INTEGRATED PEST MANAGEMENT

University of Tasmania

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UNIVERSITY of TASMANIA

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1. INTEGRATED ENVIRONMENTAL WEED MANAGEMENT

1.1 Strategic Weed Management

Integrated environmental weed management (IEWM) is the combination of social, economic and technical approaches that leads to successful weed management at all scales. It is the consideration and activation of the full range of weed control approaches in developing a weed control strategy that will be adopted and resourced by UTAS.

As with any organisation, UTAS has finite resources to manage weed control. Therefore, it is important we apply these resources effectively to achieve strategic weed management. Strategic weed management will only be achieved if there is integration of purpose and action across all campuses and all maintenance crews. The purpose of this section is to describe the pathway towards a successful integrated weed management program for the university.

Integrated weed management involves the planned use of all control options to achieve effective environmental weed management. The approaches to weed management (Figure 1) include:

- weed led control
- site led control
- resources led control
- cause led control

Figure 1- Weed Management Approaches

The challenge for integrated weed management is to look at weed control from all angles, to fully consider the range of possible approaches and then to decide the combination of approaches which will maximise outcomes. A strategic approach that assigns priorities towards implementing the strategy.

1.2 Priorities and Planning

Integrated weed management will provide UTAS with a mechanism to maximise outcomes while minimising adverse environmental impacts. The mechanism will provide the framework to allow decisions for weed control priorities to be transparent. Planning for weed control will consider the following priorities:

1.2.1 Recognise weed potential

Early detection and eradication of new weeds is the highest priority. Weeds will be assessed for their potential to become serious issues and targeted according to this priority.

1.2.2 Maintain areas of all ecosystems in good condition

Management of all ecosystems within serviced areas to be largely free of weeds will be the next priority. While areas reserved for conservation purposes are important, other areas of the landscape can often contain plant communities not represented in conservation reserves and maintenance of these areas in good condition is a high priority.

1.2.3 Control weeds impacting on other species

Management of weeds impacting on other species and planting communities is of importance to the aesthetics of all campuses.

No single approach described above will be used alone. UTAS will employ a combination of approaches. Each approach will be fully explored so the strategy and the consequential implementation plan, which utilises the best elements of each pathway, is developed. The decision as to the best combination of approaches will be a judgement-based consideration of the effectiveness of methods, urgency for control, the anticipated outcomes, and resources available.

A key consideration is possible adverse environmental impacts of weed management. Examples of adverse environmental impacts include:

- loss of faunal habitat
- protection for small mammals from predation
- weed substitution
- chemical effects on fauna.

1.3 Weed Led Control

Weed led control is a proactive strategy to prevent introduction, establishment, survival, reproduction and dispersal of an emerging weed before it becomes a major problem. Prevention and eradication are a powerful tool to control the expanding number of weeds. A species that is widespread can only be controlled as part of a site led program not a weed led one.

1.3.1 Preventing weed introductions

Weeds are transported by both natural and human sourced mechanisms. Human vectors can be controlled. The essence is good hygiene such as education to prevent garden waste disposal onto less developed areas of the campuses.

Inclusion of plant species with high weed potential into planting lists for new projects will be identified before they can cause issues.

Monitoring for the presence of new weed populations and for the proliferation of existing “sleeper” weeds will be ongoing to ensure rapid action if a weed is inadvertently or deliberately introduced or begins to spread rapidly. An action plan for eradication of new weeds will be developed, when and if required.

1.3.2 Early detection and early eradication

Early detection of localised populations of weeds should result in eradication. A small effort early in the invasion process can save considerable effort or loss of ability to control in the long run. The key is identification of the effort required, both in amount and duration, to ensure that control is possible, and resources and effort sustained for sufficient time to achieve the goal. Eradication programs can fail if one or more of the following criteria are not met:

- the population of the target species must be highly localised, and the boundaries of the population assessed beforehand.
- an effective control method needs to be available
- the infested area must not be continuously infested from soil seed reserves from surrounding areas or from nearby cultivated specimens

1.4 Site Control

Site led control focuses on identifying areas that require weed control to maintain their ecological values and sites which are currently in good condition and can maintain or improve that condition with planned effort. In some cases, it is possible to expand control from areas in good condition to gain larger intact areas. The priority ranking of a proposed site led program is based on the biodiversity value and the urgency of control.

1.5 Human Resources Led Control

The implementation relies upon our people for success. UTAS will engage with volunteers and societies within the University community and will educate them on the strategic weed management issues. This is important, as through active and passive activities, they can make contributions to weed control, particularly in natural areas on campus.

A human resources approach identifies weeds and particular circumstances best suited to possible volunteer control and those which are better managed by UTAS. It is often best for volunteers to target small populations of highly visible weeds that are readily removed by simple manual or chemical methods and are ideal for essential follow up and monitoring. A professional approach is best used where spraying or machinery is required or where a concentrated effort is required. Making the best use of the capabilities of volunteers in addition to our staff can lead to better long-term outcomes.

1.6 Contributing Factor Control

Many weeds proliferate because they are able to take advantage of disturbances such as:

- a change in soil conditions either by altered water regimes or increased nutrients
- unnatural soil disturbances such as earthworks
- by constant infestation from external sources.

This approach to weed control focuses on controlling, reducing or eliminating disturbance factors that increase ecosystem vulnerability. Examples of this approach may include:

- control of access through bushland areas and rehabilitation of superfluous tracks
- improved property management practices.

Control can be seen as preventative in terms of ensuring that vegetation and plantings are protected from disturbances through effective management strategies. Once weeds are established, then control of disturbance factors is an important adjunct to other control methods in order to ensure effective control of weeds and protection of environmental values.

2. WEED CONTROL METHODS

Weeds will be controlled by direct methods such as biological control agents, by manual methods, by using herbicides or indirectly by effective land and water management. The selection and implementation of the most appropriate method or combination of methods will form a vital part of UTAS's weed control implementation and action plans. Correct selection will ensure weeds are dealt with in a timely manner with minimal environmental costs both on and offsite.

2.1 Controlling Disturbance Processes

Controlling disturbance processes that increase susceptibility of plantings and vegetation communities to weeds is often the most effective way to control weeds.

In developed landscapes across campuses procedures such as maintenance of mulch levels, minimal use of fertilisers, the selection and planting of regionally appropriate species, fostering regeneration of indigenous species and restricting human access to managed walkways and roads all contribute to weed management. Reduction in weeds after the degradation processes are controlled may be slow and monitoring will be required to determine effectiveness and whether complementary measures such as re-mulching and/or replanting or minor weed control are also required.

In bushland areas procedures such as maintenance of buffer zones, prevention of nutrient inflows, fostering regeneration of indigenous species and restricting human access to managed walkways and roads all contribute to weed management. As with developed landscapes, reduction in weeds after the degradation processes are controlled may be slow and monitoring will be required to determine effectiveness and whether complementary measures such as revegetation or minor weed control are also required.

2.2 Herbicides

Herbicide application is often the most cost-effective method for the control of weeds. While herbicide applications are efficient, this IEWM approach will ensure we consider:

- human health implications
- increasing herbicide resistance
- That due to the current efficiency of this method, the development of alternative approaches to weed management such as mechanical, biological, cultural and overall system management are not overlooked.
- impact on non-target flora and fauna.
- the need for post treatment rehabilitation.

Careful consideration of the most appropriate use of herbicide control will occur, and unnecessary reliance on herbicides for weed control will not occur.

2.3 Biological Control

Biological control can be a very efficient form of weed management.

Biological control reduces weed populations and vigour through the support of existing, and introduction and release of additional, natural parasites and predators. Biological control has many advantages over other weed control methods as it can be cost effective in the long term, is generally environmentally friendly and can reduce the need for less desirable weed control practices such as herbicide application. Biological control does not eliminate weeds but can reduce target weed populations to a level at which they have a low impact or are more readily controlled by other means. Biological control requires considerable investment and is long term. UTAS recognises the limitations of biological control and may, in conjunction, apply additional controls if required to protect conservation values.

2.4 Manual Control

Manual control is physical removal of the weed by mechanical or human effort.

Manual control is often the most expensive form of weed removal, but it is the most appropriate method in many circumstances, e.g, for threatened flora populations where disturbance to individual native plants should be avoided. It is particularly valuable for small infestations, where chemical control is inappropriate and where resources are available. Manual control needs to be carefully managed as enthusiastic efforts resulting in gross soil disturbance can lead to weed replacement. An approach where revegetation is carried out in conjunction with weed removal should be considered.

2.5 Fire Management

Fire is an acknowledged disturbance factor that occurs naturally in Australian ecosystems but currently is often human mediated. Fire regimes have altered since European settlement, particularly in areas of high population density. The presence of environmental weeds may contribute to a fire-weed cycle that is the primary cause of bushland degradation in some areas.

The causes of the cycle are many and diverse, but some of the key points are:

- Weed species are often advantaged by the burst of nutrients available immediately after a fire.
- Weed species, particularly grass weed species, accumulate biomass rapidly thus rapidly increasing fuel loads to levels that will sustain fires more frequently.
- Grass fuels have a different structure to shrub fuels. This affects fire behavior and rate of spread, particularly in the initial stages of a fire.
- Weed seeders are usually annuals whilst native seeder species require time between fires not only to set seed but also to replenish their seed stocks.
- Epicormic re-growth can also succumb if the fire interval is so frequent that the root stock resources become depleted.

Thus, grassy weeds have characteristics that enable them to respond quickly to fires, and support more frequent fire events, than many of the native perennial understory shrubs. Some species (e.g, acacias and casuarinas) are well adapted to fire and in the absence of their natural limiting agents are able to proliferate at the expense of other endemic species.

Planned fire events may provide opportunities for weed control through the reduction in weed biomass to a treatable level and the provision of opportunities to treat epicormic regrowth of undesirable species. Fire as a weed management tool would only be conducted in areas where there is no risk to people or infrastructure. Any decision to implement this management control as part of our integrated approach would involve detailed planning and discussion with all stakeholders prior to consideration.

3. INTEGRATED PEST & DISEASE MANAGEMENT

3.1 A Strategic Approach to Pest & Disease Management

A strategic approach to pest and disease management involves evaluating pest and disease issues that arise, and then applying the most appropriate solution from the full toolbox of options.

Fewer pesticides are used in a well-run integrated pest and disease management (IPDM) program. Although this isn’t the overall objective of IPDM, it is a natural consequence of considering the entire range of control options available. UTAS recognises IPDM as a management option because it is most effective at controlling the pest or disease without any bias toward or against chemical pesticides or other management options.

Prevention of pests and diseases is an important component of IPDM. Some problems can be avoided by making the landscape an inhospitable place for pests and diseases.

The key to a successful IPDM program is to maintain good records. Record keeping and reference to those records will be constantly used to evaluate effectiveness of options. This will allow a continuous improvement process to occur to constantly refine the management strategy and deal with new issues as they arise.

3.2 A Planned Approach to Pest & Disease Management

A successful planned approach to IPDM is a systematic process. The following sections set out the steps UTAS will follow to implement a successful IPDM.

3.2.1 Maintaining the landscape to minimise pests & diseases

Healthy plants have fewer pest and disease problems. Maintaining the health of all plantings is easier if the following principles are applied:

- Managing ground cover is an important component of the control of some pests and diseases. Some pests can be managed through careful ground cover management.
- The removal of alternative hosts can be an effective method of managing pests and diseases. Certain pests and diseases have broad host ranges and can therefore move to an alternative host. Pests and diseases can also use alternative hosts as ‘stepping stone’ to spread within a landscape.
- Viruses can originate from common weed species and impact on plantings without causing obvious symptoms. Some weeds can act as reservoirs for pathogenic viruses. For example, prunus necrotic ringspot virus can cause death in extreme cases. This virus is transmitted by pollen from host to host. Its host range includes rose, blackberry and is expanding and may include other weed hosts.
- Pruning and thinning of plant canopies can result in greater airflow and shorter drying times. Consequently, disease incidence can possibly be lowered.
- Although benefits can be gained through opening up plant canopies through pruning, it can also cause problems resulting from sunburn. Sunburn can result in bark cracking and splitting and predispose plants to fungal infections therefore a balance must be reached between the two outcomes.

- Pruning techniques should focus on:
    - Removing water shoots
    - Removing diseased tissue
    - Open the canopy to allow air movement, if required.

Selective pruning to remove diseased tissue has been shown to reduce disease incidence.

Water shoots should be regularly removed from plant species as their soft vegetative growth can provide a haven for sap-feeding pests such as aphid.

Flush feeding pests such as aphids are attracted to new growth. Reducing nitrogenous fertilizer application early in the growing season can also reduce new growth and aphid infestation in some species.

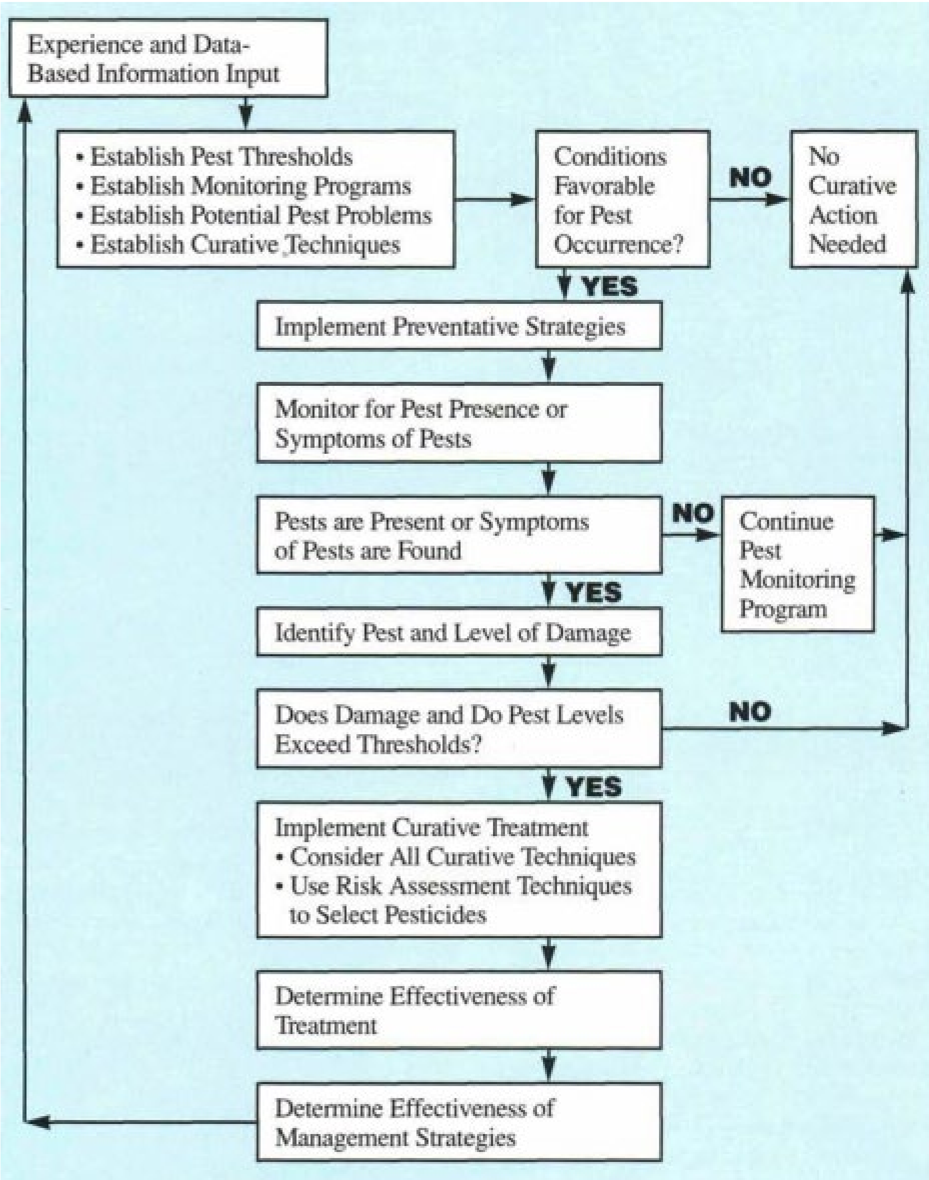

Figure 2- IPDM Decision Flow Chart. ***(Source: Peacock, C and Smart, M. 1995, IPM, Monitoring and management plans — a mandate for the future, USGA Greens Section Record May/June 1995)***

Figure 2 provides an IPDM decision flow chart that considers all factors connected with IPDM programs.

3.2.2 Starting with a plan

IPDM will not be successful unless resources are applied to constant monitoring. Monitoring should never be deferred due to other commitments. IPDM nearly always fails because monitoring loses priority at peak times.

The development of a reliable monitoring program is the key to a successful IPDM program.
Monitoring is an ongoing process and provides:

- Early detection of a developing problem
- Location of the problem pests and diseases
- Pest population status, which can be evaluated at various times of the year.

Monitoring a turf area or garden bed for pests involves inspecting the area regularly and recording any insect, weed or disease. Accurate and detailed records are required and should include:

- Identification
- Location
- Concentration present
- Stage of life cycle (insects)
- Measurement method
- Damage observed
- Treatment thresholds

In addition to this monitoring information, it is also important to record the recent weather conditions, Climatic data to be recorded should give a general indication of recent conditions for the period applicable to the lifecycle of the pest, weed or disease observed and should include:

- Average temperatures
- Rainfall
- Humidity
- Sunshine or cloud
- Wind.

Regular monitoring enables threshold damage levels to be determined. Once damage thresholds have been exceeded, control strategies can be implemented. If chemical treatment is necessary, treatments should be restricted to the target area rather than blanket spraying, which will substantially reduce the amount of chemical used and any detrimental effects to other beneficial and non-target species.

Insect Monitoring

- Irritating solutions can be used to flush surface-feeding insects to the surface for easier, more accurate observation. Dishwashing liquid (lemon-scented) at about 20 ml in 5 L of water and pyrethrum sprays (about 6 ml in 1 L of water) are effective flushing agents.
- Various traps can be used to detect the presence of insects on the move, but they do not guarantee accurate measurement of numbers.
- Presence of underground grubs (e.g., cockchafers) needs to be checked by peeling back the turf and examining the soil.
- Accurate identification is critical if cost-effective control is to be achieved.

Disease Monitoring

- Most diseases require certain climatic conditions to develop (e.g, high night-time temperatures, high humidity etc).
- Known indicator sites are to be monitored regularly. Each campus may have specific areas that are always affected first.
- Identify affected plant species/variety.
- Examine affected plants and identify any visible symptoms (e.g, lesions on leaves, lack of healthy roots etc.).

With regular monitoring, patterns will develop and can be useful to predict what is likely to happen in future years. When an issue is identified it should be recorded.

3.2.3 Action thresholds

Pest and disease threshold damage levels describe the degree of infestation that can be tolerated in relation to plant health, aesthetics, and safety. Threshold levels can be very general (e.g, treatment of some broadleaf weed species when they become visually noticeable), or quite specific (e.g, pesticide applications based on actual counts of insects).

It is essential threshold levels are set for each pest identified. They may be site-specific and are developed in consultation with the Principal's representative. What is acceptable in a low-profile part of a campus may not be acceptable at another. Threshold levels should reflect the potential for serious injury to plant species. For example, low threshold levels should be set for diseases that can cause extensive damage in a short period of time.

4. PEST & DISEASE CONTROL METHODS

4.1 Trigger Points for Implementing Control Measures

A pest or disease that reaches the action threshold should be controlled. There are usually a range of management options for controlling pests and diseases. An IPDM approach requires consideration as to which is the most appropriate in the context of aesthetic, safety, environmental issues and available resources. This is ‘appropriate action’.

In many cases, appropriate action will involve the application of a chemical, but pesticides may harm the natural enemies of many pests and pathogens, thus potentially causing secondary problems.

Management options other than chemical will always be considered first. If a pesticide is the only option likely to be effective given any constraints, it is important to also consider the pesticide’s effect on beneficial organisms such as predatory mites etc. Also cheaper chemicals may not be the most economical answer if they kill beneficial organisms and extra resources need to then be applied to control pest.

4.2 Chemical and Resistance Management

Pesticides are a major technological tool used successfully throughout the world. An adverse consequence of persistent application has been the emergence of resistant pest and disease populations. Pesticide resistance is a global phenomenon that has occurred with fungicides, bactericides, insecticides, rodenticides, nematicides and herbicides.

Resistant populations occur when the same chemical, same family of pesticides or pesticides with a similar mechanism of activity are used repeatedly at the same location. When a few naturally resistant organisms remain after a treatment, they contribute to the development of a larger population of resistant organisms. Eventually the population that develops may contain mainly resistant organisms and will not be controlled with the recommended rates of the pesticide.

To help minimise the development of pest resistance, all fungicides, insecticides, and herbicides sold in Australia are grouped according to their mode of action, indicated by a letter number code on the product label. The mode of action label allows the user to identify pesticides that work by similar means, and which share a common resistance risk.

The CropLife Australia website (www.croplifeaustralia.org.au) has mode of action tables for fungicides, insecticides and herbicides, and resistance management strategies based on these to prevent or delay resistance developing. The website also contains some regional or crop-based resistance management strategies.

The resistance development of pests to a pesticide may be slowed by limiting the exposure of a pest population to pesticides with a particular mode of action. This can be achieved by limiting the total number of applications of pesticides from any one mode of action group and by alternating pesticides from chemical groups with different modes of action.

Effective chemical resistance management requires:

- A good understanding of the pests' life cycle to target the best control methods
- Alternations or sequences of different modes of action
- Application of chemicals at recommended rates with calibrated equipment
- Good spray coverage to ensure the best possible chance of contact and subsequent control of the pest
- Incorporation of cultural techniques for controlling the pest to reduce the level of pesticide use required.

Any resistance management strategies should incorporate all available methods of control for the pest concerned.

4.3 Cultural Methods

Cultural methods involve ordinary day-to-day horticultural practices, eg, pruning, appropriate irrigation levels, removal of undesirable host plants and weeds etc. They are usually used in conjunction with other methods and are preventative and are an essential part of all plant management programs.

4.4 Biological Control

Biological control is defined as the deliberate use of a pest's natural enemies to control a pest. In practice:

- Several biological control agents may be released to control a single pest, e.g., biological control of insects and mites may be brought about by other insects and mites, diseases, pheromones, and genetic engineering.
- Insecticides, not toxic to predators assist control. Fungicides, and other pesticides used to control other pests and diseases must also be non-toxic to predators.
- As an example, some agricultural industries have guides on the impact of individual insecticides on natural predators of major crop pests. By focusing on conserving the natural enemies of major crop pests it may be possible to significantly reduce insecticide use without impairing productivity.
- Biological control agents are most effective when used as a part of an IPDM program.

4.5 Physical & Mechanical Methods

These control methods have become prominent in recent years because of the development of resistance to pesticides, the need to avoid pesticide residues and for economic reasons. These methods will always be considered first where appropriate, but unfortunately, many are difficult to apply on a large scale, are only partially effective, offer no long-term protection and can be prohibitively labour intensive.

4.6 Chemical Applications

New equipment and improved methods for delivery of pesticides and other horticultural chemicals are continually being developed.

Pesticides and other horticultural chemicals can be used to treat all plant parts, e.g.:

- Foliage and stems
- Trunks and limbs
- Flowers, fruit and seeds
- Roots, cuttings, seedlings
- Bulbs, corms, tubers, etc.
- Air space
- Seeds prior to planting
- Stored seed, grain
- Potting media and soil

Formulations of pesticides and other horticultural chemicals include:

- Liquids
  - Emulsifiable concentrates
  - Suspension concentrates
  - Liquid concentrates
  - Micro-encapsulated suspensions
- Solids
  - Baits
  - Dusts
  - Granules
  - Powders
- Others
  - Aerosols
  - Fumigants
  - Slow-release generators

The mode of action or uptake of pesticides and other horticultural chemicals is divided into two groups systemic and non-systemic:

1. ***Systemic pesticides*** are absorbed by the plant. They are carried (translocated) through the sap stream to parts remote from the site of application where they control sap-sucking pests, e.g., aphids, mites, elm leaf beetles etc., which are actively feeding. Once the pest has stopped feeding it is too late to control it by this method. They can be effective against some insects already inside the plant.

   The whole plant surface need not be treated, e.g., systemic insecticides may be applied as foliage, root, and soil or as tree injection treatments.

   New developing foliage may be protected from insect attack.

   Systemic insecticides are not necessarily evenly distributed within the plant, so the applicator must know how a particular product moves within the plant.

   Systemic pesticides may control a pest more slowly than contact non-systemic pesticide.

2. ***Non-systemic pesticides*** are not absorbed by the plant. They are only effective at the site of application. Contact sprays are only effective on insects, e.g., scales and mealybugs that are actively moving over the plant. Adult scales and mealybugs that have developed their waxy covering are difficult to kill with contact pesticides.

   They are sometimes called ‘preventative’ as they are often applied before the insect has actually been found but where it is expected.

   Contact sprays may be detrimental to beneficial insects and as a result will only be used after assessment of all other methods within the IPDM.

Appendix 1. Integrated Pest Management, Weed and Pest Inspection Report

Location	Pest/Weed Species	Measurement Method	Treatment Threshold Level	Concentration Observed & Life Cycle Stage	Infestation Active Y/N	Recent Weather Conditions	Damage Observed	Biological Control Applicable*	Cultural/ Physical Control Applicable*	Chemical Control Applicable*

* Biological and Cultural/Physical control methods must be evaluated for suitability and efficacy before chemical control is considered.

Appendix 2. Pesticide/Herbicide Chemical Use Register

Location	Application Method	Pest/Weed Being Treated	Biological, Cultural & Physical Alternatives Assessed First*	Staff Member Name	Product Being Applied	MSDS Consulted Yes/No	Weather Conditions at Time of Application	Time Start/Stop	Date

* Biological and Cultural/Physical control methods must be evaluated for suitability and efficacy before chemical control is considered.