the range of 20-30°C. *Phytophthora cinnamomi* has an optimum temperature for growth and sporangial production between 22 and 28°C. *Phytophthora nicotianae* is between 25 and 30°C and *Phytophthora palmivora* between 27 and 32°C.

In mild sub-tropical to tropical climates *Phytophthora* may be active for most of the year, particularly during prolonged summer rainfall periods.

Detecting *Phytophthora* and other fungal plant pathogens

There are many methods used in the laboratory to determine wether *Phytophthora* or other fungi are present in diseased plant material, soils or potting mixes. These methods include sieving soil or potting mixes for spores, baiting for fungi in soil and water samples, examining diseased plant tissue microscopically and direct culturing from roots or other plant parts to isolate the fungal pathogen in pure culture.

Collecting and despatching plant samples for laboratory testing

Correct sampling and handling of material to be checked for presence of fungi is essential. Samples should be collected from mildly to moderately affected plants, not from plants too advanced in decline, dead, or recently treated with fungicides. They should be despatched on the same day they are collected and must be protected from drying out and extremes of temperature. For root samples, for example, small quantities of affected roots with a small quantity of moist mix or soil from around the affected plant sealed in a plastic bag, should be despatched in an esky. Alternatively, small, well watered, potted plants could be sent so that the whole plant can be examined. Information including the name of the affected plant, total number of plants affected, distribution of damage, recent treatments and symptoms observed, should always be included with specimens submitted for disease diagnosis.

Direct microscope examination

Small segments of rotted plant tissue can be teased out, stained and examined under a microscope. Fungal structures such as oospores of *Pythium* or *Phytophthora*, spores of *Cylindrocladium* or characteristic hyphae of *Rhizoctonia* can be identified this way. Sporangia of *Phytophthora palmivora* can sometimes be detected on the surface of diseased above-ground plant parts. Incubating affected material in moist plastic bags may stimulate sporangial production, fungal growth or spore production allowing easier identification by microscope.

Although some *Phytophthora* species can be detected this way most can not and other methods must be used to determine their presence.

Wet sieving

Wet sieving of potting mix samples is a technique routinely used to test avocado nurseries for the presence of *Phytophthora cinnamomi.* These nurseries are participating in a voluntary accreditation scheme and are inspected annually to ensure high hygiene standards are maintained and that they remain free of *Phytophthora.* Samples of mix are washed through a nest of fine sieves to concentrate chlamydospores of *Phytophthora cinnamomi.* The contents of the smallest sieve (36µm diameter), with a small amount of water, is transfered to agar plates containing a medium selective for the growth of *Phytophthora.* After incubating plates overnight at 26°C, the plates are gently washed. *Phytophthora* colonies growing into the agar can be easily recognised and sub-cultured for closer examination. Any roots (in the potting mix samples) which appear rotted, are also plated out to check for the presence of other root rot pathogens such as *Pythium* or *Rhizoctonia.*

Baiting for *Phytophthora*

Soil or mix samples are placed in plastic cups and sterile distilled water added, usually about one part soil to six parts of water. Baits of plant material are floated on the surface of the soil-water samples and kept at about 26°C for 2-5 days. Zoospores are produced and these invade the bait. As soon as obvious rotting occurs baits can be plated out onto selective media, or examined microscopically.

Bait material that has been successfully used locally includes pineapple leaf bases, leaf or leaf pieces of African violets, avocados, azaleas, umbrella tree, citrus or Geraldton Wax and N.Z. blue lupin seedlings. Lupin seedlings probably have the highest success rate for baiting of most different *Phytophthora* spp. Numerous other materials can be used (3c). Semi-mature *Schefflera actinophylla* leaves have been used with reasonable success to bait for some *Phytophthora* spp. from soil and water supplies. Leaves turn dark when they begin to rot, making infected baits easy to see. This plant is a natural host of *Phytophthora drechsleri, Phytophthora nicotianae* and *Phytophthora palmivora* but not *Phytophthora cinnamomi.* Baits successful for some *Phytophthora* spp. may not be successful for others. Bacteria and *Pythium* spp. can also invade baits causing problems. Early isolations from baits, onto selective media will confirm the presence of *Phytophthora.* Sometimes sporangia can be detected microscopically on bait margins.

Baiting methods should be thought of as a back up only and to be used only when freshly infected plant material can not be directly plated out.

Direct isolations

Direct isolation from roots or other plant parts is by far the most reliable way to detect *Phytophthora.* Generally, with the aid of selective media, *Phytophthora*

is easily and rapidly cultured from freshly collected samples taken from recently infected plants. It may be very difficult to isolate from old infections or dried out samples.

In the laboratory, root, stem or leaf material showing symptoms is washed under running tap water. Leaf material is surface sterilized by dipping in a 1% sodium hypochlorite solution then rinsed in sterile water. Roots are surface sterilized by immersing in a 50% alcohol solution for 30 seconds, then rinsed thoroughly in two changes of sterile water. Plant material is then thoroughly dried between sheets of sterile blotting paper. Small segments of rotted roots or other parts from margins of rotted areas, are placed onto selective media. Media routinely used to culture *Phytophthora* and *Pythium* is 'P_{10}VP' (Pimaricin 10 ppm, Vancomycin 200 ppm, PCNB 100 ppm in a corn meal agar base), with hymexazol (50ppm) sometimes added to inhibit growth of most *Pythium* spp. (8b). '3P' containing pimaricin, polymixin and penicillin antibiotics (3b) is also used. Many other selective medias, some which may be more effective, can be used (3c).

Generally, to check for the presence of other pathogens such as *Rhizoctonia* or *Cylindrocladium* a general medium such as P.D.A. (potato dextrose agar), to which can be added streptomycin sulphate (40 µg/ml) to inhibit growth of unwanted bacteria, is also used when isolating from rotted roots or other diseased material.

Slow growing, coarse hyphae (ranging from 5-14 µm wide) of *Phytophthora* can usually be seen growing out from material on selective media within 24 - 72 hours. *Phytophthora* cultures can be distinguished from *Pythium* by their comparatively slow growing, stout and stiffly branched, non-septate hyphae, often with distinct and obvious hyphal swellings. *Pythium* spp. are generally fast growing, with fine (5-10µm wide) and flexuous hyphae. *Phytophthora* and *Pythium* cultures are sub-cultured and identification is confirmed by inducing and examining sporangia and oospores.

Isolation of most root rot pathogens is relatively easy from freshly infected plants. Non-selective culture media is successful for many pathogens and sometimes even *Phytophthora*. However, the use of a medium such as 'P_{10}VP' + hymexazol, almost exclusive for the growth of *Phytophthora*, or '3P' for *Phytophthora* and *Pythium*, gives rapid results and allows for quick identification of these serious root rot pathogens.

Phytophthora cinnamomi host list

Phytophthora cinnamomi, in terms of overall damage it has caused, is the most important and best known member of the genus *Phytophthora*. This infamous root pathogen occurs all over the world and has an extremely wide host range. More than 900 hosts were listed in 1980(9). This fungus is responsible for one of the world's most spectacular diseases, Jarrah dieback in Western Australia.

This host list, and lists for other *Phytophthora* species, emphasises nursery-grown plants but also includes some fruit, nut, or vegetable crops, trees, herbs and other plants. References to sources of information are included. For some genera

individual species are too numerous to list and only the total number of species recorded is included. Refer to original references for more detailed information.

These lists do not include all hosts recorded and recordings are not proof of pathogenicity. New recordings are continually being made. However, the lists give an appreciation of the potential of *Phytophthora* and aid in the diagnosis of problems.

Hosts of *Phytophthora cinnamomi*

Abelia - 2 spp. (9)
Abies - 5 spp. (9)
Acacia - 19 spp. (9), 4 spp. (5a)
Acer platanoides (9)
Acronychia oblongifolia (9)
Acrotriche serrulata (9)
Actinotus helianthi (9)
Adenantehos - 2 spp. (9)
Agathis australis (9)
Agonis flexuosa (5, 9)
A. hypericifolia (9)
Alectryon excelsus (9)
Aleurites fordii (9)
Ananas comosus (8, 9)
Angophora floribunda (9)
Anthoceris racemosa (9)
Antidesma pulvinatum (9)
Antirrhinum majus (9)
Aotus - 3 spp. (9)
Araucaria araucana (9)
A. cunninghamii (9)
A. excelsa (9)
Arbutus unedo (9)
Archontophoenix cunninghamii (1b)
Arctostaphylos uva-ursi (9)
Astartea fascicularis (5, 9)
A. heteranthera (9)
Astelia trinervia (9)
Astroloma - 2 spp. (9)
Astrotricha floccosa (9)
Azalea (= *Rhododendron*) sp. (9)
A. mollis (= *Rhododendron molle*) (9)
Baeckea brevifolia (9)
Banksia - 23 spp. (9)
Bauerea sessiflora (9)
Beaufotia sparsa (9)
Betula papyrifera (9)
B. pendula (9)
Boronia - 7 spp. (9)
Bossiaea - 3 spp. (9)
Brachyloma daphnoides (9)
Buddleia variabilis (= *B. davidii*) (9)
Burtonia conferta (9)
Buxux sempervirens (1, 9)
Calceolaria crenatiflora (9)
Callistemon citrinus (9)
Callitris - 2 spp. (5), 3 spp. (9)
Calluna vulgaris (9)
Calocedrus decurrens (9)
Calycanthus floridus (9)
Calytrix - 3 spp. (9)
Camellia - 4 spp. (9)
Cananga odorata (9)
Carnarvonia sp. (1b)
Cassinia aculeata (9)
Castanea (4)
Casuarina - 16 spp. (9)
Ceanothus sp. (9)
Cedrus atlantica (9)
C. deodora (9)
Ceratopetalum gummiferum (9)
Cercis canadensis (9)
Chamaecyparis lawsoniana (5, 9)
C. obtusa (9)
C. pisifera (9)
Chamelaucium axillare (5, 9)
C. cilliatum (9)
C. uncinatum (5, 9)
Chamaescilla corymbosa (9)
Chrysanthemum cinerariifolium (9)
Cinchona - 4 spp. (9)
Cinererea grandiflora (= *Senecio cruentus*) (9)
Cinnamomum - 6 spp. (9)
Clianthus formosus (5)
Coleus sp. (8)
Comptonia (4)
Conospermum longifolium (9)
Conostephium pendulum (9)
Conostylis setigera (9)

Coprosma - 3 spp. (9)
Cordyline murchisoniae (1b)
Cornus - 2 spp. (9)
Corokia buddleoides
Correa - 4 spp. or cv. (9)
Cotoneaster (4)
Crowea dentata (9)
C. exalta (9)
C. saligna (9)
Cryptandra tomentosa (9)
Cryptocarya - 2 spp. (9)
Cryptomeria sp. (9)
Cupressus - 9 spp. or cv. (9)
C. sempervirens (5)
Cyathodes - 3 spp. (9)
Daboecia cantabrica (9)
Dampiera linearis (9)
Daphne - 2 spp. (9)
Darlingia darlingia (1b)
Daviesii - 5 spp. (9)
Dianella nigra (9)
Dicranopteris (4)
Didymochlaena truncatula (10)
Dillwynia - 6 spp. (9)
Dipterocarpus turbinatus (9)
Dodonaea - 3 spp. (9)
D. triquetra (5a)
Dracena (4)
D. marginata (1)
Dryandra - 4 spp. (9)
Echeveria gibbyflora (9)
Elaeocarpus reticulatus (5a)
Embothrium coccineum (9)
Endiandra discolor (9)
Epacris - 4 spp. (9)
Erica - 17 spp. (9)
Eriostemon - 4 spp. (9)
Escallonia macrantha (9)
Eucalyptus - 152 spp. (9)
as *Eucryphia*
Syzgium aromaticum (9)
Achmena smithii (9)
Exocarpus cupressiformis (9)
Fagus sylvatica (9)
Fatsia japonica (9)
Ficus (4)
Flindersia (4)
Forsythia sp. (9)
Freycinetia arborea (9)
Ghania xanthocarpa (9)
Gaultheria - 2 spp. (9)
Geniostoma ligustrifolium (9)
Geranium sp. (9)
Gleicheria circinnata (9)
Grevillea - 20 spp. or hybrids (9)
Hakea - 12 spp. (9)
Haloragis - 3 spp. (9)
Helichrysum diotrophyllum (9)
H. obcordatum (9)
Helmholtzia glaberrima (10)
Hibbertia - 10 spp. (9)
Hibiscus rosa-sinensis (9)
Homoranthus virgatus (5a)
Hovea - 3 spp. (9)
Hypericum hookeranum (9)
Hypocallyma - 3 spp. (9)
Ilex - 6 spp. (9)
Iresine lindenii (9)
Isopogon - 6 spp. (9)
Jacaranda acutifolia (9)
Juglans (4)
Juniperus - 3 spp. (9)
Kalmia latifolia (9)
Knightia excelsa (9)
Kunzea - 4 spp. (9)
Lagunaria patersonii (9)
Lambertia multiflora (5)
Larix - 2 spp. (9)
Lasiopetalum floribundum (9)
Laurus nobilis (9)
Lechenaultia - 4 spp. (9)
Leptospermum - 9 spp. or cv. (9)
Leucadendron - 22 spp. (7)
Leucopogon - 11 spp. (9)
Leucospermum - 24 spp. (7)
Leucothoe catesbaei (9)
Leycesteria formosa (9)
Libocedrus decurrens (9)
Lilium sp. (9)
Lissanthe strigosa (9)
Lithocarpus densiflorus (9)
Lomandra sp. (9)
Lupinus - 2 spp. (9)
Lycopodium (4)
Macadamia - 2 spp. (9)
Macrozamia - 3 spp. (9)
Matthiola incana (9)
Melaleuca - 11 spp. (9)
M. hypericifolia (5)
M. striata (5)

Melastoma malabathricum (9)
Melicytus macrophyllus (9)
Meryta sinclairii (9)
Metrosideros collinus (9)
M. excelsas (5)
Micranthemum ericoides (9)
Microstrobus fitzgeraldii (9)
Morus alba (9)
Mucuna giganea (9)
Myristica fragrans (9)
Myrsine - 2 spp. (9)
Myrtus compacta (9)
Neopanax arboreus (9)
Nicotiana - 3 spp. (9)
Nothofagus - 6 spp. (9)
Olea sp. (9)
Olearia - 2 spp. (9)
Oxylobium - 3 spp. (9)
Pandanus sp. (9)
Passiflora sp (9)
Patersonia - 2 spp. (9)
Pernettya mucronata (9)
Persea - 12 spp. (9)
Persoonia - 3 spp. (9)
Petrophila - 4 spp. (9)
Phebalium - 3 spp. (9)
Phyllocladus - 3 spp. (9)
Phymatocarpus maxwellii (9)
Picea - 3 spp. (9)
Pieris - 2 spp. (9)
Pimelea ferruginea (6, 9)
P. imbricata (9)
Pinus - 20 spp. (9)
Pipturus albidus (9)
Pittosporum tobira (9)
Platanus orientalis (9)
P. racemosa (9)
Platylobium obtusangulum (9)
Platytheca verticillata (9)
Podocarpus - 2 spp. (9)
Polystichum (4)
Pomaderris - 2 spp. (9)
Prostanthera 6 spp. (9)
Protea - 16 spp. (7)
Prunus - 6 spp. (9)
Pseudopanax - 2 spp. (9)
Pseudotsuga sp. (9)
Psidium sp. (9)
Psychotria (4)
Pteris ennsiformis (1)
Pterocarya stenoptera (9)
Pterostylis concinna (9)
Pultenea - 16 spp. (9)
P. villosa (5)
Punica granatum (9)
Pyracantha (4)
Pyrus - 2 spp. (9)
Quercus - 12 spp. (9)
Regelia inops (9)
Rhododendron - 19 spp., cv. or hybrids (9)
Robinia (4)
Ricinocarpus glauca (9)
Ricinus communis (9)
Rubus - 2 spp. (9)
Salix caprea (9)
Scaevola thesioides (9)
Schinus molle (9)
Sciadopitys (4)
Scirpus antarcticus (9)
Sedum sp. (9)
Sellaginella uliginosa (9)
Senecio sp. (9)
Sequoisea sempervirens (9)
Serruria florida (7)
Solanum - 3 spp. (9)
Sophora - 2 spp. (9)
Spartium junceum (9)
Spiraea cantoniensis (9)
Sprengelia - 2 spp. (9)
Stewartia malacodendron (9)
Stylidium graminifolium (9)
Styphelia - 3 spp. (9)
Symphytum x uplandicum (8)
Syncarpia - 2 spp. (9)
Syzygium wilsonii (9)
Taxodium distichum (9)
Taxus - 3 spp. (9)
Tecomaria capensis (8)
Telopea mongaensis (9)
T. speciosissima (9)
Tetratheca - 3 spp. (9)
Themeda australis (9)
Thomasia - 2 spp. (9)
Thryptomene calycina (5)
T. saxicola (5)

Thuja - 2 spp. (9)
Toonna (4)
Trachymene - 2 spp. (9)
Tristania (now *Lophostemon) confertus* (9)
Trymalium spathulatum (9)
Tsuga - 2 spp. (9)
Ulex europaeus (9)
Vaccinium - 2 spp. (9)
Verticordia - 4 spp. (9)
Viburnum sp. (9)
Vicia faba (9)
Vitex lucens (9)
Vitis - 5 spp. (9)
Wehlia cordata (9)
Woollsia pungens (9)
Xanthorrhoea australis (9)
X. preissii (9)
Xylomelum occidentalis (9)
Zieria laevigata (9)

Phytophthora nicotianae **host list**

A very wide range of plants are attacked by this fungus which occurs in all or many parts of the world. This pathogen causes root, stem, crown, leaf and fruit rots as well as damping-off diseases. This list includes hosts listed under *Phytophthora nicotianae, P. parasitica, P. nicotianae* var. *nicotianae* and *P. nicotianae* var. *parasitica.*

Abelmoschus (4)
Allium (4)
Agapanthus sp. (10)
Agonis flexuosa (6)
Aloe vera (= *A. barbadensis)* (1, 10)
Ananas comosus (8)
Anemone sp. (5a)
Anigozanthos manglesii (5a)
Anthurium scherzerianum (5a)
Antirrhinum majus (1)
Aphelandra squarrosa (2)
Araucaria cunninghamii (8)
Atropa (4)
Banksia - 6 spp. (6)
Bauera sessiflora (6)
Beaufortia eriocaphala (6)
Bidens (4)
Bougainvillea spp. (1)
B. glabra (1)
Buxus (4)
B. microphylla (1)
Calothamnus gracilis (6)
C. villosus (6)
Castanea (4)
Cajanus (4)
Callistemon (4, 5a)
C. citrinus (1)
Callitris rhomboidea (8)
Capsicum (4)
Carica (4), (10)
Carissa (4)
Carthamus (4)
Catharantus roseus (11)
Cattleya sp. (5a)
Cedrus deodara (8)
Celosia (4)
Chamaelaucium uncinatum (5, 6)
Chrysanthemum (4)
C. x morifolium (1)
Cissus rhombifolia (1)
Citrullus (4)
Citrus - 9 spp. or hybrids (1), 4 spp. (8)
Cordyline (4, 5a)
Coriandrum (4)
Cornus (4)
Crotalaria (4)
Crowea saligna (6)
Daphne (4)
Dendrobium sp. (5a)
Dianthus (4)
D. caryophyllus (5a)
Diosma sp. (5a)
Dracena (4)
D. deremensis 'Warneckii' (1)
Dryandra speciosa (6)
Eucalyptus pulverulenta (5a)
Euphorbia (4)

E. pulcherrima (1)
Eutaxia obovata (6)
Fatshedera (4)
x *Fatshedera lizei* (1)
Fatsia (4)
F. japonica (1)
Fortunella (4)
F. margarita (1)
Fragaria x ananassa (8)
Fuchsia (4, 5a)
Gastrolobium calycinum (6)
Gossypium (4)
Grevillea baueri (5a)
G. biternata (6)
G. drummondi (6)
G. glabrata (6)
G. rosmarinifolia (6)
G. thelemanniana (6)
Gypsophila paniculata (1, 5a)
Hakea - 5 spp. (5a, 6)
Hebe speciosa (6)
Hedera (4)
Hibiscus (4), 3 spp. (1)
H. rosa - sinensis (5a, 8)
H. sabdariffa (8)
Hovea purpurea (5a)
Howeia forsteriana (10)
Hypocalyma angustifolium (6)
H. tetrapterum (6)
Ilex (4)
Jasminum (4)
Juniperus (4)
Kopsia sp. (11)
Lavandula angustifolia (5a)
Leptospermum laevigatum (10)
Lilium (4)
L. longiflorum (1, 10)
L. tigrinum (1)
Limonium perezeii (5a)
Lupinus (4)
Lycopersicon (4)
Macadamia (4)
Mandevilla x amabilis (11)
Manihot esculenta (1)
Melaleuca bracteata (5a)
M. hypericifolia (6)
M. lateriflora (6)
M. 'Revolution Gold' (10)
Melia (4)
Mucuna (4)
Murraya (4)
Nicotiana (4)
N. tabacum (tobacco) (8)
Opuntia (4)
Passiflora edulis (passionfruit) (8)
Pastinaca (4)
Pepperomia - 3 spp. (1)
Persea (4)
Petroselinum (parsley) (4)
Petunia (4)
Paphiopedilum (5a)
Phaseolus (4)
Philodendron - 4 spp. (1)
P. martianum, P. 'Pluto' (5a)
Pilea (4)
P. microphylla (1)
Piper (12)
Pimelea ferruginea (5a, 6, 8)
Pinus (4)
P. clausa (1)
Pistacia (4)
Pittosporum undulatum (5a)
Poncirrus (4)
P. trifoliata (1)
Prostanthera - 2 spp. (5a)
Protea cynaroides (5a)
Prunus (4)
Pyrus (4)
Radermachera sinicia (10, 11)
Rheum (4)
Rheum rhaponticum (Rhubarb) (8)
Rhododendron - 4 spp. (1)
Ricinus (4)
Robinia (4)
Saintpaulia (4)
S. ionantha (2, 5a)
Salvia splendens (8)
Saxifraga sp. (5a)
Schefflera (as *Brassaia) actinophylla* (2)
S. arboricola (1)
Schlumbergera truncata (5a)
= *Zygocactus truncatus* (1)
Sempervirum (4)
Simmondsia chinensis (10)
Sinningia speciosa (1, 8)
Sollya heterophylla (6)
Solanum (4)
Spathiphyllum (4, 10)
Thryptomene saxicola (5a)

Tibouchina sp. (8)
Trifolium (4)
Vanda spp. (8)
Viburnum tinus (10)
Vinca (4)
Viola (4), 3 spp. (1)
Washingtonia (4)
Westringia fruticosa (5a)
= *W. rosmariniformis* (6)

Phytophthora palmivora host list

Phytophthora palmivora occurs world wide in high rainfall warm temperate, sub-tropical and tropical regions; it occurs on at least 138 species of plant (3), causing bud rot, root rot, damping-off, stem rot, foliage and fruit rots. Many orchids and palms as well as cacao, papaw and rubber are susceptible. 70 hosts are listed.

Agave wightii (3) F
Allium (4)
Ananas (4)
Antirrhinum majus (3)
Aralia sp. (5a) F
Archontophoenix alexandrae (3)
A. cunninghamiana (10)
Arecastrum (= Syagrus) romanzoffianum (3)
Beucarnea recurvata (1a)
Borassus spp. (3)
Bougainvillea spectabilis (3) F
Brachychiton populneum (3)
Bryophyllum calycinum (3) F
Butia capitata (2b)
Cocos nucifera (3)
Carica (4)
Catharanthus roseus (1a) (10)
Cattleya sp. (5a)
Citrus spp. (1a) (3)
Chamaedorea elegans (5a) (1a)
C. erumpens (1a)
C. seifrizii (10)
Chrysalidocarpus lutescens (3) (10) F
Cinchona ledgerana (3)
Cornus florida (1a)
Crotalaria (4)
Dendrobium (4) (5a)
Dianthus chinensis (3)
Dieffenbachia spp. (1a) (3)
Elaeis guineensis (2b)
Epidendrum sp. (3)
Erythrina spp. (3)
Euphorbia peplus (3)
Ficus lyrata (5a) F
Grevillea biternata (5a) F
Hakea sericea (5a) F
Hibiscus spp. (3) F
Hedera helix (5a) F
Hibbertia sp. (5a) F
H. scandens (10) F
Howeia forsteriana (3) (5b), F, R
H. belmoreana (3)
Impatiens balsamina (3) F
Kentia sp. (2b)
Livistona spp. (1a) (3)
Mucuna (4)
Neodypsis decaryi (1, 10) F
Nolina (4)
Normanbya normanbyi (2b)
Paphiopedilum sp. (3) (5a)
Peperomia spp. (3)
Phalaenopsis amabilis (3)
Phoenix canariensis (1a)
Pinanga insignis (3)
Pitosporum eugenioides (5a)
P. undulatum (5a)
Ptychosperma sp. (1a)
Ptychosperma macarthuri (3)
Ptychosperma acuminata (10)
Rhopalostylis sp. (2b)
Ricinus (4)
Roystonea sp. (2b)
Schefflera actinophylla (5a) F
Santalum album (3)
Sabal sp. (3)
Syagrus (4)
Techoma smithii (3)

Techomaria capensis (5a)
Trachycarpus fortunei (5a)
Vanda spp. (3) (5a)
Viburnum tinus (10)
Washingtonia filifera (1a) (3)
W. robusta (3)
Yucca gloriosa (3)
Zinnia elegans (3) F

F = foliage affected; R = root rot.

Phytophthora cryptogea/drechsleri host list

Hosts listed for *Phytophthora cryptogea* and *Phytophthora drechsleri* are included. It has been proposed that these two species be merged with the name *P. cryptogea* having priority. *Phytophthora cryptogea* has a very wide host range, occurs worldwide and in most, if not all states of Australia.

Abies (4)
Actinidia (4)
Adenanthos sericeus (6)
Albizia (12)
Allium (4)
Ananas (4)
Antirrhinium (4)
Azalea indica (6)
Banksia - 5 spp. (6)
Bauera sessiflora (6)
Beaufortia - 2 spp. (6)
Begonia (10)
Beta (4)
Boronia megastigma (6)
Cajanus (4)
Callistephus (4)
Callistemon citrinus (4)
C. viminalis (4)
Callitris pressei (6)
Calluna vulgaris (6)
Carpobrotus (4)
Carthamus (4)
Calytrix angusta (6)
Celosia plumosa (7b)
Chamaelaucium uncinatum (6)
Chrysanthemum (4)
Chicorium (4)
Citrullus vulgaris (12)
Citrus (4)
Coleonema pulchrum (6)
Coprosma repeus (6)
Cordyline australis (6)
Crowea saligna (6)
Cucumis (4)
Cucurbita spp. (7b)
Dahlia (12)
Dodonea viscosa (6)
Dryandra - 2 spp. (6)
Eucalyptus (12)
E. ficifolia (6)
Erica sp. (6)
Euphorbia (4)
Eutaxia obovata (6)
Gerbera jamesonii (1a)
Gloxinia (12)
Grevillea biternata (6)
G. dielsiana (6)
G. 'Honey Gem' (6)
G. 'Robyn Gordon' (6)
G. 'Sandra Gordon' (6)
Gypsophila (12)
Hakea - 3 spp. (6)
Hebe speciosa (6)
Helianthus (4)
Hypocalyma tetrapterum (6)
Indigofera australia (6)
Isopogon cuneatus (6)
Juniperus (4)
Kunzea - 2 spp. (6)
Lagerstroemia indica (6)
Leptospermum petersonii (5)
L. scoparium (10)
Leucaena (4)
Lycopersicon (4)
Malus (4)
Matthiola (4)
Medicago (4)
Melaleuca armillaris (5, 6)

M. bracteata (5)
M. diosmaefolia (6)
M. hypericifolia (6)
M. linariifolia (5)
M. lateriflora (6)
M. nesophila (6)
Mucuna (7b)
Nasturtium officinale (1a)
Osteospermum (4)
Papaver (12)
Parthenium (4)
Pelargonium zonale (7b)
Petunia (12)
Pimelea ferruginea (6)
Pinus (4)
Prunus (4)
Pseudostuga (4)
Rhododendron (12)
Schefflera actinophylla (5)
Schinus molle (7b)
Senecio cruentus (7b)
Sinningia speciosa (1a)
Solanum (4)
Spinacia (4)
Tagetes (4)
Tulipa (12)
Viburnum tinus (6)
Westringia fruticosa (5)
= *W. rosmariniformis* (6)
Zantedeschia spp. (1a)
Zinnia (4)

Phytophthora sp. host list

This list contains some recordings where the specific identity of the fungus was not determined.

Acacia - 4 spp. (5)
Aechmea (1)
Aglaonema spp. (1)
Albizia julibrizzia (1)
Anthurium spp. (1)
Aralia spp. (1)
Ardisia spp. (1)
Beaufortia sp. (5)
Begonia spp. (5)
Brachyscome multifida (5)
Caladium spp. (1)
Calceolaria crenatiflora (1)
Caryota spp. (1)
Casuarina spp. (1, 5)
Cedrus spp. (1)
Chamaedorea seifrizii (1)
Chrysalidocarpus lutescens (1)
Cinnamomum camphora (1)
Codiaeum variegatum (1)
Cordyline terminalis (1)
Crossandra infundibuliformis (1)
Cryptanthus spp. (1)
Cryptomeria japonica (1)
Cuphea hyssopfolia (1)
Cussonia spicata (1)
Cycas revoluta (1)
Delonix regia (5)
Dianella laevis (5)
Dracaena spp. (1)
Epiphyllum spp. (1)
Epipremnum aureum (1)
Episcia spp. (1)
Eucalyptus cinerea (1)
E. ficifolia (5)
Euonymus spp. (1)
Eustoma grandiflorum (10)
Ficus benjamina (1)
F. elastica (1)
F. pumila (1)
Fittonia verschaffeltii (1)
Gardenia spp. (1)
Grevillea - 6 spp. or hybrids (5)
Guzmania sp. (1)
Gynura aurantiaca (1)
Hakea - 3 spp. (5)
Hemerocallis spp. (1)
Hoya spp. (1)
Ilex spp. (1)
Impatiens spp. (1)
Iris laevigata (1)
Ixora spp. (1)
Juniperus - 4 spp. (1)
Justicia spp. (1)
Kalanchöe spp. (1)

Lagerstroemia indica (1)
Leptospermum brachyandrum (5)
Ligustrum spp. (1)
Leucadendron - 2 spp. (5)
Limonium spp. (1)
Magnolia spp. (1)
Malpighia coccigera (1)
Maranta leuconeura (1)
Medinilla magnifica (1)
Monstera deliciosa (1)
Myrica cerifera (1)
Nandina domestica (1)
Neoregelia spp. (1)
Nephrolepsis exaltata (1)
Nerium oleander (1)
Nidularium spp. (1)
Oreocallis pinnata (1)
O. wickhamii (5)
Orthosiphon aristatus (5)
Pentas sp. (5)
Pimelea sp. (5)
Platycerium bifurcatum (1)
Plectranthus australis (1)
Podocarpus spp. (1)
Polyscias spp. (1)
Prostanthera - 2 spp. (5)
Quercus spp. (1)
Rhoeo spathacea (1)
Rosa spp. (1)
Salvia splendens (1)
Sansevieria spp. (1)
Senecio spp. (1)
Spathiphyllum spp. (1)
Syngonium spp. (1)
Telopea speciosissima (5)
Ulmus spp. (1)
Verbena x hybrids (1)
Viburnum spp. (1)
Vinca minor (1)
Vriesea spp. (1)
Xanthostemon chrysanthus (5)
Yucca elephantipes (5)

Other major nursery pathogens

Many other fungi, apart from *Phytophthora*, also threaten nursery plant production. Other important plant pathogens include *Pythium, Rhizoctonia, Cylindrocladium, Fusarium, Sclerotinia, Sclerotium* and *Verticillium* spp. They may cause root rots; they may invade vascular systems or rot crowns, stems or foliage; eventually plants collapse and die.

Pythium

The genus *Pythium* comprises a major group of plant pathogens. At least 87 species of *Pythium* occur word-wide as parasites or saprophytes, and are common in most cultivated soils. *Pythium* spp. can seriously damage many ornamentals as well as numerous other plants.

Most seedlings are susceptible to *Pythium* attack. Soft and young plant material is the most vulnerable. As well as causing damping off, *Pythium* spp. cause root and stem rots and soft rots of fruit and other plant structures.

Environmental factors play a major role in the development of disease. Like *Phytophthora, Pythium* is a water-mould; a high moisture level is necessary for disease development and spread. Zoospores are rapidly and efficiently produced and dispersed in water and surface water supplies are frequently contaminated by them. Thick-walled spores produced by the fungus enhances it's survival in soils, in plant debris and in potting mixes.

Pythium splendens is one species which causes root rot disease in many foliage plants. It has been a serious and particularly persistent problem in pothos (*Epipremnum aureum*) production.

Control measures, including chemicals, effective for *Phytophthora* are usually also effective for *Pythium*.

Rhizoctonia

Rhizoctonia is a very important plant pathogen, causing diseases on a very wide range of plants. It is best known for causing damping-off in seedlings, but also causes stem or collar rots, cutting rots, root rots, foliage blights, and rots of structures such as bulbs, corms or tubers.

Rhizoctonia solani is a soil dwelling fungus that occurs in most soils throughout the world. It is readily recognised under a microscope by its pale to dark brown mycelium with characteristic broad, uniform, septate hyphae with right-angled branching; it may be seen with the naked eye as a web-like growth on plant parts it invades. This fungus can live indefinitely in soil as a saprophyte, it also produces sclerotia (resistant resting structures) which ensures it's survival.

Damping-off diseases includes the rotting of seeds or seedlings which fail to emerge, or die soon after emergence. Infected seedlings often show a shrunken 'wire stem' like symptom. Foliage blight affects ferns and many other ornamentals, particularly those grown under plastic. It can 'climb' through tightly packed foliage.

Rhizoctonia is spread with moving water, contaminated soil, with dust, and sometimes in seed. Moderate to high temperatures and high humidity favours activity of this pathogen.

Cylindrocladium

Cylindrocladium species are also important nursery pathogens.

Cylindrocladium scoparium occurs worldwide, causing serious disease in over 66 plant genera; damping-off, root rot, leaf spotting, basal stem rots or cankers, cutting rots or needle blights, are all disease symptoms caused by this fungus. Most recordings are from young plants or recent, field plantings. Root and/or basal stem rots are commonly occurring problems in many native plants particularly Geraldton wax. *Cylindrocladium* has recently been responsible for large scale losses in new field plantings. Generally, losses of large established plants attributed to this pathogen are rare, although a highly pathogenic form which attacks *Eucalyptus* in plantations and nurseries occurs in Brazil. Overseas, leaf infections of azalea have led to later development of the root rot phase of the disease.

Other species of *Cylindrocladium* also occur, but less frequently than *C. scoparium*. Cylindrocladium leaf spots are important diseases of foliage plants such as palms. *Cylindrocladium spathiphylli* is a devastating root rot pathogen

restricted to spathiphyllums. It causes a total root rot, basal petiole rot and occasionally leaf spotting.

Cylindrocladium scoparium hosts: *Abies, Acacia, Callistemon, Chrysanthemum, Citrullus, Conocarpus, Dianthus, Eucalyptus, Euphorbia, Ficus, Fragaria, Gardenia, Howeia, Ilex, Juglans, Juniperus, Lagerstroemia, Liquidambar, Magnolia, Malus, Melaleuca, Pelargonium, Persea, Photinia, Picea, Pimenta, Pinus, Prunus, Quercus, Rhododendron, Rosa, Rumohra, Trifolium, Tsuga, Ulmus* (4).

Cylindrocladium spp. hosts: *Banksia, Baeckea, Metrosideros, Grevillea, Agonis, Hakea, Chamaelaucium, Thryptomene, Coloeonem, Phoenix, Washingtonia, Howeia, Litchi, Angophora* and *Erythrina.*

Cylindrocladium spp. produce mircosclerotia, special resistant structures, ensuring survival in soil and plant remains for many years. Some species may invade and survive on certain plants without causing disease symptoms. During wet conditions an abundance of cylinder-shaped spores are produced on necrotic plant material; these appear as a fine white fuzz covering dead tissue; they are splash dispersed to new sites. As with other pathogens, spread is by movement of infected plant material infested mix or soil, or in moving water.

Fusarium

Fusarium spp. are major plant pathogens all over the world. They are widespread and highly destructive to many major food crops and ornamentals. The most notorious *Fusarium* diseases are the vascular wilts. Forms of *Fusarium oxysporum* cause wilt diseases of ornamentals such as asters, carnations, gladiolus, sweet peas, cyclamen, some palms and heliconia to name a few. Generally, plants are infected through roots and wounds. The fungus invades vascular tissue restricting water and nutrient movement. Infected plants wilt, often in sections or on one side first, high vascular browning can be seen when stems are cut.

Other *Fusarium* spp. cause cortical rot diseases, such as stem rot or stub dieback in carnations, stem rot in cacti, stem rot in *Dieffenbachia,* and rots of flowering bulbs such as narcissus, iris or lilliums. Less serious fusarium diseases, such as leaf spot of dracaena (caused by *Fusarium moniliforme*) also occurs.

Like other major fungal pathogens, *Fusarium* can infest soil or potting mix and survive there almost indefinitely. Survival in soil and plant remains is enhanced by formation of thick-walled resting structures (chlamydospores). Spread is with movement of infested soil, water, plants, planting material and contaminated tools or other equipment. Spread by cuttings is very common.

Sclerotinia* and *Sclerotium

Sclerotinia and *Sclerotium* spp., although less common in nurseries, also cause destructive plant diseases. Herbaceous or young woody plants, or plants at any stage of growth are attacked. Stored fruit or vegetable products and occasionally

flowers, are also damaged. In ornamentals a rot usually begins at the soil line and spreads up and down the plant. A white fluffy fungal growth is readily seen on affected parts, followed by the formation of sclerotia. These are survival bodies; they are circular, small (1-2 mm diameter), at first white, becoming brown (*Sclerotium rolfsii*); or are larger and irregular, becoming black (*Sclerotinia* spp.)

These fungi survive in soil and decomposing plant material. Undecomposed plant residues favours development and spread of these fungi. They are also favoured by high moisture and humidity.

As with the other fungal pathogens spread is primarily with infested soil, potting mixes, plants, plant parts or remains.

Verticillium

Verticillium spp., like *Fusarium* causes vascular wilt disease of many different plants including flower, fruit, vegetable, tree and ornamental crops. *Verticillium* occurs all over the world but is most important in temperate areas. Infected plants usually wilt and die. Sections of plant may be affected first. Vascular browning may be visible when stems of affected plants are cut. *Verticillium* produces microsclerotia and these allow the fungus to survive for many years in infested soil. Spread is with infested soil, water, plants or plant structures.

Root-knot nematodes

Other root pathogens are nematodes, microscope worm-like animals, the most important of which are root-knot nematodes (*Meloidogyne* spp.). They cause formation of swellings or galls on roots that they attack. Root injury may also make plants more prone to attack by other plant pathogens. As well as root damage, nematode infected plants show symptoms of poor growth, nutrient deficiency and wilt easily.

Root-knot nematodes are spread by movement of soil, planting material and water. Once introduced they can multiply rapidly in susceptible hosts. Infested sand used in potting mixes is apparently the most common source of contamination for nurseries.

Nematodes are well adapted to living in soil and can survive for long periods without host plants.

Once plants are infected chemical treatments will not eradicate the nematode. General hygiene measures to prevent infections are therefore most appropriate for control.

Bacterial diseases

A number of bacterial diseases also cause problems in nurseries and field plantings. Crown gall, causing formation of galls or tumours (usually near ground level), and hairy root, causing root proliferation, are diseases caused by

Agrobacterium spp. Crown gall affects many different plants. Many woody plants such as roses or stone fruit, but also herbaceous plants are affected.

Other bacterial diseases include vascular wilts, leaf spots or blights and soft rots of leaves, stems, corms or bulbs. These are caused by *Pseudomonas, Xanthomonas* and *Erwinia* spp.

Bacterial pathogens are common soil inhabitants, and can survive there as saprophytes. Infections often occur through injury sites. Wounds caused by taking cuttings, pruning or cultivating, or damage caused by insect attack, or other diseases may be followed by bacterial soft rots.

Bacteria spread with the transport of infected plants, cuttings, seeds or other material, as well as with soil and water.

Chemicals are not effective for control. General hygiene measures to exclude pathogens, the use of healthy propagation material, avoidance of injury and conditions of excessive moisture will prevent bacterial disease problems.

Disease control

In a survey by Hardy and Sivasithamparam (6) *Phythopthora* was detected, in varying degrees, in all of 14 nurseries sampled in Western Australia. If similar surveys were done in other states by competent extension and plant pathology workers it would be very likely that similar results would be obtained. The presence of such serious pathogens in nurseries is cause for concern. **Any nursery accreditation scheme should include the elimination of *Phytophthora* problems as a major aim.**

Disease control measures that are effective against *Phytophthora* will also be effective against other major pathogens. Serious disease problems can be directly associated with poor standards of nursery hygiene. The only permanent way to reduce problems is to improve standards and general cleanliness in all areas of plant production. All other measures are short term. Chemical treatments are very useful in halting spread of disease, and they may keep disease to a very low level if used regularly. However, they are costly, their effect is temporary and they do not guarantee eradication of the pathogen. There are not effective chemicals for all the major disease organisms, and resistance may develop with regular use of some products. Biological control agents are also temporary and suppress rather than eliminate disease.

General hygiene and control measures - container production

1. Eliminate soil and it's associated pathogens from all growing areas.

   - Use gravel beds or benches to stand potted plants on.

   - Use gravel, bitumen or concrete to cover paths and bare soil areas.

- Control dust which may carry pathogens such as *Rhizoctonia*.

2. Prevent spread of diseases by nursery personnel.

   - Use footbaths where applicable, handwashing facilities, and regularly clean and disinfect tools and equipment.

3. Regularly clean down and disinfect work areas, benches, and pot-standing surfaces and regularly remove plant debris.

4. Treat, by pasteurising or sterilising, propagation or growing media or use materials unlikely to contain pathogens (for example from accredited media suppliers).

5. Use propagation material, seeds or cuttings, only from reliable sources or collected from disease-free plants. Take cuttings preferably from above the splash-line without risk of soil contamination. Some at-risk material can be treated (for example, hot water treatment of some seed to eliminate pathogens).

6. Provide an environment (inside and outside the pot) not conducive to disease development and spread.

   - Avoid overfertilisation and other salinity problems.

   - Use correctly composted potting mix with adequate air-filled porosity and percolation rate.

   - Provide well-drained gravel surfaces, or benches for plants.

   - Use well-designed drainage systems to rapidly remove surface water, eliminate ponding and prevent outside drainage entering and contaminating nursery areas.

   - Water correctly to avoid lengthy periods of leaf wetness and saturated potting mixes.

7. Prevent re-contamination of mixes, mix ingredients pots or equipment by storing in clean, dry or well-drained areas.

8. Treat water supplies at risk of contamination by surface run-off water before use (for example, by chlorination).

9. Provide completely isolated areas for incoming plants which may be symptomless carriers of disease, and retain them there for a suitable period of time.

10. Train all nursery staff to appreciate the importance of disease control measures. Small breaches of hygiene may jeopardise whole propagation operations.

11. Use fungicides to reduce damage but do not rely on chemicals for long-term control of *Phytophthora, Cylindrocladium, Pythium* or *Fusarium.* Disease may re-appear after sale, when chemical effects have worn off.

In ground production

1. Select soils with good internal drainage for in-ground production. Plant on mounds if soil drainage is marginal.

2. Use well designed surface drainage systems as for container production.

3. Select areas that have been tested free of serious root rot pathogens, preferably from testing vegetation or crops grown in the area.

4. Alternatively fumigate soils before use with methyl bromide.

5. Exercise strict hygiene to prevent re-infestation.

6. Use only planting material from reliable sources, grown as for measures outlined for container production.

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APPENDIX II

The Nurserymen's Association of Victoria Accreditation Scheme

Introduction

Accreditation schemes are not new to Victoria. In ornamental crop production, flower growers Australia-wide benefited greatly from the Victorian Pathogen-tested Plant Scheme, which enabled the production of planting material free of serious diseases. While the Victorian Department of Agriculture is no longer responsible for the production of pathogen-tested nucleus stock for this scheme, it set the standard and procedures for the growing of cuttings today. It enabled Victorian specialist propagators to corner the market for many years and guarantees marketing opportunities to the present. The scheme was responsible also for the expansion in production and the greater economic viability of the flower growing trade. The scheme no longer operates but propagators can now obtain elite nucleus stock from a range of overseas-based accredited nurseries, and by following the previously established disease exclusion procedures, are still widely recognised as the suppliers of a superior product.

The Nurserymen's Association of Victoria (NAV) operates an assessment procedure whereby all applicants for membership must pass or eventually pass an inspection carried out by a NAV employed technical officer. The technical officer uses the guidelines produced for the Accreditation Scheme but in this instance they are applied less rigorously. The technical officer aims to visit all members at least annually. The inspector is responsible for not only the membership assessment inspections but also for suggesting how the nursery should technically upgrade to meet NAV requirements. The job is a large one, there are 330 NAV members, (120-130 wholesalers, 200-210 retailers).

The membership assessment requirement is a helpful precursor to joining the Accreditation scheme. It also encourages member nurseries to continually upgrade and this should sustain, with promotion, a better overall image than is possessed by non-member nurseries. The cost of assessment is part of the NAV membership fee. The operation of the assessment scheme also enables the more economic deployment of the technical officer.

Operation of the accreditation scheme

Accreditation is not compulsory but only NAV members can join the Scheme. The technical officer responsible for the NAV membership assessments also conducts the Accreditation Scheme inspections. He has extensive nursery experience as well as professional training. The costs of the technical officer are paid for by the applicant. The annual fee of $300 is paid directly to the NAV and covers two inspections per year. Part of this goes to promotion of the scheme. An additional $100 may be necessary where an extra visit or disease sampling is required. Other benefits include a fee exemption for display sites at Garden Week and free advertising in the association newsletter.

The technical officer's report goes directly to the Accreditation Committee. This consists of the Executive Director of the NAV, the inspector, three member nursery operators (all from Accredited nurseries) and the technical officer. The nursery operators on the committee represent bedding plant, tree and shrub and flowering potted/indoor plant production. There is consequently a good range of expertise on the committee, both professionally and technically. The committee members each produce different commodity ranges. There is consequently a mechanism in place which reduces a possible conflict of interest when competitors to the trade of a committee member are being assessed for accreditation.

The draft guidelines were debated at a special forum attended by 50-60 NAV members. At this meeting, specific requirements were discussed and argued on prior to their adoption.

Nursery operators were then invited to join the Accreditation Scheme.

Apart from an initial technical input and a continuing diagnostic service, there is no involvement by government in the NAV accreditation scheme. That is, it is entirely regulated by industry. NAV members were generally antagonistic to further government involvement.

The Scheme is now over two years old. All accredited members are wholesalers. It is not considered feasible to have accredited retailers at this stage as there is not a sufficient range and volume of greenstock available from accredited wholesalers. The guidelines for retailers will be similar to those for wholesalers.

Inground grower guidelines are not yet fully developed. Inground growers are at a disadvantage when similar stock can be obtained from a container nursery, as containerised plants are comparatively less difficult to maintain free of serious pathogens. For this reason there is some antagonism to the scheme by the inground growers.

Accreditations are given on individual case histories (for example disease freedom in cases where disease preventative techniques are not entirely adherent to the guidelines), as much as by formula. The discretionary power of the technical officer relies heavily on both industry experience and technical ability.

Reports are permanently filed to act as starting post references for those nurseries required to upgrade, and in case of disputation.

Confidentiality is extremely important. There are a number of confidentiality safeguards. For instance, it is important that the technical officer knows that an adequate pest and disease control programme has been implemented by the applicant. That is, the nursery operator has the technical expertise, the right equipment and satisfactory chemicals for the job. If the nursery operator wishes to maintain confidentiality because a superior programme gives a competitive advantage, it may only be necessary that the inspector assesses the quality of the crop, the application equipment, chemical storage facilities, safety equipment and the technical competence of the operator. Alternatively the information may be given to the inspector but not included in the report. Confidentiality is also maintained at the Accreditation Committee level. The Accreditation Committee reviews the inspector's recommendation but may not necessarily peruse the written report. If it is perused the members are obliged to maintain confidentiality. No

information on an applicant is retained by committee members with commercial interests. Applications for accreditation are confidential, as are the rejections. The entire Committee only needs to discuss an application when it is successful. If there is a possible confict of interest situation during committee meetings, the relevant member is excused from the room.

Where the technical officer regards any factor to be inadequate with regard to successful accreditation, he can suggest a remedial course of action. It is vital that the applicant is informed of the existence of a problem and the method of correction so that progress is made before the next inspection.

The report is eventually passed onto the NAV Executive Committee where it is enacted and certification given.

If, on the annual inspection the nursery is found to no longer meet the guidelines, the operator is immediately notified by the technical officer and the Committee. While the nursery could technically be immediately disaccredited, it is not considered to be a desirable course of action unless the failure is other than minor. It is more desirable that the operator is given an opportunity to rectify the problem and is also given as much assistance as possible in doing this.

The Victorian Scheme is quality conscious. Stock sold by an accredited nursery is expected to be of overall better quality than that sold by other nurseries. To do this, it must be protected as much from environmental disorders, such as inadequate nutrition, poor irrigation scheduling etc, as from pests and disease. While the prevention of diseases such as *Phytophthora* root rots are considered to be of major importance, it is recognised that a plant with good health status alone is not necessarily recognised by the buyer as being a superior plant. For instance, a plant infected with *Phytophthora* but managed by an effective disease control programme, and grown under good conditions, may look much better than an uninfected plant grown in an unsuitable environment. Even though the infected plant will die prematurely after sale, it may win on immediate appeal. Thus accreditation means satisfying a wider range of consumer selection criteria than health status alone. In addition the accredited nursery must look like a superior nursery. In Victoria, even the landscaping and state of repair of structures are considered. Good weed control both within and without the crop is considered to be very important. As there is still a limited number of accredited suppliers, there are plants from unaccredited nurseries entering accredited sites. It is required by the nursery operator however that these plants are of a standard expected by the NAV guidelines.

While the scheme is largely user pay, there is a NAV subsidy. However the Scheme is considered important enough to subsidise as it acts as a stimulus to ordinary NAV members to upgrade, and is also seen as a promotional aid for membership.

The current guidelines are not rigidly adhered to, nor are they considered perfect by the NAV. They are interpreted to the level of making it possible for a representative range and appropriate number of nurseries to join the scheme and make it initially viable. The produce sold must be better than the average. It is intended to gradually tighten the interpretation of the guidelines, and to even change the guidelines where necessary, to ensure a steady increase in the quality of produce leaving accredited nurseries. There is considerable evidence that Scheme members are already enjoying marketing

advantages. Interstate buyers, and in particular, regular purchasers of root rot prone stock are seeking plants from accredited sources.

The nurseries which are currently accredited were those technically adept prior to application, and also had most of the necessary facilities. Some nurseries needed six months to upgrade but others took much less time.

There is no tiered system contemplated, for example, relaxed guidelines for nurseries selling to retailers as opposed to more rigid guidelines for propagation nurseries selling to other wholesale nurseries, orchardists and landscapers.

The NAV scheme does not accredit part of a nursery unless it is divisible in terms of both operations and marketing, from its unaccredited portion. Problems have occurred where one of two sites belonging to the one business has failed to meet the necessary standards. In this case, two business names had to be adopted for marketing purposes.

The members of the Accreditation Committee consulted during the study, indicated that there was a current lack of momentum in the progress of the scheme and that they were attempting to reverse this.

The NAV had initially made few plans to actively promote the Scheme, considering that accredited nurseries should promote themselves. This did not eventuate and the previously mentioned advertising incentives were introduced. There is however, according to committee members, still insufficient promotion of the Scheme.

Now that the scheme is in a stage of consolidation, the guidelines are being reviewed.

As there is no requirement to treat soilless media composed of approved materials, it is essential that these come from reputable sources. At the present there are several satisfactory media producers in Victoria. The NAV Accreditation Committee is drawing up a set of guidelines for media manufacturers.

The NAV is also operating a nursery course where money spent in educating operators in technical areas pertinent to accreditation, is recoverable under the Training Guarantee Act.

The NAV is in favour of a national nursery accreditation scheme, providing that acceptable compromises are reached, if compromises are necessary.

Western Australia and Queensland have adopted, and New South Wales intends to adopt, a logo similar to that used by the NAV Accreditation Scheme.

There was concern in both Victoria and WA that the integrity of the product may be lost after the plants leaves the nursery. This could occur if labels are switched or the plants are treated poorly in the retail site, thus reflecting poorly upon the supplier and the Scheme.

The nursery assessment and accreditation guidelines

As mentioned above, the same guidelines are used for assessing both the eligibility of a nursery for NAV membership and for membership with the Accreditation Scheme. The

interpretation of the guidelines for NAV membership however is more lenient. Individual circumstance is also considered in the interpretation of the guidelines. Both the interpretation of the guidelines and the assessment criteria are to become more exhaustive as the Scheme gains maturity.

The criteria used for accreditation assessment in Victoria are outlined as follows. Note that these are currently under review, particularly in terms of water disinfestation techniques.

1. Nursery structures

(a) Structures for plants

Nursery structures should be appropriate for the purpose and in good repair. They should be capable of sustaining the growth of plants for the required period.

Bench and floor surfaces

To prevent the contamination of potting media with pathogens, containers should not be placed directly on the soil surface. There should be good drainage beneath the pots to ensure there is no build up of water which will assist the spread of diseases from one pot to another. Two-tier benches should not be used as the drainage from one level will contaminate the lower deck.

Suitable bench surfaces may include wire mesh (aluminium or steel).

Suitable ground level container areas include galvanised welded mesh over concrete; 50 to 75 mm of screenings over soil; sloping (well drained) concrete or bitumen.

The screenings should be free draining and the sub-surface sloped to ensure all free water flows away from the pots.

The surface beneath benches should be concrete or screenings and drained to ensure no build up of waste water.

Unsuitable bench surfaces include solid bench tops; wooden benches lined with plastic (where pots stand on solid surface).

Unsuitable ground level container areas include concrete and bitumen floors, where they are poorly drained; black plastic; impervious weed mat (where pots stand on solid surface).

All these surfaces allow drainage water flowing from diseased plants to be taken up by adjacent plants through drainage holes. Weed mat may not allow free drainage and cause transfer of pathogens as puddles of water build up on the surface. Also the plant roots may grow out of the drainage holes and penetrate the mat contacting the contaminated soil beneath. If general

hygiene is good and the nursery is free of soil-borne pathogens, then the drainage from pot to pot is of little importance.

Problems can also develop where water standing around pots is taken up into the media by capillary action. This can cause the media to remain wet and provide ideal conditions for the development of soil-borne pathogens. Capillary matting is only acceptable if hygiene is of the highest standard and no soil/water borne pathogens are present in the nursery.

Condition/suitability

This refers to the condition and suitability of the structure for the purpose allocated and also the condition and suitability of the bench and floor surfaces as well. If the plants require protection from shadecloth or plastic/glass structures, then this must be in suitable condition and capable of performing the desired function. Where possible, the performance of plastic and fibreglass coverings should be considered and if the light transmittance may be adversely affected then this should be taken into account. The degree of shade offered by shadecloth or slatted structures should be appropriate for the plants beneath.

Benches and floor surface must be in suitable condition and conducive to good hygiene as outlined above and appropriate for effective and efficient handling and holding of container plants. Concrete floors with cracks and holes beneath benches may be a hygiene risk and would adversely affect efficient handling of plants.

(b) Working areas

Cutting preparation area

Suitable benches include stainless steel, galvanised steel, laminex or melamine laminate.

Suitable floor surfaces include concrete, bitumen.

This area should be isolated from the nursery stock plants and growing-on areas to ensure no casual transmission of plant pests and diseases to the new propagating material.

Benches should be of an impervious material which can be washed down regularly with disinfectants. Steel top benches are suitable but care should be taken when washing down with Biogram as this may damage the surface if it remains in contact for long periods.

The floor of the propagation area should be suitable for frequent cleaning and washing down with disinfectants.

The condition and suitability of the structure used for propagation and the equipment and fittings should be considered. If the structure or fittings are

inappropriate or are in poor condition, then there is a risk of introduction of pests and diseases. Such a structure would be downgraded.

Cutting growing area

1. Various raised heated beds with concrete or screenings on floor.

2. Ground level beds with screening surface for standing cuttings or wire mesh on concrete (drainage).

The comments above for cutting preparation areas should be considered for cutting growing areas. The level of hygiene should be of the same high standard. The cutting growing area should be set up to provide good drainage beneath raised beds or have a suitable drainage system beneath ground level beds.

Transplanting or potting areas

The type and condition of benches and floor surfaces in transplanting areas should be as outlined above as it is appropriate to ensure the same standards of hygiene and management as for propagation areas.

(c) Storage areas

Pesticide storage

The appropriate Hazchem labelling should be displayed throughout the nursery and on the pesticide store. The storage area should be secure and appropriate for the range of pesticides stored. A locked cupboard may be suitable for small quantities, but where large amounts are stored, a separate shed should be available. No pesticide should be stored for more than two years. Large quantities should be avoided and pesticides should be purchases as required for the current season's use. The specific considerations for pesticide storage are listed below.

. Pesticides should be labelled with purchase date.

. Lockable, well ventilated, insulated storage.

. Provision for weighing and measuring.

. Should be resistant to fire.

. Isolated from other buildings.

. Protected from moisture.

. Large storages should have door sills to retain spills.

. Separate storage for herbicides.

The above criteria are necessary because the shelf life of a pesticide will be adversely affected by extremes of temperature and by exposure to moisture. Also, as pesticides are often volatile and highly inflammable, they should be stored in isolation in a structure resistant to fire. Where large containers are stored it is essential that door sills and gutters are constructed to prevent spilled pesticide draining from the pesticide store. The staff should have access to facilities for weighting solid materials and measuring liquids in an area appropriate for the purpose, with adequate ventilation preferably by an exhaust fan. Kitchen scales are unsuitable for the smaller quantities often used by nurseries and a balance scale should be used.

Herbicide should always be stored separately to insecticides and fungicides as there is always a risk of contamination or accidental use on susceptible plants.

Container/pot storage

Suitable storage: clean, dry area free of soil/media, separate from used containers.

Clean containers should be stored to ensure they remain clean and free of pests and plant pathogens that may be introduced by contact with soil or used potting media.

Media storage

Suitable storage in a concrete structure or timber bins with a concrete floor and should be:

- Covered to prevent contamination.
- Suitable for regular washing/disinfection.
- Separate from used media/containers.
- Away from soil contamination.
- Well drained and free from contamination with drainage water.

Media for potting must be sterilised or be composed of ingredients that are free of pests, weed seeds and pathogenic diseases (that is, obtained from a reputable source). They must be stored to ensure continued freedom from contaminants. The area should be constructed for ease of cleaning and disinfection between loads. Permeable covers should be used, as plastic covers prevent escape of gasses from the mix and may contribute to excessive build up of heat. The storage area should be raised or positioned to prevent drainage water from entering and contaminating media. Mixes incorporating slow release fertilisers should be used within seven days of mixing.

2. General nursery layout

Uncovered growing areas for plants

(a) Prepared areas for growing plants

The area should be constructed as described previously (section 1a) to ensure free drainage of water away from pots and growing area. The drainage should be appropriate for the area and be adequate to prevent flooding during heavy rain. Some attempt should be made to clean dead plant material from these areas between batches of plants. Where possible pre-emergent herbicides should be used to minimise the germination of weed seeds.

(b) In ground growing areas

Field grown material should be planted to minimise disease and pest problems and facilitate easy maintenance and good hygiene and pest and disease control practices. Continued production of the same type of plants in the field area should be avoided. Some form of crop rotation would be beneficial. Plants should be spaced to prevent physical damage due to crowding of roots and foliage and to minimise disease problems associated with high humidity and restricted air movement. Row spacing should allow easy access for pest and disease control and ensure all plants can be readily inspected. Within row spacing should allow room for the plant to grow without crowding during the later stages of development.

Drainage should prevent waterlogging of the soil which will promote the development of root rotting fungi. Lifted plants should be maintained in good condition and there should be no set-back in growth. The containers or bags should contain the roots firmly during storage and transport.

3. General hygiene

(a) Sterilising surfaces

Biogram 2%
Sodium hypochlorite 2%
Methylated spirits
Hibitane
Formalin 2%
Kendocide

(b) Sterilising media

1. Heat, Min. 60 degrees. Min. 45 minutes (all mix must be heated to 60 degrees).

Alternatives:

a. steam
b. electrical
c. microwave
d. solar

Temperature should be monitored - exposure should be timed.

2. Chemical, treated at seed bed moisture

a. Methyl bromide. One can for each 10 m^2 covered with gas proof sheeting.
b. Metham sodium (Carbam, Vapam, Unifume).
c. Dazomet (Basimid) (appropriate delay for gas escape).

Where the potting media is obtained from an accredited or reputable source, there is no requirement for sterilisation. Soil components in mixes should be sterilised unless they are obtained from an area known to be free from pathogens.

(c) Sterilising media storage

Disinfecting (see 3a above) detergent should be used.

(d) Sterilising containers

Washing and disinfecting (see 3a) detergent should be used.

(e) Sterilising tools and equipment

Cleaned regularly, dipped in disinfectants (see 3a), should be rinsed after formalin (prevent corrosion/toxic to plants).

(f) Sterilising footwear

Footbaths should be provided. These should be at all entrances to clean area. Disinfectants as 3a above.

(g) Signposting clean area

All clean areas should be labelled. Hygiene requirements should be displayed.

4. Propagation practices

(a) Source of plant propagating material

Propagating material should be from disease/pest-free stock in healthy condition.

(b) Quarantine of plant material

Any plant material brought into the nursery should be isolated from healthy stock for at least three weeks and treated with a suitable fungicide for root rot (for example 'Aliette®' or 'Fongarid®').

5. Plant protection practices

(a) Spray program

A regular spray program should be appropriate for the range of plants grown (no phytotoxicity) and be suitable for the potential pest and diseases of those plants. If herbicides are used, they should be appropriate for the weed species present and suitable for the various weed situations in the nursery. Long term residual herbicides should be avoided.

All pesticides used should be recorded and the date of application, plants treated, quantity used, spray equipment used and weather conditions recorded.

(b) General vigour of plants

The general vigour and health of plants is important as this is a direct indication of the quality of the final product. Plants should not be suffering any physical or nutritional disorder and they should be of consistent and even quality. Plants that have been treated with growth regulators or subjected to any special treatment should be capable of growing to full potential after sale. Saleable plants should be well presented with regard to the appearance and structure and be grown in a suitable container. Plants ready for sale should be correctly labelled with information provided which will assist the final customer to successfully grow the plant. Misleading or incorrect promotional material should not be used.

(c) Potting media

The components in a potting mixture should allow for appropriate drainage and nutrient balance. If the medium is purchased from a reputable or accredited source, then no detailed assessment is required.

(d) Fertiliser program

Fertilisers should be of appropriate composition for the purpose used, they should be applied correctly (quantity and application method) and at an acceptable frequency to ensure continued growth and development beyond sale.

(e) Pest status of the nursery

All areas in the nursery should be as free as practicable of weeds. The propagating area should be weed free as this is a potential source of major weed problems in the nursery. Standing areas for pots and in-ground growing

areas should have few if any weeds, and those present should be immature and controlled prior to seeding. Saleable plants should be weed free and there should be sufficient evidence to indicate that every care has been taken to prevent weed seeds from contaminating the potting media (that is the source and nature of the potting media, the spray program and general weed status should be considered).

Pest and disease levels should be minimal throughout the nursery, and there should be evidence that the situation is under control. This requires that the staff recognise that they have a problem, know what they are dealing with or have taken steps to identify the cause and have or intend to implement appropriate control measures.

(f) Spray equipment

The spray equipment used should be appropriate for the size and layout of the nursery. It should be adequate to spray the nursery with a minimum of effort and be capable of completing the job in a reasonable time. Although knapsacks can be effective, they are inefficient if large areas are to be sprayed and as a consequence of this they may be poorly used. The equipment should be in good condition and set up for the intended purpose. Sprayers for herbicide should not be used for insecticides and fungicides as the risk of damage is great.

6. Pesticide application and safe handling

The protective clothing available should be appropriate to the hazard of the chemicals used. In most cases full protective clothing should be available including;

- Respirator and face mask or hood.
- Overalls or waterproof clothing.
- Rubber boots.
- Rubber gloves suitable for spraying.

The spray operator/s should be appropriate for the job and capable of preparing the spray mix according to the label instructions and be able to carry out the operation effectively and safely. The operator/s should have appropriate training or experience, or be supervised by an experienced person.

A minimum of one day re-entry delay should be enforced before handling sprayed plants or working in glasshouses. If sprayed plants must be handled within several days of spraying, then the staff should wear protective gloves and clothing to prevent skin contamination.

Appropriate first aid equipment should be available, including antidotes for pesticide poisoning. Information should be available on the specific chemicals used and the relative toxicity of each displayed to indicate the type and extent of protective clothing to be used. The appropriate protective clothing should always be worn. If the pesticide is classified as relatively safe, then it is unnecessary to wear a respirator although all the other equipment listed above should be worn.

Full protective clothing is uncomfortable to wear, particularly on hot days and so operators should be encouraged to know the hazard and dress accordingly.

7. Irrigation and water supply

Irrigation water is a potential source of disease organisms and the source should be considered to determine if filtering or chemical treatment is necessary. Mains supply and bore water are usually free of pathogenic organisms, but ground water from dams and creeks may need to be treated. Any techniques employed should be evaluated to determine their suitability for the potential hazard. Application pattern and the subsequent wetting pattern achieved should ensure consistent growth of plants.

Suitable treatments for ground water include.

- Chlorination (minimum of 2 ppm). A biocide/pathogen minimum contact period of 20 mins is likely to be imposed in the future.
- Filtration to 5 microns.
- Ultra Violet irradiation.

8. Disposal of waste

Pesticides should only be purchased in small quantities where possible, to ensure all stocks are used during the current season's spraying. Mixed chemicals should not be stored and there should be a minimum of waste to be disposed of. This waste, plus the washings from spray equipment, should be poured into a pit in a situation where it can't wash into waterways, creeks etc. Pesticide containers should be broken or crushed and buried or taken to the local land-fill tip (if their regulations allow dumping of pesticide waste).

Damaged plants and other waste should be disposed of to avoid contaminating healthy plants.

APPENDIX III

The Northern Territory Nursery Clean Scheme

The scheme is a joint venture between the Northern Territory Nurserymen's Association (NTNA) and the Northern Territory Department of Primary Production, and has operated since 1988.

It is a voluntary scheme concentrating predominantly on nursery hygiene.

The costs are largely borne by the Department of Primary Production.

The guidelines essentially differ from others in that all growing media used in the nursery must be treated and treatments must have commenced six months prior to the nursery becoming accredited.

Other differences include a mandatory quarantine period (one month) for plants that are purchased from an unaccredited supplier after they enter the nursery. These plants also have to be situated in an approved quarantine area of the nursery.

Accredited nurseries are certified annually. Inspections include one exhaustive annual inspection, with one or two supplementary inspections where required.

Lapses in adherence to accreditation guidelines are given one month for rectification before accreditation is lost.

Appeals by growers who feel that they have been unfairly treated are possible. Appeals are conducted by a nominee of the NTNA and the head of the Plant Pathology section of the Department of Primary Production.

The guidelines and the check list for accreditation follow.

The NTNA Accreditation Guidelines

Chapter One

The Clean Scheme standards cover the following aspects of nursery operation:

1. Soil/potting mixes
2. Planting material
3. Personnel
4. Growing containers
5. Growing surfaces
6. Water
7. Work benches and equipment
8. Routine disease and pest control
9. Layout

The standards listed in the following pages are the criteria on which nurseries are assessed for certification under the Scheme.

There are a number of alternative ways by which standards can be met, which allow for personal preferences most suited to your nursery situation.

This chapter looks briefly at the nine areas, which are considered with more detailed information where applicable in chapter two.

1. Soil/potting mixes

(a) Heat sterilisation : steam-air mixtures; solarisation; microwave, or

Fumigation: methyl bromide; Basamid(R).

One of the above needs to be carried out for six months prior to acceptance for accreditation, and

(b) no contact, after treatment, with an untreated surface or material, and

(c) log of all treatments.

2. Planting material

(a) **Seed**

(i) Hot water treatment, or chemical surface disinfection, or seed obtained from certified clean source - these are pathogen free, and

(ii) no contact, after treatment, with untreated surface or material.

(b) **Vegetative material**

(i) Chemical surface disinfection or hot water or aerated steam treatment (if appropriate) or obtain material from an approved source.

(ii) Cuttings should be kept off the ground after collection. Store in a clean container, and no contact, after treatment, with any untreated surface or material.

3. Personnel

(a) Operators to wash hands with an appropriate disinfectant on entering the clean area and before handling any treated materials.

(b) Ideally, a disinfectant foot bath should be used on entering the clean area, but this will be optional.

(c) The public should not have access to the propagating area. Ideally, the main growing area should be separate from the selling area.

The clean area should be restricted to a few well trained people who really understand basic hygiene and adopt it meticulously.

Routine cleaning after each contact operation reduces the chance of spread should pathogens be present.

4. Growing containers

Includes pots, bags, tubes, trays, etc.

(a) Heat sterilisation or fumigation or washing with appropriate disinfectant or use new containers, and

(b) no contact, after treatment, with an untreated surface or material.

5. Growing surfaces

The approved growing surfaces are as follows:

(a) 100 mm of gravel.

(b) 50 mm gravel plus weedmat, whether it be placed on top of the gravel or underneath it.

(c) Well drained sand plus weedmatting, as per (b) above.

(d) Well drained cracker dust plus weedmatting, as per (b) above.

(e) Concrete.

(f) Bitumen.

(g) Corrugated roofing iron - must be replaced when it starts to rust severely.

(h) Raised bench, which can be anything that creates an air space between the natural ground and the plant.

Wood is not to be used.

Treat growing surfaces with disinfectant.

Any bags or pots that are 50 L or more need to be placed on slight mounds for drainage with weed matting material on top of this, to prevent material from coming into contact with the bare earth.

Any material not complying with the above recommendations to date for the 50 L container or more, shall be exempt provided they are sold within 18 months. All new material potted up into 50 L plus containers must comply with the above specifications for entry into the Clean Scheme.

Treat growing surfaces with disinfectant.

6. **Water**

Use mains water, bore water or roof run-off water or ground run-off water (for example, from stream or dam) if treated.

7. **Work benches and equipment** (including tools, receptacles and barrows)

(a) Washing of work benches or other surfaces on which plant materials are handled with appropriate disinfectant - to be done before each batch of material is handled, and

(b) clean out and disinfect the equipment between batches of cuttings, and any equipment which has been in contact with untreated material, with an appropriate disinfectant. Tools and equipment used in the nursery should be kept in a shed on the nursery site and not used for other operations on the property. They should be kept for exclusive use in clean areas, and be so marked. They should be kept clean, regularly disinfected after use and not taken from one area of the nursery to another without disinfection.

8. **Routine disease and pest control**

Routine disease and pest control is particularly important in the ornamental nursery situation where a blemish-free plant is sought by the customer.

Spraying programmes must be designed to take into account the diseases or pests present and the types of plants grown. Chemicals have limited ranges of activity and plant species differ in their sensitivities to chemicals.

Pots should be regularly cleaned of any weeds as they rob the plants of valuable water and nutrients. The nursery surroundings should also be cleaned of any unsightly weeds by the use of weedicides or regular mowing as they can harbour pests and diseases.

Some diseases and pests most likely to be encountered in the nursery situation are:

Diseases: Leaf spots - fungal, various types.

Powdery mildews - especially on Acacias, other legume species, Lagerstroemia etc.

Damping-off diseases - various fungal organisms responsible.

Pests: Mites - several types.

Scales.

Mealy bugs.

Beetles.

Caterpillars.

Grasshoppers.

Experience will suggest the pests and diseases which require preventative chemical treatment. Seek advice from the Clean Scheme adviser on the most suitable chemicals for the types of plants grown in the nursery.

9. Layout

Nursery design/layout should facilitate the nursery operation - with respect to pathogen control, two areas need careful consideration.

(a) Non-sterile or contaminated materials should never be allowed into areas where clean plants are growing. They should be isolated so as to provide an opportunity for observation for pests and diseases and prevent contamination of clean areas.

(b) Public access to propagating and growing-on areas should be restricted as much as practicable. It is undesirable to allow anyone access to plant growing areas except nursery staff. Smokers should be prohibited within the propagation and growing areas as tobacco mosaic virus is easily spread by smokers who have or are smoking infected leaves. The best policy is to separate sales from growing and propagating areas.

NTNA Clean Scheme Standards

Chapter Two

As outlined in the previous chapter, the Clean Scheme covers a number of aspects of the nursery operation. Some of these have a number of options available which need to be dealt with in more detail.

This chapter will give information necessary to understand and if necessary, to carry out the appropriate operation, in order to bring the nursery up to clean scheme standards for certification into the NT CLEAN SCHEME.

Soil potting mixes

There are three options available for the control of soil borne pests and diseases, all of which are disguised to help you choose the most practical for your nursery situation with two other methods which may be of use in the future.

1. <u>Steam treatment `pasteurisation'</u>

   It is desirable that all propagation media be treated in some way. However, media containing materials known to be free of pathogens, do not need to be treated. Such materials include perlite, vermiculite and styrofoam with many peats thought to be free of pathogens. potting media is treated with fumigants and heat, which is usually in the form of steam, to help eliminate weeds, nematodes and disease causing organisms.

   Pasteurisation with aerated steam

   Steam is the best and most common heat source for soil treatment. Aerated steaming, a mixture of steam and air blown through the medium, so that its temperature is raised to between 60 and 80°C for 30 minutes. Temperatures in this range kill most plant pathogens but leave many of the micro-organisms that are beneficial to, or do not harm the plants. This medium is said to be pasteurised.

   Temperature of 60°C for 30 minutes is most desirable since, while killing pathogens, it will leave many beneficial organisms which, if present, will prevent explosive growth of harmful organisms if recontamination occurs. The above temperature and duration is recommended for entry into Western Australia.

   If a medium is to be capable of suppressing pathogens after pasteurisation, micro-organisms capable of such suppression must be in it before treatment. Therefore, including 10-15% `dump' or recycled mix in a new batch prior to pasteurisation enhances later disease control. The recycled mix supplies large numbers of suppressive micro-organisms.

   Equipment

   The main type of equipment needed is a steam generator, an air blower and a chamber in which to hold the medium. In the best systems, a pre-set temperature sensor in the

aerated stem line near its point of entry into the steaming chamber automatically regulates the proportions of steam and air. Another sensor in the medium near the outlet from the chamber can automatically cut back the air-steam flow rate as soon as all the medium has reached the required temperature. It can also be connected to a time clock that will automatically cut off steam flow after 30 minutes, leaving the air flow to cool the medium.

Concrete mixers have been used for steaming. The disadvantages with these are:

(a) It is impossible to be sure that all the medium has been at the required temperature for long enough.

(b) The mixer can only be one-third full if mixing of air and steam is to be thorough and overheating is to be avoided.

(c) Cooling is a problem.

(d) The bowl must be turning for about an hour. Mix components can be severely damaged.

Media preparation

The components of the media should be thoroughly mixed at the moisture content normal for planting. For many mixes this will be about 25-40 volume % water. The medium should be left for at least four hours before air-steaming to enable seeds and spores to take up water, as they are less resistant to heat when moist than when dry. The medium is then filled loosely and evenly into the chamber.

Medium in which cuttings are to be propagated or seeds germinated is normally filled into containers - flats, trays, etc before treatment. This allows the containers to be pasteurised at the same time. The containers should be separated by at least 1 cm in all directions to allow steam to penetrate freely.

Aerated steam application

The aerated steam can be applied to the medium from above or below. The heating up time should not be longer than 30 minutes, which is counted from when the medium at the furthest point from the steam inlet reaches the chosen temperature. The steam is cut off at the end of the 30 minutes and air alone blown in until the temperature drops to about 35°C. The medium is ready for use as soon as it is cooled to 30-35°C.

Pasteurising mixes containing slow release fertilisers at 60°C for 30 minutes does not release toxic levels of nutrient salts. However, full heat (that is, 100°C) steam can destroy some or all of the slow-release properties of the fertilisers.

2. Methyl bromide

Nursery media fumigation

What is it?

Methyl bromide (MB) is a colourless highly toxic gas. When compressed in pressure cylinders, it forms a clear non-inflammable liquid.

What does it do?

MB is one of the most effective fumigants known to man. It kills insect pests, soil-borne fungi, weed seeds and nematodes. Its high degree of penetration makes it the ideal soil fumigant.

Available forms

MB is available either as Agrigas M which is 99% pure with no other additives, and Agrigas MC2 which is 98% MB 2% Chloropicrin which is a tear gas and acts as warning of any leaks.

MB is available in large steel cylinders for commercial use and comes in sizes from 12 kg, 80 kg and 100 kg.

Media condition

The medium should be free of clods, and crop trash in the event of reusing old soil mixes. It should not be dry and dusty nor wet and puddly. The medium should be moist enough for planting, and to activate dormant weed seeds and disease agents (propagules), breaking their resistance and making them more sensitive, in order for the fumigation to be most effective.

The medium should be in a free loose condition and can be fumigated in loose piles of 38 cm (15 in) to 46 cm (18 in) in height and of any size depending on the size of the cover. You need 60-90 cm (2-3) of sheet overlap around the edges which you cover with sand or the equivalent to help seal and prevent MB from escaping into the surrounds and causing illness to passers-by.

Necessary equipment

Fumigation sheet - gas impervious material 0.2 mm thickness or greater.
Loose sand - help seal the edges of sheet.
Concrete slab.
Storage facilities - cage for MB cylinder.
Masking tape - heavy duty.
Gas mask and respirator.
Approved gloves - liquid proof safety gauntlet.
Gas supply line - copper or PVC tubing 1.27 cm (½ in) OD.
Scales - weigh MB.
Supports to keep sheet off media.

MB dispenser - able to purchase with cylinder.
Fumigant.
Evaporation pan or bottle to empty MB into.
First aid kit - optional - all nurseries should have one anyway.

Fumigation procedures

The cover must be supported in a way so that it does not touch the medium. The edges of the cover may be anchored in a shallow trench around the perimeter. The edge of the cover should be folded back and sand placed on the double thickness.

A special metering device, called a dispenser, can be used to pass pre-determined weight of methyl bromide from the cylinder, through the tubing into the reservoir to evaporate. Platform scales can also be used to measure direct from the cylinder.

Rates of 0.45-0.91 kg/9.29 m^2 (1-2 lb/100 ft^2) are used for the control of weed seeds, soil insects and nematodes, while a dosage of 0.91-1.8 kg/9.29 m^2 (2-4 lb/100 ft^2) will usually control many disease causing fungi.

To ensure adequate MB distribution, you may need a number of evaporation receptacles, depending on the size of the area. One will generally take care of 7.5-10.5 m (25-35 ft) on a bed of average width.

After release of the required quantity of MB, before removing the dispenser from the tube leading under the cover, wait for a minute or two to ensure that all liquid in the tube has vaporised. After, the tube should be plugged off to prevent leakage and to keep dirt out of it, or be withdrawn and the remaining hole under the cover plugged with soil or sand.

The requirement for export into Western Australia is the use of MB at 0.5 kg/m^3 (1.1 lb per 35 ft^3) for 24 hours on an impervious floor with the material to be fumigated being not more than 300 mm deep, or 0.6 kg/m^3 (1.32 lb per 35 ft^3) for 72 hours with the medium being not more than 660 mm deep.

Exposure/aeration period

The cover should remain over the medium for 24-48 hours. Twenty-four hours is sufficient if 0.45 kg/9.29 m^2 (1 lb/100 ft^2) has been used and the soil medium temperature is 15.5°C (60°F) or over. If less, the cover should rmain in place for 48 hours. If 0.91 kg/9.29 m^2 (2 lb/100 ft^2) has been used, the cover should be removed in 12-24 hours depending on the soil medium temperature.

Soil medium temperature should be taken at the 10 cm (4 in) level.

Aeration period varies from 3-10 days depending upon the nature of the soil medium. With sandy soils, three days would be sufficient aeration whereas in heavy clay soils 10 days may be required. Sowing/planting before sufficient aeration may effect growth of the plants.

Caution

MB vapours are poisonous and every possible precaution should be taken. A full faced respirator, fitted with the approved MB canister (no other) should be worn, particularly when removing the cover.

MB can cause burns to the skin from contact with the liquid, therefore you need to wash it off immediately. It can also cause damage to the brain and nerves and possibly to the kidneys. Repeated exposure to low concentrations may be harmful.

Someone exposed to low concentrations may not receive any warning signs. Exposure may therefore be prolonged. Within a short time, however, the person may feel unwell, suffer headache, smarting of the eyes, nausea and damage to the nervous system. Routine blood testing should therefore be carried out due to the frequent use of MB.

3. Nursery application of Basamid(R) granular

Basamid(R) granular acts over the broadest spectrum, giving an outstanding degree of soil disinfection against, fungi causing root diseases, nematodes, insects and larvae, and germinating weed seeds.

Maximum pest destruction is the end result sought by the applicator. The work of killing commences when gases start to form within 10-15 minutes of the Basamid(R) granules coming into contact with the warm moist soil. It takes a little longer in very cold conditions.

Most nematodes, soil inhabiting insects, most root rot and damping-off fungi, rhizomes of perennial grasses and germinating weed seeds are controlled by Basamid(R) using the following rates:

Recommended rates of application

Situation		Rate/m^2	Rate/ha Incorp.	Depth* of Treatment	Bulk soil
A.	Germinating weed seed	35 g	340 g	10-15 cm	150-220g/m^3
B.	Most nematodes, soil inhabiting insect, moist root rot and damping-off fungi, rhizomes of perennial grasses, germinating weed seeds.	50 g	500 kg	20-23 cm	150-220g/m^3
C.	Cyst forming nematodes and situations referred to in B that occur below 23 cm	60-70 g	590-680kg	30 cm	150-220g/m^3

* Increase application rate by 17 g/m^3 for each 10 cm extra depth.

Advantages of Basamid(R) usage

(a) Basamid(R) greatly reduces the chance of drift, although it should not be spread under windy conditions.

(b) It is visible against the soil which makes even spreading easy.

(c) Can be used with safety within 60-90 cm of the root zone of plants in open situations.

(d) Basamid(R) is also safe when following with carnations - unlike most other soil fumigants.

Treatment of bulk soils

Quantities of between 150-220 g/m^3 of Basamid(R) granular needs to be thoroughly incorporated into the medium by use of soil blending equipment. If blending equipment is not available, spread the Basamid(R) on the base of the container (concrete), then spread the medium in 10 cm layers and add an amount of Basamid(R) between each layer, working in Basamid(R) each time. If the moisture is low, add a little water.

To restrict the loss of gases, the heap of medium should be enclosed either by covering with plastic sheets which may be in continuous contact with the medium, or by storage in bins or drums equipped with gas tight lids.

If the heap is to be used within six weeks of treatment, it should be aerated 5-7 days after treatment. Two to four weeks after aeration, a germination test should be carried out to determine whether all the Basamid(R) residues have gone and it is safe to plant.

If the medium is not required for use within six weeks of treatment, aeration may not be necessary and the medium can simply be used from the top of the heap as required, after the germination test has indicated that gases have cleared.

Germination test

This test is very simple and takes only a short time.

(a) A medium sample needs to be taken from the depth of treated medium, quickly filling a far with a screw top lid to the ¾ mark. Also fill another jar with untreated medium.

(b) Place moist cotton pads or moist filter paper on the medium with cress or lettuce seeds on this in the jar, and close the jar quickly to prevent loss of any gases that may be present and place in a room at about 20°C.

(c) After 48 hours, if the seeds have germinated in the untreated medium but not in the treated medium, then the toxic gases have not yet escaped and therefore the medium should be worked again for aeration. If all test seeds germinate normally, then the medium is clear and planting can commence without any adverse effects to the plants.

Caution

Basamid(R) causes mild irritation of the mucous membranes. On short contact there is no irritation of the skin. Distinct skin irritation only occurs after a long period of contact (20 hours or more) with the active material. When spreading the granules, rubber gloves and wellington boots should be worn. Wash contaminated areas of skin thoroughly with soap and water, as well as overalls, boots, gloves and any equipment used in the application of Basamid(R) granules.

These recommendations, if followed accurately, are adequate for the requirements for soil sterilisation for approval to enter Western Australia.

4. Soil solarisation

Introduction

Soil sterilisation is an essential part of maintaining healthy disease free plants in the nursery. Methods used to rid the soil medium of harmful disease organisms include, fumigation, steam pasteurisation or sterilisation and soil solarisation.

Heating the soil medium is by far the safest method available to the nursery, although it may not be the cheapest method. Use of aerated steam with temperatures from 55-60°C for 30 minutes will control most micro-organisms, insects, viruses, weed seeds, while only being slightly injurious to the soil physically.

Objectives of soil treatments

There are three such objectives, and these are as follows:

(a) Eradication, in which the pathogen is eliminated from the soil. This is principally used for soil in containers, but is not considered economically feasible for field soil.

(b) Protection, the localised elimination or suppression of organisms from the soil in which roots develop, such as by row or spot treatments aimed at delaying recontamination. This method is therefore most useful on short-term crops.

(c) Antagonism, in which the microflora is so manipulated as to inhibit pathogen development by the competitive, antibiotic, or parasitic activities of other micro-organisms. These effects possibly exist to some extent in all soil treatments, but are not yet used commercially because of insufficient knowledge.

What is soil solarisation?

Soil solarisation is the process which involves the use of heat as a lethal agent for the control of pests (soil borne diseases), through the use of clear polyethylene tarps which capture solar energy.

As you might expect, black polyethylene tarp, though greatly heated by itself, is less efficient in heating the soil than transparent polyethylene. Therefore transparent and not black polyethylene should be used since it transmits most of the solar radiation that heats the soil.

Soil mulching should be carried out during the period of high temperatures and intense solar radiation. This soil should be kept wet during mulching to increase thermal sensitivity of resting structures and improve heat conduction. This can be carried out by means of a drip irrigation system, enabling additional light irrigations during mulching.

Satisfactory results can be obtained by a simpler method; that is, the soil is sprinkler irrigated and then, 1-4 days later, mulched with no additional irrigations.

As a result of the formation of water droplets on the inner surface of the polyethylene film, its transmittance to long-wave radiation is highly reduced, resulting in better heating due to an increase in its green house effect. Allow close contact between the plastic sheets and the soil preventing the formation of 'air pockets' which reduce heat conduction.

The thinnest polyethylene tarp (25-30 um, 0.03 mm) is recommended, since it is both cheaper and somewhat more effective in heating, due to better radiation transmittance, than the thicker ones.

Temperature regimes

Extensive studies have shown that 30 minutes at 65°C will kill most of the important plant pathogens, insects and weeds.

In practice, populations of soilborne fungal pathogens are greatly reduced at temperatures of 40-50°C, exposure time ranging from minutes to hours for the higher temperatures, and up to days for the lower temperatures. Solar heating is carried out at relatively low temperatures, as compared to artificial heating; thus, its effect on living and non-living soil components are likely to be less drastic.

Typical maximal temperatures in the mulched soil may reach 50-44°C at 5-20 cm respectively below the soil. Since temperatures at the deeper soil layers are lower than at the upper ones, the mulching period should be sufficiently extended, usually four weeks or longer.

Moisture level is a crucial factor since micro-organisms are much more resistant to heat under dry conditions. In the presence of water, less energy is required to unfold the peptide chain of proteins, resulting in a decreased heat resistance. In wet mulched soils, increased temperatures are due primarily (80%) to the elimination of heat loss by evaporation and heat convection during the daytime and partially to the greenhouse effect, that is preventing part of the long-wave radiation from leaving the ground.

Inoculum of *Verticillium dahliae, Pythium ultimum, Phizoctonia solani* and *Thielaviopsis basicola*, were eliminated or greatly reduced to depths of 46 cm in soil solarised for 3-5 weeks during summer months.

Benefits

Pathogens are less resistant to heat than many saprophytes and antagonists including *Trichoderma* spp. and *Bacillus subtilis*. Solar heating is carried out at temperatures that are even lower than aerated steam, thus further reducing the chances of a biological vacuum in the soil. Saprophytic bacteria and actinomycetes survive much better than fungi in heated soils.

The phenomenon of increased growth of plants in soils that are partially sterilised and free of known pathogens has been known for decades. This often occurs in steamed as well as fumigated soil.

Limitations

The absorption of solar radiation varies according to the colour, moisture and texture of the soil.

This process of soil sterilisation may take between 3-5 weeks for it to work effectively which is undesirable if you need the soil media sooner. In that case, the use of methyl-bromide fumigation may be more appropriate.

It has been shown that temperatures below 45°C can be lethal to both bacteria and fungi if maintained for long periods.

Soil solarisation should not be regarded as a universal method of disease control but rather, as an additional method which, when used correctly, has many advantages. This method is safe and nonchemical, does not produce phytotoxic residues, is relatively inexpensive and is simple to use.

5. Microwave sterilisation of potting media

This form of potting media sterilisation can destroy targeted soil pathogens when infected media is exposed to microwaves for approximately one minute at 65°C. *Lotus major* seeds and soil borne pathogens were destroyed when the infected media was passed through the unit in a similar time but at 100°C.

The cost of sterilising media using microwave techniques compares favourably with costs of steam treatment; say at 5 tonnes/day, the cost per is:

Micro - 65°C	Micro - 100°C	Steam - 65°C
$3.16	$4.88	$5.14

Continuous sterilisation of media mixing appears to be possible using a conveyer belt/ microwave technique whilst steam treatment appears to be locked into a batching procedure.

Plants grown in pots after being treated with microwaves at 65°C and 100°C were of equal quality to similar varieties grown in steam treated controls.

Planting material

Vegetative material

(a) The surface of cuttings can be partly sterilised by dipping for a few minutes into a solution containing about 400 ppm or 0.04% chlorine (75 mL of sodium hypochlorite containing 12.5% active chlorine to 25 L of water). Rinse with clean water. Chlorine bleach available at retail stores has about 3% active chlorine, therefore you need to use 312 mL of sodium hypochlorite in 25 L of water. Dettol or Hibitane may also be used. Planting material should be carefully selected and be free from any signs of disease or pests, or

(b) hot water or aerated steam treatments may be suitable only for some types of material. Seek advice from the CLEAN SCHEME OFFICER.

(c) All incoming material needs to be from a approved source, for example, Clean Scheme Nursery or a nursery that treats its potting mix. Plants coming from a non-approved source must be placed in a quarantine area with the following restrictions applied.

  (i) Restricted access to staff only.

  (ii) All runoff water is to be diverted away from the existing nursery stock.

  (iii) All such plants must be sprayed with a broad spectrum insecticide and fungicide.

  (iv) Plants are to be placed on one of the approved surfaces under conditions suitable for the plants continued health.

(v) The quarantine area is to be situated such that it is isolated from other nursery stock.

(vi) Such quarantined plants are to remain in this area for one month prior to release.

(vii) A log book showing when plants enter the quarantine area, what they are sprayed with and when they leave.

Tubestock in peat/vermiculite need only be sprayed appropriately and then potted into clean mix. Bare rooted plants must be fungicide dipped before potting-on.

Seeds

(a) Seeds are soaked in hot water at 49-53°C for 30 minutes. they are held in thin cotton bags, then cooled in sterile cold water. This hot water treatment can be valuable for the treatment of seed against internal pathogens. The temperature and duration of treatment are critical, and seed of some species can be damaged by treatment. seeds treated this way should be used immediately, or

(b) seeds can be soaked in sodium or calcium hypochlorite, Dettol or Hibitane as surface sterilents. Chemical seed dressings may also be used. These include thiram, maneb, chloranil and dichlone which protect the germinating seed from pathogens in the media not on or in the seed. Others such as thiabendazole, benomyl and benzene hexachloride may not penetrate to kill all pathogens.

Growing containers

If growing containers are to be reused for potting on, they should be treated first to stop infection from contaminated pots.

(a) Heat sterilisation (steam) or fumigation as for soil and potting mixes should be used. If necessary containers can be sterilised with the soil/mix to help reduce operations.

(b) When using a disinfectant, containers should be washed first with water to remove any soil or other material, then rinsed with sodium hypochlorite, formalin or a zephiran solution.

(c) New containers are regarded as being clean, disease free.

Growing surfaces

Potted plants should be properly separated from the soil surface in order to stop contamination from the soil entering the pots. This can be accomplished in a number of ways:

(a) 100 mm of either gravel or sand.

(b) 50 mm of gravel, sand or well drained cracker dust, plus weed matting which can be placed on top or underneath the desired aggregate.

(c) 50 mm depth of concrete.

(d) 50 mm depth of bitumen.

(e) Corrugated iron. This must be replaced once it starts to rust severely.

(f) Raised benches. They must be of a design that will not allow the accumulation of drainage water. A bench can be any technique that creates an air space between plants and the natural ground level.

Containers that are 50 L or more need only be placed on a slight mound for drainage with weed matting being placed on top of the mound to prevent the containers from coming in contact with the bare ground.

Growing surfaces should be disinfected by washing or spraying with sodium hypochlorite, formalin or zephiran. This should be done after a batch of plants is removed from an area or which a build up of algal growth is present.

Water

Water can introduce plant pathogens into a nursery with disastrous results, as the most important disease pathogens present in water are *Phytophthora, Pythium, Fusarium* species and bacteria, therefore the treatment of water is a very important part of good nursery management. All surface water supplied (streams or dams) should be treated by means of chlorination, filtration (to microbiological standards, 5 micron filters), heating to 65°C for 30 minutes or use of ultraviolet sterilisation systems.

Chlorination is a cheap and effective means of treating water. Most town water supplies are chlorinated and therefore free of pathogens. There are three main sources of chlorine used:

(a) calcium hypochlorite,

(b) sodium hypochlorite, and

(c) chlorine gas.

When chlorine is added to water it will:

(a) be used in reactions:

(i) to kill bacteria and fungal spores,

(ii) to oxidise other organic matter,

(iii) to react with inorganic chemicals, and

(b) breakdown in the presence of sunlight, which can be avoided by treating in the evenings.

It is important to ensure with regular checks that some residual chlorine (minimum two parts per million) is present after mixing. A low concentration (less than 0.5 ppm) is best for use in plants.

It is difficult to make recommendations on the rate of chlorine required, as this will vary with situation and water quality. As an example, a rate of 7 gm/1000 L of calcium hypochlorite (approximately 8 mL of granules) or 40 mL of 12.5% sodium hypochlorite will give a theoretical value of 5 ppm; of this, 3 ppm may be used in chlorine reactions leaving 2 ppm residual chlorine. A swimming pool test kit can be used to confirm that 2 ppm of chlorine is available.

Ultra violet (UV) light offers the advantage of being automatic, cheap and free of chemical residues. Those organisms that are carried in water are killed by exposure to an appropriate dose of UV radiation, which is measured in micro-watt seconds per square centimetre (MWS/cm^2). The exposure is made by flowing the water around a UV light tube.

The dose required varies with different organisms, for example, coliform bacteria are killed by 6600 MWS/cm^2 and virus particles by 8000 MWS/cm^2 or higher to cause death. Rates required to kill *Phytophthora, Pythium* and *Fusarium* from preliminary experimental work is about 70 000 MWS/cm^2.

The major problem with the use of UV treatment is nurseries is that we do not know the required dose for killing all pathogens. when this has been determined and the machines appropriately calibrated, UV sanitation of water could become an important part of nursery hygiene.

Work benches and equipment (including tools, receptacles and barrows)

Such equipment should be treated with 2% sodium hypochlorite, remembering that household bleach contains about 3% active chlorine. A 2% formalin solution (55 mL of industrial formaldehyde - 37%, diluted to 1L) or methylated spirits may also be used. Zephiran is another disinfectant which can be used to clean equipment and benches.

Such equipment should be treated prior to use on clean material, whether it is cuttings or a soil mix. Ideally such equipment should be labelled for use on clean material only and not to be used for any other purpose.

Routine disease and pest control

This part of the nursery operation involves the use of a variety of chemicals to help in the control of particular pest and disease problems. Every available precaution must be taken when using various chemicals as they can be extremely hazardous to both the operator and any passers by. There are no CLEAN SCHEME STANDARDS for the use of chemicals, but, as the operator is the one most likely at risk, suitable protective clothing should be worn at all times. This includes overalls, rubber boots, gloves, respirator and a hat.

There are a large number of chemicals available for use, according to the organism needing to be controlled. Each label should be read thoroughly prior to use.

Below is a list of the common pests and diseases likely to be found in a nursery situation. As there are new chemicals being developed all the time, these lists are by no means complete, so consult your CLEAN SCHEME OFFICER if you are unsure as to any new chemical.

An example of log book entries

Date	Details	Name
10.9.80	Steam pasteurisation of potting mix - 30 min at 65°C	J. Smith
10.9.80	Fungicidal dressing of *Carpentaria acuminata* with thiram	D. Jones
10.9.80	Washing 8" pots with detergent and water and then a bleach solution	C. Johnson
10.9.80	Sprayed shadehouse No. 1 with Dithane and Plictran	J. Smith
11.9.80	Cleaned cutting bench with bleach	B. Fisher
11.9.80	Surface sterilised cuttings with bleach solution - cuttings were *Dieffenbachia*	D. Jones
11.9.80	Scrubbed concrete pathways in the propagation house with bleach to get rid of the algae build-up.	B. Fischer
11.9.80	Washed 6" pots and the rest of 8" pots with detergent and water and then in a bleach solution.	C. Johnson
11.9.80	Spray shade house No. 2 and 3 with Rogor	J. Smith

It does not take much to fill in the log book. If it is done properly, you can trace an infection back to its source. Perhaps the potting mix was not pasteurised for long enough or the cuttings were not dipped. Whatever the cause, the log book enables you to find the possible source of infection.

Log books are to be used for:

(a) Growing media - which treatment and when treated.

(b) Incoming plants - from where, and what type of plants.

(c) Quarantine areas - date of entry, disinfesting treatments used and date of exit from area.

(d) Chemical applications - what chemicals are used for diseases, pests and weeds, where and when used.

APPENDIX IV

The Queensland Nursery Industry Association Voluntary Accreditation Scheme

The Queensland Nursery Industry Association launched the Voluntary Nursery Accreditation Scheme in July 1992. It is administered by the Queensland Nursery Industry Association (QNIA) and is endorsed and technically supported by the Queensland Department of Primary Industries (QDPI).

It is envisaged that the Queensland Scheme will be compatible with a national nursery accreditation scheme when it is developed at some future time.

Accreditation is the recognition of a nursery business which meets a set of standards determined by the QNIA. The standards essentially deal with the prevention of a number of diseases which, once the plants are infected, cannot be satisfactorily controlled. In addition to disease prevention there is an emphasis on good pest and disease control and an expectation that the crops will be well managed nutritionally.

ACCREDITATION IS TOTALLY VOLUNTARY AND OPEN TO BOTH MEMBERS AND NON-MEMBERS OF THE QNIA ALIKE.

Accreditation means that a nursery enterprise can be recognised by consumers as a source of above average quality plants. The better overall performance of plants from nurseries operating according to accreditation guidelines means improved repeat sales.

Consumers of plants which are particularly susceptible to the diseases addressed by the various nursery industry association schemes are already selectively buying from accredited nurseries. Good examples of these stock lines are azaleas, tubestock, many fruit trees, cut flowers, natives and proteas and susceptible landscape plants such as grevillea and banksia.

While accreditation is applicable to all nurseries it is of particular importance to propagation nurseries, that is, nurseries producing large quantities of tubestock. The way that these are run often means they are already close to complying with the accreditation guidelines. There are very significant improvements in output, plant vigour and quality and the range of plants which can be grown by a nursery using the accreditation guidelines.

Being involved with the Accreditation Scheme means that a nursery operation has improved access to technical consultation, particularly with regard to crop protection (disease, pest diagnosis and control) and nutrition.

Additional capital costs are not always necessary for accreditation but where they do occur there are extensive side benefits. The guidelines formulated by the QNIA in consultation with the QDPI are essentially a summary of the direction in which any modern nursery operation should already be moving. This means in effect that there are no capital costs additional to those already necessary to improve plant quality.

Utilisation of the accreditation guidelines is a vital part of quality management, a process which is of ever increasing interest to nursery operators Australia wide.

There are also additional benefits including:

- future participation in a national nursery accreditation scheme and to lead on this issue rather than be forced to follow,
- instigating the first steps towards reduced reliance on pesticides and insecticides,
- improving plant growth and vitality by reduced reliance on chemicals,
- instigating the first steps in the introduction of Quality Management and Quality Assurance which is now being demanded by many Government, semi-Government departments and the private sector.

In conclusion there are probably some distinct marketing advantages in handling plants from accredited nurseries. These will be conveyed to the public as more and more accredited nurseries come on line.

The costs associated with participation in the Scheme may vary over time but have initially been set as follows:

Year One	**$**
Non refundable application fee which covers the initial assessment visitation.	50.00
(Applicant may decide not to proceed at this stage.)	
Applicants proceeding within a three month period pay a yearly fee to cover the costs association with two additional visits and analysis of up to five sample.	375.00
(Applicants receive comprehensive advice on remedial recommendations and subject to approval the appropriate Accreditation Certificate.)	
Year Two and subsequent	
The subsequent yearly fee covers two inspections and up to five samples.	425.00

(Additional visits and sampling in Year Two and
subsequent years would be at a cost yet to be determined.)

Administration and funding will be controlled by a committee comprising representatives from Accredited nurseries, QNIA and QDPI.

Implementation of the Queensland Nursery Industry Voluntary Accreditation Scheme

It is proposed that:

1. The QNIA will administer the scheme and all of its financial transactions.

2. Accreditation will not be obligatory for membership.

3. The QNIA pursue any taxation benefits likely to accrue from monies spent in related research, education and training, and in pursuing quality assurance.

4. The QNIA will be largely instrumental in promoting the scheme.

5. Accreditation will be open to all Queensland nursery operators.

6. The QNIA conduct an annual short course related to membership assessment and accreditation, the technical content to be provided by the QDPI.

7. All accredited nurseries be involved in assessments of the success of the guidelines and the Scheme in general.

8. The technical advisers initially be QDPI officers specialising in nursery crop extension and plant protection.

9. The Accreditation Committee shall consist of an appropriate number of nursery operators (not less than three) representing a comprehensive range of nursery crops, the executive director of the Association and one QDPI officer/inspector.

10. No restrictions shall be placed on applicants because of the type of nursery enterprise.

11. Confidentiality shall be maintained, emphasising the use of a numbering system for applicants, as used in other states.

12. The applicant shall be given a copy of the inspector's checklist and the checklists be kept on permanent file.

13. The guidelines will be reviewed on a regular basis and changed accordingly.

14. Formalised accreditation inspections will be annual, with a less intensive six monthly inspection. Inspections should be scheduled by arrangement.

15. Accredited nurseries which fail to meet the guidelines on subsequent inspections will be treated similarly to those in the Victorian and Western Australian accreditation schemes.

16. The Association will encourage potting mix suppliers to become accredited.

The guidelines and checklist follow.

Administration guidelines - Queensland Nursery Industry Voluntary Accreditation Scheme

1. Aims of the scheme

The Scheme shall foster:

(a) Benefits to the consumer (identifiable sources of accredited plants).
(b) Improved nursery practices.
(c) The prevention of soil-borne plant pathogens.
(d) The promotion of accredited members as the suppliers of superior plants.

2. Eligibility

Any nursery business or growing media supplier may apply for accreditation.

3. Administration

The Scheme shall be administered by the Queensland Nursery Industry Association in consultation with its Accreditation Committee.

The Accreditation Committee shall consider applications for accreditation as required. All dealings between applicants and the Accreditation Committee shall be confidential.

The Accreditation Committee may seek competent technical advice before reaching a decision on any application but shall reach its decision independently of that advice.

The Accreditation Committee shall be responsible for granting and rescinding accreditation.

The Accreditation Committee will maintain a list of accredited nurseries and publish that list on at least a six monthly basis.

4. Applications for accreditation

Applicants will be advised when accreditation has been granted or of any reason why accreditation cannot be granted or continued.

Accreditation will in general be for one year, commencing with certification, but shall be subject to periodic review by the Accreditation Committee.

5. Privileges

An accredited nursery may state so in advertising and use the approved logo.

Accredited nurseries shall be entitled to a minimum of two inspections per year to monitor the successful operation of the technical guidelines.

Accredited nurseries have access to additional technical services, on a fee for service provision.

6. Responsibilities

A nursery operator may not guarantee plants as being 'disease-free' or 'pest-free' as a consequence of gaining acceptance under the Scheme, nor shall any warranty be implied by the QNIA, the Accreditation Committee, cooperating organisations (QDPI) or their personnel.

An applicant or accredited nursery operator shall agree on request to allow an inspector under the Scheme to make inspection and/or take samples for assay, where these have relevance to the successful operation of the Scheme.

A nursery operator shall agree to refrain from using the logo and advertising as an accredited source of plants, if eligibility for accreditation lapses, and do so until accreditation is restored.

7. Termination or suspension of accreditation

Accreditation shall be suspended if, in the opinion of the Accreditation Committee:

(a) Satisfactory plant health is not maintained.
(b) The nursery does not abide by the schedule of fees.
(c) The nursery misrepresents non-accredited plants.

The period of suspension is reliant on the time taken to implement remedial action.

Restoration of accreditation

The Accreditation Committee retains ownership of the annual and dated certificate of accreditation and requires its return if accreditation is suspended or terminated.

The Accreditation Committee will restore accreditation upon the nursery once all of the necessary guidelines are again successfully met.

Assessment guidelines - Queensland Nursery Industry Voluntary Accreditation Scheme

The following assessment criteria were chosen to represent a range of factors which influence the quality of the nursery end product. Particular emphasis is given to plant health.

Hygiene guidelines

1. Propagation

1.1 Growing media

1.1.1 Treatment

Propagating media or propagating media components must be treated with either steam/ air pasteurisation (where the medium or medium component is brought to a temperature of 60°C and held at that temperature for 30 minutes) or methyl bromide (at 600 g methyl bromide per 2 m x 2 m x 250 mm deep volume of potting mix laid out on a sealed surface and under a gas proof sheet) for 24-48 hours.

Treatment need not apply to media or media components which are properly stored and are generally recognised as being free of major root pathogens, or are tested free of root pathogens.

1.1.2 Storage of media and media components

Vehicle approaches to storage facilities should preferably be sealed or else covered with consolidated roadbase or gravel.

All media and media components which are already treated, or do not need treatment are to be stored on surfaces and in areas which both shed and exclude runoff water and exclude contamination by soil and other possibly contaminated materials. Alternatively, media can be stored in bins, trailers and trolleys.

Different batches of media should be stored separately.

All storage surfaces must be cleaned and disinfested between batches.

Records are to be kept of deliveries and sources of media and media components.

Soil mixing areas where media are not to be subsequently treated, are to be constructed with sealed surfaces.

Treated media storage areas must be effectively separated from untreated media storage areas.

1.1.3 Transport of treated media

Treated media and media determined as being free of pathogens must not be confused with possibly contaminated media during transport and handling operations. Therefore, media should be labelled. Equipment used to transport media must be washed and sanitised between batches where different batches are handled, to avoid possible cross contamination.

1.2 Propagating facilities

1.2.1 Propagation area

Ideally this should be separated from growing areas.

1.2.2 Access

Access to propagation areas should be restricted to necessary staff only. The propagation area must not be a thoroughfare for staff or materials and plant handling operations.

1.2.3 Footwear

Footbaths and/or specially allocated gumboots should be available at entry points. They must be available where propagation is on beds rather than benches.

1.2.4 Floor surfaces

Paths and preferably all of the floor surfaces should be sealed. Aggregate or gravel can be used under benches but should be covered with weedmat or an alternative which facilitates the removal of media spill and plant detritus. Spilt media must not be used unless retreated beforehand. Floor surfaces should be washed and treated with sanitising solutions regularly. Plant debris must not remain on the floor and dead or diseased propagules removed from beds or benches should be placed directly into receptacles which are sanitised frequently.

1.2.5 Working surfaces

Bench and table tops used to plant and prepare propagules need to be constructed of non-porous materials or covered with non-porous materials which are cleaned daily (or between batches of media or cuttings) and swabbed with solutions containing chlorine (5 000 ppm), methylated spirits or a quaternary ammonium chloride (for example, Biogram at 2%) or other disinfectants approved by the inspector.

1.2.6 Tools

All tools need to be cleaned between batches of media or cuttings by dipping in any of the chemicals listed in section 1.2.5.

1.2.7 Washing facilities

Hand washing facilities need to be provided near entry points and used before commencing work and between batches of media and cuttings.

1.2.8 Containers

Where new containers can be stored free of soil, plant and drainage water contamination, they need not be sanitised. Clean and sanitised containers must be stored above floor level.

Used containers must be scrubbed and washed prior to sterilisation. Methods of sterilisation include treating with steam (as for propagating media), chlorine solutions (5 000 ppm available chlorine for five minutes), formalin or fumigants. They must then be stored as recommended.

1.2.9 Removal of plant and media wastes

Discarded and diseased plants and spilt media are to be accumulated in specially allocated containers and disposed of on a frequent basis.

1.3 Propagating beds and benching

1.3.1 Propagating beds

Beds should be raised above surrounding surfaces (preferably a minimum of 30 cms) and freely draining beneath the medium or containers. Splash from the floor must be avoided where beds are used.

1.3.2 Benching

All containers need to be removed from contact with bare ground. Benches should be above 30 cm from the floor, preferably 75 cms or higher.

1.3.3 Irrigation

Irrigation water must be from a pathogen-free source or treated to eliminate pathogens. Once treated, it must be stored in contamination-excluding facilities. Splash from possibly contaminated surfaces onto surfaces must be avoided. Hose nozzles must be kept off the floor and other possibly contaminated surfaces.

1.3.4 Maintaining clean surfaces

Beds and benches, once sanitised, must be kept free of possible sources of contamination (for example, plants and media of unknown cleanliness, and untreated tools, etc).

2. Potting-on

2.1 Potting-on media

2.1.1 Treatment

Media components must be treated as specified (Section 1.1.1) if they are from possibly contaminated sources. Records of deliveries and sources of media need to be maintained.

2.1.2 Storage

Media need to be stored by methods which prevent contamination by materials likely to be infested with disease organisms.

2.1.3 Transport

Media need to be transported according to the guidelines for propagating media (section 1.1.3).

2.2 Potting-on facilities

Containers, plants to be potted-on, the growing medium used and the newly potted plants must not come into contact with possibly contaminated materials during potting-on operations.

3. Motherstock and propagules

3.1 Motherstock

3.1.1 Motherstock sources

Motherstock should, wherever possible, be obtained from accredited sources. If not from an accredited source, it should be given a period of quarantine before entering the motherstock area or propagation areas. It must not be treated with chemicals, which disguise root-rot symptoms.

3.1.2 Motherstock maintenance

Motherstock should be treated regularly with fungicides to decrease the possibility of diseases entering propagation facilities. Where motherstock is in-ground, good drainage is essential. Trickle irrigation is preferable to overhead irrigation as it reduces foliage wetting and splash. Mulching also reduces soil splash but it must be restricted to inert or only slowly decomposing organics.

3.2 Propagation material

Cuttings should only be taken from healthy plants.

Cuttings and seeds should not come into contact with soil. Where soil contamination has occurred, or is suspected, the propagules must be treated with appropriate fungicides, hot water treated or possibly surface sterilised.

4. Nursery growing areas

4.1 Container-grown plants

4.1.1 Benches

Where benches are used, the suitability of the height is dependent on the type of surface underneath. Benches over either sealed or aggregate surfaced floors and paths and grown in polyhouses with low precipitation rate irrigation outlets, need not be higher than 30 cms.

However, where splash and other methods of contamination are likely to occur, a suitable bench height is 75 cms.

The bench surface should preferably be free draining and easily disinfested. Solid surfaces on benches, such as those used in capillary watering systems, are permitted where all other hygiene factors are sound.

4.1.2 Beds

The surface of the bed and the pathways adjacent to it, must prevent contact of the plant, the plant roots or the container, with soil or soil-contaminated water or water draining from containers. Weedmat alone is insufficient. Polythene on soil is definitely not permitted. Concrete and bitumen surfaced beds are permitted only where exceptionally good drainage occurs and all other hygiene practices are excellent. Experience would indicate that aggregate (screenings of 1 cm and higher) covered surfaces are effective, where good drainage also exists and the aggregate is 7.5 cm deep or deeper. Puddling in the production site is not permitted. Weedmat over the aggregate is preferred, as it keeps the aggregate free of crop detritus and potting mix spill and prevents root escape. Where the nursery soil type is likely to allow its intrusion into the aggregate, the area should first be surfaced with roadbase or geotextiles and graded and drained. Fumigation of the soil with methyl bromide and chloropicrin mixtures is preferred prior to surfacing disease contaminated nursery soils with aggregate, but extreme care must be taken, not to recontaminate the treated area.

Note that no surface will work effectively unless the bed is well drained.

4.1.3 Pathways

Pathways must not allow ponding of water. They should preferably be lower than the bed heights.

4.1.4 Run-off mitigation

Run-off water from other production sites, adjoining land, roadways, car parks, and paths must be excluded from the beds.

4.1.5 Traffic control

Vehicle access to the growing areas should be as restricted as possible. Vehicles used in the growing area should be taken out of it as little as possible and cleaned and disinfected prior to re-entry. Where necessary, the area should be fenced to limit the access of unauthorised traffic and the movement of animals.

4.1.6 Disposal of damaged plants

Plants that are diseased, and the potting mix used, must be placed into specially designated containers and removed from the production site and burnt or buried deeply. Used media can be reused if it is first given a period of composting and then sterilised.

4.1.7 Treatment of used growing media

This must not be reused unless it is first treated accordingly.

4.1.8 Freedom from weeds

There must be substantial freedom from weeds, both in containers and their surrounds.

4.2 In-ground production

4.2.1 Soil type and topography

The area selected must be able to be effectively and easily drained. Where the soil type is heavy and consequently internal drainage may be restricted, a suitable raised bed system must be developed.

4.2.2 Soil disinfestation

Where either previous experience or soil and/or vegetation testing indicates the presence of soil-borne pathogens, the production area must be fumigated with methyl bromide and chloropicrin mixtures before planting. Strict hygiene must be employed to prevent reinfesting the sterilised area. The plants used must also come from an accredited source or from a source that is tested free of major soil-borne pathogens.

4.2.3 Drainage

All water from adjacent areas must be deflected from the production area and its roadways. The production site needs to be broken up into discretely drained blocks. In this manner, if infection does occur, it can be restricted to a limited part of the nursery. Surface drains need to be properly stabilised.

4.2.4 Weed control

Weed control must be thorough. Nutgrass and other troublesome perennial weeds are not permitted in the growing area.

4.2.5 Roadways

Roadways should be all weather and properly drained. Vehicle access to the production site should be restricted to reduce the possibility of contamination.

4.2.6 Fencing

The growing area needs to be fenced to prevent the access of large animals and vehicles, which may be carrying soil infested with weeds and disease organisms.

5. Water disinfestation

5.1 Source

In terms of carrying disease organisms, water from bores deeper than three metres, not contaminated by surface run-off,and from town supplies is considered safe. Water from streams, dams and springs may be contaminated. Where water from a 'clean' source is lifted into an earthen walled dam that is not constructed in a previously infested site, it may not require treatment. However in this situation, a laboratory assay of the dam water, after significant rainfall, would be required before it could receive an exemption from treatment.

5.2 Treatment

5.2.1 Filtration

Phytophthora spores can be filtered out of irrigation water using five micron filters. Extensive pre-filtration is required before water passes through microfilters. Microfiltration using five micron filters does not eliminate all soil and water-borne pathogens.

5.2.2 Chlorination

Chlorination is the most widely used method of water treatment. It eliminates a wider range of disease organisms than filtration to five microns. Either the direct injection of chlorine or hypochlorite solutions into the irrigation line or preferably the use of sodium and calcium hypochlorite in holding tanks, is acceptable. Chlorination to a minimum concentration of 2 ppm residual chlorine is required. Water quality (mineralisation as well as the presence of suspended organic materials) affects the amount of chlorine that needs to be added.

Chlorine demand can increase or decrease after rainfall.

Therefore, chlorine concentrations need to be periodically tested by the nursery operator to determine the dosage rate needed to compensate for variable water quality.

In some situations, it is necessary to settle and/or filter turbid water to enable its effective treatment. The position of the intake valve is very important when pumping from surface waters. An intake attached to a float positioned well away from the dam wall, so that

water is pumped from 40-45 cms below the surface and well above the bottom, is ideal.

6. Pest, disease and weed control programmes

6.1 Equipment

Application equipment must be suited to the task, be calibrated regularly and kept in good working order. The personnel operating the equipment must have access to adequate and properly used measuring devices and safety equipment.

6.2 Records

Complete records of the chemicals used, the rates, the dates of application, the combinations made, the approximate volumes (or weights) applied, the name of the spray operator, and the crops sprayed, must be maintained.

6.3 Programmes

These must have been designed by experienced personnel and capable of controlling the target organisms without producing significant damage due to phytotoxicities.

7. Purchased stock requirements

Greenstock obtained from unaccredited sources for growing-on must be separated from existing stock until it can be proven free of soilborne pathogens. It must not, prior to this provision, be sold as accredited material.

8. Retail nurseries

It will be difficult to immediately accredit retail nurseries until there is a sufficient supply of accredited materials available from wholesalers. However, it would be of benefit to the consumer and to the retailer if the retailer observed the relevant recommendations for containerised plants.

9. Personnel

The nursery management must ensure that they and their staff are fully aware of the hygiene requirements for accreditation and how to recognise problems that may affect Scheme eligibility. It would be of great benefit if one or several persons from each nursery attended a QNIA run short course based on major factors concerned with accreditation.

10. Site accreditation

Stock sold as accredited plants can only be produced on accredited sites. Nurseries producing on a number of different sites may either have each site accredited, or market independently from both accredited and unaccredited sites.

Physical Guidelines

1. Water

1.1 Quality

The quality of the various supplies of irrigation water available to the nursery must be tested to determine the degree of mineral content and its possible effects on the quality of stock produced. Where previous analyses indicate that salinity levels are borderline or likely to fluctuate, analyses should be conducted on at least an annual basis. Analyses are currently conducted free by government laboratories. Where irrigation water is deemed of borderline quality, salinity mitigation procedures should be employed, as should methods of water treatment such as iron precipitation.

1.2 Disinfestation

Unless testing for the presence of soil and water-borne pathogens indicates otherwise, water from surface and near surface sources must effectively be treated with either chlorine or microfiltration. Ultraviolet sterilisation may be considered where testing for the presence of disease organisms indicates that the water is not contaminated. Water from bores deeper than three metres and reticulated town supplies is considered to be free of pathogens.

1.3 Storage

The storage of treated irrigation water requires facilities that do not allow for contamination by untreated water, soil, plant debris, dust and animal movement.

1.4 Irrigation

Irrigation equipment and practice must be suited to the needs of the crop in terms of the uniform distribution of water and effective irrigation scheduling. Waste water, particularly that containing fertilisers and/or pesticides should be minimal in volume and preferably disposed of by the use of an approved discharge system. Growing media should have a suitable range of physical properties in terms of water holding capacity, aeration and drainage. Plants requiring a hardening-off period should be able to be placed under a modified watering regime.

1.5 Humidity

The humidity of atmospheres maintained in nursery structures should not continually exceed levels beyond which plant health becomes a persistent problem.

2. Wind control

The physiological and physical damage sustained by plants should be, where necessary, minimised by the use of suitably constructed windbreaks. Windbreaks and other methods of dust control must be employed **where applicable.**

3. Light

The crops should be grown under light regimes suited to the needs of the species. Where necessary, facilities should exist to acclimatise plants to light levels used by the purchaser. Light levels in the dispatch area and in the transport process should not exceed the tolerance of indoor plants. Light levels in retail sites must be sufficient to sustain growth of both indoor and outdoor nursery crops.

4. Temperature

Modified temperature regimes should not be outside of the tolerance range of the majority of crops grown. In the event of an environmental control failure (for example, with low precipitation frost mitigation, greenhouse cooling or greenhouse heating), the nursery operator must be prepared to grow-on the damaged plants for a period sufficient to guarantee both quality and continued plant vitality.

5. Nutrition

The nursery operator should demonstrate a thorough knowledge and control of crop nutrition. In addition, enough information on the nutritional practice of the nursery should be relayed to the inspector to assure him/her that the operator consistently uses an effective programme. The operator needs to supply the outgoing plants with the nutritional reserves required to maintain the plants for long enough to meet the needs of the purchaser.

6. General appearance of nursery establishment

Roadways and drains are to be properly maintained.

Good drainage is absolutely essential.

Structures should be adequately maintained, and suited to their design purposes. Weeds capable of entering the crop must be eliminated from the surrounding areas.

APPENDIX V

The Nursery and Landscape Industry Association of South Australia - proposed scheme

An accreditation scheme is being considered by the Association but no guidelines have yet been drafted. The association has worked in the past with the South Australian Department of Agriculture on developing a scheme based on the production of planting stock with freedom from disease and pests and possible quality assurance criteria. Together they applied to the AHC in 1991 for financial assistance to develop the scheme but were unsuccessful in their application.

It is anticipated that any scheme developed for SA will strongly feature *Phytophthora* prevention. The widespread presence of *Phytophthora* in nurseries has been well documented over the past decade from samples received for diagnosis at the pathology laboratories of the Department of Agriculture. The frequencies of soil and water-borne pathogens in SA nurseries has also been assessed in research programs conducted by the CSIRO Division of Soils.

There is also interest in the association to work towards the goal of voluntary accreditation of a majority of its members.

APPENDIX VI

DRAFT Guidelines for the Nursery Industry Association of New South Wales (NIAN) Nursery Accreditation Scheme

NIAN has drawn up the set of draft guidelines, which follow. At this stage there are no accredited members. NIAN is interested in the development of a national accreditation scheme.

Introduction

Application for Accreditation may be lodged when a nursery has been a NIAN member for a minimum period of one year.

The innovation of accreditation to nurseries producing superior quality material is being enthusiastically received by Government and the industry: a sure sign of the recognition that the scheme is in every sense a real promotional tool and of great benefit to the industry; its essence spelt out in the them 'Setting the Standards'.

Aims of assessment

To improve the quality of nursery stock by setting standards of hygiene in production nurseries and to reduce the spread of plant pests and diseases.

To assess the operational standards of production nurseries, accredited nurseries can display and advertise their status.

Assessment rating

Quality of end product is of importance.

Owing to the variety of methods of management and the widely differing operations in nurseries, a precise system of scoring in assessment is neither possible nor desirable. The scale, scope and different techniques need to be taken into account. The standards however can be set to cover all types of operation and these have been carefully designed by NIAN.

These standards will be regularly monitored to ensure consistency over time.

Assessment criteria may be modified as changes occur in the industry. The changes will be publicised in advance of implementation.

All nurseries will be assessed on merit and no special considerations will be given.

Nurseries applying for accreditation will receive a report following assessment which can be of considerable value in improving standards. Where a nursery does not meet the standard on a particular criteria, there is the opportunity to apply for re-assessment and the observations and information on all of them will be recorded. Where necessary, soil and water testing and pathogen testing of plants will be included to aid the assessment.

Nursery Industry Association of N.S.W. Limited

Code of Ethics

To do all in my power to maintain the highest possible standards of honesty and integrity.

To be loyal to my customers and give service to the full extent of my ability.

To produce and offer for sale a properly labelled product of a high standard, from quality source material, correctly named and free from any known pest and disease.

To only deliver that nursery stock to my customers that conforms to samples or representations made and not to substitute varieties without the consent of the purchaser.

To ensure my staff and I have a high standard of knowledge of my industry and the products we sell and to impart to the best of our ability this knowledge to my customers.

To encourage and ensure safe work practices are employed in my place of business and ethical business standards are imparted to the staff.

To maintain my establishment to a high professional standard, both in appearance and technical operation.

To promote and improve social and business friendship and understanding between members.

Criteria for Assessment

1. Nursery structures (glasshouses, polyhouses, shadehouses etc)

Nursery structures should be appropriate for the purpose and in good repair. They should be capable of sustaining the growth of plants for the required period.

Age, size, materials used and number of structures are unimportant for accreditation assessment.

(a) Glasshouses, polyhouses, fibreglass or other acceptable glass substitutes (eg. acrylic sheeting) should be maintained in good repair to ensure that the desired environmental control can be achieved.

(b) The internal surfaces of such structures must be kept clean, free from excessive algae build up, fungal growth adhering to timber structures. Nurseries are to provide an environment less likely to harbour pests and diseases in both internal and external areas.

(c) Environmental control agencies including heaters, coolers and ventilators should be in good mechanical order and functional, appropriate to suit the particular need, eg. forced air ventilation to be operated in such a manner to inhibit the introduction of dust or other harmful pollutants to the greenhouse environment.

Floor surfaces

To prevent the contamination of potting media with pathogenic organisms, containers should not be placed directly on the soil surface. There should be good drainage beneath the pots to ensure there is no build-up of drainage water which will assist the spread of diseases from one pot to another.

Flooring to be free of puddled water, weeds, plant debris and general litter that can harbour pests and diseases.

The whole site is to be free of puddled areas, persistent weeds and general untidiness that can possibly harbour pests and disease.

Bench surfaces

Can be of any material but constructed to eliminate any impediment to drainage.

Working areas

Cutting preparation area.

Suitable benches should be constructed in such a manner with such materials that can be maintained in a clean, hygienic condition.

2. Main points of accreditation

New container media storage area

Selected to be a naturally free draining site.

(a) The pad or floor area can be compacted soil of clay type.

(b) Should concrete be preferred, then a moderate slope or pitch is desirable to shed any rain water or added water used for moistening purposes.

(c) This alleviates slushiness and the possibility of providing conditions for unfavourable anaerobic bacteria.

(d) Pad, whether concrete or earth to be raised 10-12 cm above surrounding area to avoid contamination from ground water.

(e) Suitable perimeter drains surrounding pad to prevent run off water from nursery or any other area that could contaminate the soil with pathogens, eg. water from bushland.

Media

(a) Can be any, chosen by the grower for specific purpose and prepared by the grower, OR purchased from reputable media supplier to the grower's specification.

(b) OR where the grower does NOT specify the media requirements, then the soil media company MUST supply a media conforming to the Australian Standards.

(c) Soil storage area to be protected from wind blown weed seed or other possible wind blown diseases.

(d) Pasteurisation, fumigation, solarisation etc should be used where the soil portion of media is suspect or known to contain noxious weeds, harmful plant pathogens etc.

(e) Storage pad to be kept free from used nursery pots and mobile machinery, such as tractors used for general nursery work, to avoid contamination. Mobile machines used for media movement should be kept away from pad when not in use.

(f) Media storage to be kept free from dumped, used nursery media where a crop has failed for some particular reason.

(g) No such dumped soil to be in close proximity to new media storage area where contamination is likely to occur.

(h) Dump soil can be re-used if desired, but essentially treated in some way to destroy pathogens. Stem, fumigation etc, pH salinity, air filled porosity should be evaluated to determine suitability for re-use.

Only 10% of dumped growing media should be added to the new media AFTER TREATMENT ONLY to avoid nutritional problems.

Dump soil to be located in such an area that complies with clauses (a), (b), (d) and (e) of new container media storage area, (p 5) and kept in such a manner that inhibits any run-off water from dump to enter any nursery production area.

Water

(a) Run off irrigation water from nursery production areas that contains nutrients or other impurities should not be discharged into municipal drains or natural creeks where pollution could occur or natural ecology affected.

(b) Any such run-off water that is collected on the property in dams or tanks must be chlorinated, or suitably disinfected prior to re-use for container production.

(c) Where collected water is found unsuitable, or recycling considered unsatisfactory, then such waters can be used for irrigating grass - land and treed areas set aside for such purposes, to avoid creek and river pollution.

(d) Where a nursery uses stored dam water only for container production, then such water must be chlorinated or other suitable treatment to eliminate pathogens.

Beds

Nursery beds for container production must be constructed and planted in such a manner that satisfactorily drains all such areas used.

Puddled areas, irrespective of ground preparation and covering used, is not permissible.

Beds and containers to be kept free of wees and nursery debris.

Nursery layout of production area to be of suitable design to facilitate spraying for pest and disease control.

Storage of chemicals

Structure must be lockable with flooring designed to contain spills should they occur.

Structure and safety requirements must comply with Local, state and Federal Government regulations.

Propagation

Sheds used for cutting production, grafting, seeding etc must be kept clean, free of unused plant material etc.

Propagation media to be kept in a hygienic manner, away from foot traffic or other implements that may cause contamination.

All tools used in propagation must be kept serviceable and in a state of cleanliness.

Gum, resin and sap residue must be cleaned away frequently, preferably using a disinfectant.

Used propagation media to be treated as in clause '(h)' media (p 5).

3. General nursery layout

Outdoor growing areas for plants

A. Prepared areas for growing plants

The drainage should be appropriate for the area and be adequate to prevent flooding during heavy rains.

Containerised plants should be spaced according to the requirements of the particular crop to minimise spread of disease and ensure quality production.

B. In ground growing areas

Field grown crops should be planted in such a manner as to minimise disease and pest problems and facilitate easy maintenance and good hygiene for pest and disease control. Crop rotation should be practiced.

The drainage should be installed to prevent waterlogging of the soil. Poor drainage can promote the development of root rotting fungi. Lifted plants should be maintained in good condition.

(ii) Make a statement to the effect that the onus is on the grower to maintain those services in the required hygienic state. Documentation of action is necessary.

(b) Media must be maintained in a hygienic state.

5. Quarantine areas

Should be built and maintained to Government requirements.

6. Propagation practices

Propagation material should be from disease/pest-free stock in healthy condition.

7. Plant protection practices

Spray program

An effective control program should be used for pests and diseases. The chemicals used should be appropriate for the range of plants grown (no phototoxicity) and be suitable for potential pest and diseases on those plants. If herbicides are used, they should be appropriate for the weed species present and suitable for the various weed situations in the nursery. Long term residual herbicides should be avoided.

All pesticides used should be recorded and the date of application, plants treated, quantity used, spray equipment used and weather conditions all recorded.

General vigour of plants

The general vigour and health of plants is important as this is a direct indication of the quality of the final product. Plants should not be suffering any physical or nutritional disorder and they should be of consistent and even quality. Plants that have been treated with growth regulators or subjected to any special treatment should be capable of growing to full potential after sale. Saleable plants should be well presented with regard to the appearance and structure and be grown in a suitable container. Plants ready for sale should be correctly labelled with information provided which will assist the final customer to successfully grow the plant.

Potting media

The components of a potting medium should allow for appropriate drainage and nutrient balance as required by the species.

Such media shall be free of noxious weeds, insect pests and serious oil borne pathogens.

Fertiliser program

Fertilisers should be of appropriate composition for the purpose used. They should be applied correctly (quantity and application method) and at an acceptable frequency to ensure continued growth and development beyond sale.

Spray equipment

The spray equipment used should be appropriate for the size and layout of the nursery.

The equipment should be clean and in good condition.

8. Pesticide application and safe handling

The protective clothing available should be appropriate to the hazard of the chemicals used. In all cases protective clothing should be available and used, including:

- respirator and face mask or hood,
- overalls or waterproof clothing,
- rubber boots,
- rubber gloves suitable for spraying.

The spray operator/s should be appropriate for the job and capable of preparing the spray mix according to the label instructions and be able to carry out the operation effectively and safely. The operator/s should have appropriate training or experience in disease and pest recognition and their control.

A minimum of one day re-entry delay should be enforced before handling sprayed plants or working in glasshouses. If sprayed plants must be handled within several days of spraying, then the staff should wear protective gloves and clothing to prevent skin contamination.

Appropriate first aid equipment must be available, including antidotes for pesticide poisoning. Information should be available on the specific chemicals used.

9. Retail garden centre (nursery)

Requirements for accreditation pertaining to wholesale nurseries are equally applicable to retail garden centres.

Businesses with five or more permanent staff to have a fully Accredited Sales Person on duty at all times to give customers all the guidance and advice. (The Accredited Sales Person is one who has successfully completed a joint NSW Dept of TAFE/NIAN course on retail nursery practices.)

Less than five permanent persons to be encouraged to try to have an Accredited Sales Person on hand.

Business to be able to advertise that they are accredited and have trained accredited staff on hand.

Staff to be accredited along the guidelines as set down in the booklet 'NSW Nursery Retail Scheme' as distributed by the NIAN office.

APPENDIX VII

The Nursery Industry Association of Tasmania - proposed scheme

NIAT is currently proposing an accreditation scheme, for which it will eventually be obligatory for members to belong.

The Association has a sub-committee of three members investigating accreditation scheme possibilities. The sub-committee is affiliated with government technologists who strongly support this industry driven initiative. There are currently no government regulations involving nursery accreditation however these may be sought in the future by NIAT, as a means of suppressing the supply of inferior product from non-accredited nurseries. NIAT is looking at a period of several years to achieve a full introduction of the scheme.

The aim of accreditation is to establish and promote member nurseries as suppliers of products of all round superior quality. Freedom from diseases caused by organisms such as *Phytophthora* spp is considered to be part of the package.

There have been no retrievable disease surveys conducted in Tasmanian nurseries and consequently no information on soil and water-borne pathogen losses. No inspector(s) have been selected yet. The costs of inspection and accreditation, administration etc. will be recovered from individual nurseries.

NIAT is interested in belonging to a national nursery accreditation scheme.

APPENDIX VIII

The Western Australian Nursery Accreditation Scheme

Introduction

The Nursery Accreditation Scheme is administered entirely by the Nursery Industry Association of Western Australia. It focuses largely on the prevention of *Phytophthora* and places relatively less emphasis on overall quality than does Queensland, Victorian and proposed New South Wales schemes. This emphasis is essentially due to the sensitivity of much of the West Australian native flora to *Phytophthora*. The development of the WA Scheme was given impetus by the possibility of an eventual governmental regulatory process featuring *Phytophthora*. Much of the blame of the spread of *Phytophthora* in WA was placed on the nursery industry by a former State Minister of Agriculture. Little attention at that time was given to other methods of spread, such as the passage of contaminated vehicles and earth-moving equipment, and the movement of plants produced by householders.

While *Phytophthora* is currently not scheduled under the WA Diseases in Plants Act it may eventually be so. The WA State Government most likely will not pursue the inclusion of *Phytophthora* in the Diseases in Plants Act if the industry can provide accredited sources of *Phytophthora*-free material within a reasonable period of time. Random checks may eventually be carried out on unaccredited nurseries. The Nursery Industry Association of Western Australia is seeking governmental input into the accreditation process and the penalisation of non-scheme participants to support accreditation. If the WA Department of Agriculture elects to do this, it would be probable that tighter restrictions would occur on live plant imports.

Operation of the Western Australian accreditation scheme

The Accreditation Committee consists of eight members. The membership was selected, not elected, and members are all nursery operators (wholesalers, retailers and wholesaler/retailers).

The formulation of the guidelines represents the collective effort of the industry association, the Department of Agriculture and an input from the University of Western Australia.

The Accreditation Committee makes the final decision and provides certification, based on the recommendation of the inspector.

If a nursery fails to meet the guidelines after it has been accredited, its certificate can be withdrawn. The certificate remains the property of the Nursery

Association of WA. The nursery does not lose its accreditation membership however, and is given a suitable period of time to rectify the problem(s). The duration is dependent on how severe the problem is, and the attitude of the operator.

Both wholesale and retail nurseries are involved in the Scheme. Retailers must obtain 895% of their greenstock from accredited wholesalers to qualify. This is not strictly enforced as there is currently an insufficient range and volume of greenstock available from accredited wholesalers. Similarly, wholesalers can experience problems in obtaining tubestock from accredited suppliers.

There is no process of appeal other than to the Accreditation Committee. However, if the Department of Agriculture becomes involved in accreditation, dissatisfied nursery operators may use this impartial organisation as an arbitrator.

There is no ongoing programmes in place in WA (or in Victoria) to assess the efficacy of guideline recommendations and their administration in terms of disease control. This may be of more concern in New South Wales, Queensland and the Northern Territory where different species of *Phytophthora* achieve more relevance and may not be as successfully contained by recommendations essentially developed for *P. cinnamomi.*

As in Victoria, the Scheme in WA does not entirely pay for itself. The cost of inspections are borne by the applicant nurseries, but the nursery association pays for administration, certification, co-ordination, etc.

The administration of the Scheme has been and is currently not without problems. The workload is considerable and the Scheme is generally unpopular with nursery operators, particularly in the retail area. With an estimated 416 nurseries in WA and only 132 of these belonging to the Association, the cost of upgrading without supporting penalising legislation by the State Government is not generally seen as being a competitive advantage.

There was general interest in belonging to a national accreditation scheme but a lack of certainty with regard to how this would benefit WA nursery operators, apart from perhaps making it easier to consign plants interstate.

Confidentiality was an issue. Anonymity of applicants was preserved by the use of a numbering system cross referenced by the executive secretary and the inspector. Accounting is entirely handled by the Association staff. Thus information other than a favourable recommendation is not available to the Accreditation Committee. One accredited nursery operator did not approve of a Committee visit to the property and this wash was obliged. Even in this instance, the operator did not find fault with inspectorial confidentiality.

There were until recently, two inspectors employed part-time by the Association. With one being a former nurseryman and the other being a retired Department of Agriculture plant pathologist there was a good mix of expertise. The one remaining inspector is the plant pathologist.

The inspector maintains permanent records of the inspections he has preformed. Both inspectors were formerly occupied conducting Association membership assessments, for, as in Victoria, applicants, in order to gain membership, were required to meet a certain standard. However, as all members are now obliged to become accredited, they perform this function instead. The guidelines for accreditation are of course, more rigorous than the previous requirements for membership.

The objective is to have all members, both wholesale and retail, eventually accredited.

The frequency of reinspection is currently determined to be annual. Inspections are by arrangement, that is, there are no snap inspections. The inspectors handle up to four nurseries per day, where there is a close proximity of the properties.

The cost of the inspections is recovered from the nurseries. Charges are as below:

Wholesale nurseries

. Inspection and report	-	$70.00
. Delivery of samples to laboratory	-	$15.00
. Testing of samples (per test)	-	$35-40
. Outside of the metropolitan area, travel and accommodation costs are reimbursed, and the inspector charges $5.00 for every 15 minutes spent travelling		

Retail nurseries

. Inspection and report	-	$60.00
. All other costs are similar to those above		

There is no direct payment from the nursery operator to the inspector. The inspector makes a claim to the Association which then bills the nursery and pays the inspector.

When performing the inspection, a formal checklist is used. There are separate checklists for wholesalers and retailers.

Sand and potting mix suppliers can be accredited using the wholesale checklist, by deleting non-applicable factors. The ornamental plant pathologist of the WA Department of Agriculture performs the inspections, and for no charge.

It is very necessary that media are from acceptable sources, as there is no requirement for disinfestation of grow-on media in the WA Scheme. Tests

performed in WA to date indicate that there is only a low level of risk involved in using untreated media obtained from reputable suppliers.

Where samples are processed however, there is a charge. Plant samples requiring a laboratory diagnosis cost $35 each if handled by the Government laboratory, $40 each if handled privately. Baiting for *Phytophthora* in water samples costs $17 for the first sample and $9 for each additional sample. Three to four day old lupin seedling baits are used as these are susceptible to a wide range of *Phytophthora spp.* As an incentive to the development of the Accreditation Scheme however, the Department of Agriculture offered 100 free diagnoses.

The inspector's report (the checklist) is produced in triplicate, with the nursery operator, the inspector and the Accreditation Committee all receiving a copy. The report is confidential.

At this stage, the nursery is inspected to ensure that it meets the guidelines. There is no sampling of plants unless the operator wishes for this to occur. Sampling by the inspector is rare. It is not known if operators regularly obtain diagnostic support. In essence, the operators are given a period of grace, in which successful adherence to the guidelines will allow the production of uninfected stock to gradually replace possibly infected former crops. Stock health is considered as being a separate issue by the Scheme administrators. The future of this attitude will depend on the official stance of the WA Government, with regard to limiting the spread of *Phytophthora* within and into that State.

As mentioned above, *Phytophthora* prevention is the major emphasis of the WA Accreditation Scheme. There is a requirement for propagating media other than those consisting of peat, perlite and vermiculite, (for example bark, sand or sawdust-containing media) to be sterilised or steam pasteurised. However there is no requirement for grow-on media from reliable sources to be treated. Untreated media do constitute a risk, particularly those containing river sand, surface sands and sands washed with surface water. Media from reputable sources, such as the major manufacturers, have been tested and observed on numerous occasions in WA and generally appear to offer limited risk.

The operation of an elite status system where an additional requirement for accreditation is treatment of all media used, has been considered in WA but has been rejected.

Under the current Diseases in Plants Act in WA, notification of a disease has to occur within 24 hours of purchase if suppliers are to be penalised. There is now a less hardline governmental approach to the spread of *Phytophthora* (a change in administration). Consequently there is not much strength in the existing legislation to support the Accreditation Scheme. There is also little clear indication as to how strong the legislation will be in the near future.

The Department of Agriculture strongly supports the initiative of the nursery industry in adopting accreditation. There is a possibility that it will take a part

in the accreditation process, either as an endorsement or by the allocation of an officer to assist in final inspections (thus decreasing the risk of bias), or both. This support was being actively sought by the Association, at the time of the study.

The guidelines of the WA accreditation scheme follow. Note that they are essentially for disease prevention.

The nursery accreditation guidelines

The GUIDELINES cover basic hygiene practices which need to be routinely adopted in the nursery in order to prevent, as far as possible, contamination of propagation/growing-on media and infection of nursery stock by *Phytophthora* fungi. These GUIDELINES have been listed in a sequence which, for convenience, follows the listing of the hygiene practices detailed in the Nursery Accreditation CHECK LIST.

For the purpose of Accreditation, propagation media is defined as a prepared mix, as distinct from natural soil, that is, nursery ground. The natural soil is considered to be a potential source of *Phytophthora* fungi.

1.0 Propagation

1.1. Propagation media storage

For preference, storage facilities should be located close to an entry point to minimise outside truck movement through the nursery. Approaches to storage facilities should be sealed or else covered with crushed limestone.

Bulk components are to be stored on freely-draining sealed surfaces so located and constructed as to exclude run-off water and soil contamination from adjoining land, roadways, car parks, track and paths. Wooden sleepers or formers are not to be used because of difficulty with decontamination.

Alternatively, propagation media components can be stored in metal or plastic bins, trailers or trolleys.

Bagged mix components should be stored on a sealed surface or on racks under cover.

Such sealed surfaces and containers must be cleaned between batches.

Records are to be kept of deliveries and sources of media components.

Soil mixing areas to be sealed surfaces constructed as for storage of bulk components.

1.2 Media treatment, storage and transport

1.2.1 Media treatment

All propagating media must be treated by either Steam/Air Pasteurisation - with the potting mix being brought to a temperature of 60°C and held for 30 minutes at that temperature, or Methyl Bromide Fumigation. The rate of application is 600 mg Methyl Bromide per 2m x 2m x 250 mm deep volume of potting mix. A gas-proof sheet is used to cover the mix during treatment and is left on for a minimum of 24 hours (preferably 48). NOTE: This gas is very poisonous and appropriate precautions need to be adopted.

All tubing mix needs to be treated as for propagating media.

1.2.2 Treated media storage

Treated media must be stored on a clean sealed surface so constructed as to prevent water and soil contamination. Such media is to be covered, for preference. Alternative storage can be in metal or plastic bins, trailers or trolleys or else in bags on a sealed surface or on racks under cover.

Treated propagation media storage areas/systems need to be separated from untreated media storage area/systems.

Such storage facilities need to be cleaned/washed free of mix between batches.

1.2.3 Treated media transport

All equipment used to transport treated media, for example front-end loader bucker, barrows, mobile bins, trolleys or plastic containers needs to be cleaned/washed between batches. Such cleaning/washing should be carried out on a sealed area, with appropriate drainage into a sump or drain, located so as to minimise risk of contamination of loading, mixing and growing areas.

1.3 Propagation area facilities

1.3.1 Propagation area

This needs to be separated from the growing areas.

1.3.2 Access

Access to the propagation area is to be restricted to authorised nursery staff.

1.3.3 Clothing

Clean clothing should be worn by staff authorised to undertake propagation tasks.

1.3.4 Floor surface

The propagation floor is to be sealed. It should be swept free of mix and washed down daily or else after each batch of mix is used. The swept-up mix is not to be re-used unless re-treated but is to be removed away from the nursery.

1.3.5 Working surfaces

Bench or table tops need to be cleaned daily or else between batches of mix and swabbed with hypochlorite solution (2% available chlorine), Methylated Spirits or Biogram 2%. A commercially available concentrated hypochlorite solution contains 12.5% available chlorine. The 2% chlorine solution is obtained by diluting one part of this concentrate with five parts of water. The working surfaces are to be at least 75 cm above the floor.

1.3.6 Tools

Secateurs, knives, trowels, etc need to be cleaned and sterilised daily or else between batches of mix by diping in any of the chemicals listed under section 1.3.5.

1.3.7 Washing facilities

Appropriate facilities need to be provided so that staff can clean their hands before commencing propagation operations.

1.3.8 Pots and containers

No sterilisation of new pots and containers is required. They must be stacked under cover on racks on a clean sealed surface away from non-treated potting media and non-cleaned used pots and containers.

Non-cleaned used pots and containers are to be stored in a separate location away from the propagating area. They need to be washed thoroughly to remove adhering potting mix and then either subjected to a steam/air treatment, as for propagation media, or else, soaked in hypochlorite solution, containing 2% available chlorine, for five minutes. They must then be stored as for new pots and containers.

1.4 Propagation beds, tube racking

1.4.1 Propagation beds

The propagation mix needs to be removed from the bed between batches of plants so that the bed/tray/frame can be cleaned and then sterilised with hypochlorite solution (2% available chlorine), methylated spirits or Biogram 2%.

1.4.2 Tube racking growing system

All plants in tubes need to be located on racks on in an alternative growing system that avoids oil contact or contamination with soil by water splash or drainage.

1.4.3 Floor surface

The floor surface beneath propagation beds and tube racks should be sealed. It must be cleaned and washed down, as necessary. Alternatively it can be covered with screenings or slag to prevent possible soil splash.

1.4.4 Water facilities

Hose nozzles must be kept off the floor at all times.

2.0 Potting-on

2.1 Potting-on media

This needs to be either pasteurised or fumigated, as specified for propagation media (refer Section 1.2.1) or else obtained from Accredited Suppliers specified by the Association.

Records must be kept of deliveries and sources of media components.

2.2 Storage

Treated or Accredited status potting-on media needs to be stored according to the guidelines for propagation media (refer Section 1.2.2).

2.3 Transport

Treated or Accredited Status potting-on media needs to be transported according to the guidelines for propagation media (refer Section 1.2.3).

2.4 Potting-on area facilities

All facilities for potting-on are to be either those used for propagation or else similar facilities located elsewhere and operated at similar standards of hygiene (refer Section 1.3).

3.0 Propagation material

3.1 Cuttings should only be taken from healthy plants. Cuttings of susceptible host plants must not be taken from plants in areas where *Phytophthora cinnamomi* or other *Phytophthora* species are known to occur or are suspected of occurring.

3.2 Cutting should be taken, wherever possible, from at least one metre above ground level to minimise risk of internal infection by *Phytophthora cinnamomi*, depending on the plant involved.

4.0 Nursery standing or growing areas

4.1 Container-grown plants must be placed on a bench, shelf, rack or else on a surface bed that prevents contact of the plant, plant roots or container with soil or soil-contaminated water. Weed mat alone is not acceptable.

4.2 The surface bed should be constructed in such a way that water can drain freely from the container.

4.3 The surface bed must drain freely.

4.4 Short term container-grown plants must not be permitted to root through the surface bed into the soil below. Surface bed could be blue metal aggregate, blast furnace slag or else jarrah woodchips. If desired an additional barrier to root penetration could be provided beneath the surface bed, for example crushed limestone, black plastic (provided adequate drainage occurs).

4.5 Long-term container-grown plants (for example palms) need to be located on a special base which prevents rooting into the soil. Suitable bases are concrete slabs, sloped concrete or other impervious rafts or black plastic 'coasters' on aggregate beds. An alternative base could be jarrah woodchips drenched with a root-inhibiting copper-containing chemical (for example copper sulphate or copper napthanate).

4.6 The pathways should not allow ponding of water.

4.7 Run-off water from adjoining land, roadways, car parks, tracks and paths should be excluded from the nursery standing or growing area.

4.8 Vehicle access to the nursery should be restricted to essential deliveries and loading areas located to minimise risk of contamination by outside soil.

4.9 Diseased plants should be removed to an isolation area prior to forwarding to a testing laboratory where specific tests for *Phytophthora* fungi can be undertaken.

If unhealthy plants collected from a nursery are tested positive for *Phytophthora cinnamomi* or other *Phytophthora* species, the results will be reported back to the nursery via the Association office. The Field Officer will be informed accordingly and the nursery may then consult with the Field Officer for assistance with cleaning up the problem.

4.10 Plants that have died as a result of disease infestation and the potting mix they grew in must be destroyed by burning or by disposal away from the nursery by deep burial.

4.11 Used potting mix should not be re-used unless sterilised.

4.12 Hose ends and hand tools should be hung up after use.

5.0 In-ground production

5.1 Seed beds

The propagation media needs to be either pasteurised or fumigated as specified for general propagating media (refer Section 1.2.1).

5.2 Growing area

The area must be treated with an appropriate chemical sterilant (for example Methyl Bromide or Metham-Sodium) before planting.

5.3 Unhealthy or dying plants should be submitted to a testing laboratory as indicated for container-grown plants (refer Section 4.9).

5.4 Dead plants should be destroyed by burning or else deep burial away from the nursery.

5.5 Plants should not be treated with systemic fungicides containing phosphorous acid or phosphorous acid precursor in an attempt to cure infection by *Phytophthora* fungi. In the case of *Phytophthora cinnamomi* it is known that such a treatment will mask disease symptoms without killing the fungus.

6.0 Water

6.1 Acceptable water sources for both container-grown and in-ground plants are scheme water and bore water taken from below three metres. No treatment of this water is required.

6.2 Water obtained from dams, soaks, streams, rivers, lakes or re-cycled water is to be treated to remove or destroy possible *Phytophthora* fungi depending on the plants grown. Acceptable methods of treatment are:

(a) Filtration, using a five micro filter. Inclusion of a pre-filter in the system may be advantageous.

(b) Chlorination to 2 ppm residual chlorine (equivalent to 160 ml of hypochlorite concentrate, containing 12.5% available chlorine, in 10 000 litres of water). Tests must be conducted on water samples, prior to chlorination, to determine the dosage rate increase to compensate for organic matter and/or to determine the need for precipitation of suspended mineral impurities. It may be necessary to construct settlement tanks to remove much of the organic matter prior to treatment.

6.3 Re-cycled water must be treated.

7.0 Plant material introduced from other sources

7.1 Plants coming into the nursery should, for preference, be isolated in a separate area until their health has been established.

8.0 Elite nursery status - standards for stock

(Section 8 now not applicable).

Accreditation to ELITE STATUS is aimed at ensuring the highest standards possible are achieved for the supply of plants into commercial activities (for example, wildflower farms, tube suppliers for nursery growing-on, orchards).

In addition to all other hygiene measures in the GUIDELINES the following additional requirements must be met:

8.1 Plant material of ELITE status will always be raised in treated propagation/potting-on media.

8.2 Both treated propagating and potting-on for ELITE status plants must be stored as specified in Section 1.1.2 and transported as specified in Section 1.2.3.

8.3 Propagation beds need to be raised at least 75 cm off the ground.

8.4 All ELITE status plants will need to be grown on benches or racks at least 75 cm off the ground.

8.5 Separate areas must be provided for the growing of ELITE and NON-ELITE stock. Stock received from another nursery into an ELITE section of a nursery must only be of ELITE status. Separate areas must be provided within the nursery for the growing of ELITE and NON-ELITE stock.

9.0 New technologies

Newer systems of plant growing, including hydroponics and ebb and flow systems, will need to be assessed using different criteria as the need arises.

10.0 Retail garden centres - accreditation standards

The goal is for retail garden centres to stock only plants with accreditation status. However this will be unattainable in the early stages of the scheme and will therefore be a gradual process as more and more production nurseries receive accreditation rating.

10.1 All plant material that is purchased with an accredited label must be displayed with that label. This label must not be tampered with or removed and placed on plants that are not of accreditation status.

10.2 All container-grown plants must be maintained to the same hygiene standards that operate for production nurseries (refer Section 4).

10.3 Where re-potting is carried out, all hygiene requirements for storage of media, media origin and treatment, media transport and potting-on facilities must be in accordance with the standards listed for production nurseries (refer Section 2).

10.4 Water. The same specifications apply as for production nurseries (refer Section 6).

10.5 Plants exhibiting poor growth/dieback are to be submitted to a testing laboratory, as for production nurseries (refer Section 4.9).

10.6 Dead plants are to be disposed of in a similar manner to those in production nurseries (refer Section 4.10).

11.0 Personnel

The nursery management must ensure that they and all staff are made well aware of the hygiene standards required for accreditation and of the symptoms, development and spread of *Phytophthora* root-rotting disease.

Accreditation of potting mix component suppliers in Western Australia

It is realised that there is no economical procedure available at present for treating the large quantities of potting-on media, required by nurseries, to eliminate *Phytophthora* fungi. The Association is therefore arranging for suppliers of untreated media components to meet stringent requirements in the procurement of components and so to be registered as accredited suppliers. Adoption of such high standards by these suppliers will minimise the risk of introducing *Phytophthora* into nurseries in these mix components.

The following constraints will apply to accredited suppliers:

. The area of supply must be shown to be free of *Phytophthora cinnamomi.* Inspections of the sites are undertaken by the Department of Agriculture.

. Inspections will be made of vegetation growing around the area as CALM (Department of Conservation and Land Management) has indicated this is the most efficient way of assessing the presence of *Phytophthora cinnamomi.* Any plants in the area that appear unhealthy will be tested.

. Suppliers will be asked to provide a map of the site showing:

(a) The location of the sources of the various materials.

(b) The tracks or roadways linking the source areas to the main thoroughfares. Thus the vegetation around these areas needs to be inspected to ensure that *Phytophthora cinnamomi* is not established.

. Sand must come from sources of a minimum of three metres beneath the surface. No surface soil can be used in potting-on mix supply.

. Trucks must be clean and free from contaminated soil and mud. Facilities for washing down before loading should be provided.

. Annual inspections will be required in order to maintain accreditation.