

Management of weeds in commercial timber plantations located in public drinking water source areas in Western Australia

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Summary Approximately 40 000 ha of State-owned pine plantation in Western Australia is established in Priority 1 zones of existing Public Drinking Water Source Areas (PDWSAs). Whilst these plantations were established at a time when there were few regulations governing the management of plantations in water catchments, with the full agreement of the relevant water agencies the situation today is quite different.

PDWSAs include catchment areas, water reserves and underground water pollution control areas proclaimed under the Metropolitan Water Supply Sewerage and Drainage Act, 1909 and the Country Areas Water Supply Act, 1947. The Water and Rivers Commission of Western Australia (WRC) has responsibility for the protection of PDWSAs and has introduced a policy for water quality protection in these areas that is consistent with the water quality protection framework for drinking water sources.

According to WRC policy, plantation growers are required to adopt best management practices, including the development of Plantation Management Plans for these areas. These plans are developed in association with, and endorsed by the WRC.

This paper outlines the process for managing weeds when establishing plantations in PDWSAs in Western Australia. The issues, particularly in relation to the use of herbicides, are explored and an economic assessment is made of the viability of plantations managed under such strict environmental conditions.

Keywords Plantations, catchments, drinking water, pollution, herbicides, weed control.

INTRODUCTION

Plantations of radiata pine (*Pinus radiata* D. Don) in Western Australia are confined to the moister regions (>750 mm rainfall per annum) in the south west of the State and are located for the most part on igneous derived soils associated with mid to lower valley slopes. It so happens that some of these plantations surround dams and weirs constructed for urban drinking water supply and were considered at the time of establishment to be compatible with the values of water catchments. Restrictions on the use of pesticides now apply to these areas.

Maritime pine (*Pinus pinaster* Ait.) plantations were established on the deep sandy soils of the Swan coastal plain. Of these the majority (87%) lie over the Gnangara Water Mound, the aquifers of which provide more than 18% of the potable water for the Perth metropolitan area. Restrictions on silvicultural practices have prevented the Forest Products Commission (FPC) from re-planting this area after the trees are harvested.

Blue gum (*Eucalyptus globulus* Labill.) plantations are grown in the south west of the state and are confined to sites with deep soil profiles and an annual rainfall exceeding 650 mm. Although a significant area of plantation is located in the Denmark river catchment, restrictions on the use of herbicides have, to date, not been applied.

PDWSAs include catchment areas, water reserves and underground water pollution control areas proclaimed under the Metropolitan Water Supply, Sewerage and Drainage Act 1909 and the Country Areas Water Supply Act 1947, and associated By-laws. The Water and Rivers Commission of Western Australia (WRC) administers these Acts.

PDWSAs are divided into three zones according to the level of disturbance and the perceived risk to the integrity of the water (WRC 2001a). In addition, environmental and water resource values are assessed against existing land asset and improvement values. The priority rankings are:

Priority 1: risk avoidance

Priority 2: risk minimisation

Priority 3: risk management

The use of some forestry herbicides (e.g. atrazine and simazine) is prevented in Priority 1 zones and the use of others is severely restricted.

Approximately 40 000 ha of State-owned plantations are located in Priority 1 zones. It should be noted that all public land in PDWSAs, irrespective of the level of disturbance or position in the catchment, is zoned Priority 1.

The WRC has introduced policies and guidelines for water protection that are consistent with the water quality framework for drinking water sources (WRC, 2001b). These policies and guidelines are often in conflict with the silvicultural requirements of commercial plantations. The WRC has determined that forestry is

a conditional activity in Priority 1 zones and subject to restrictions on the use of pesticides (WRC 2001a).

IMPLICATIONS OF WATER PROTECTION POLICIES ON THE MANAGEMENT OF WEEDS IN PLANTATIONS LOCATED IN PDWSAS

Management planning The Code of Practice for Timber Plantations in Western Australia (2002, as revised) stipulates that all plantations should be established according to a Plantation Management Plan. The 'Code' makes mention of specific conditions for plantations located in PDWSAs. In addition to the general conditions in the 'Code', the WRC, or its agent, has the power to enforce specific conditions where it considers these appropriate. For example, there may be requirements on cleared land to rehabilitate riparian zones back to endemic native vegetation to provide buffers between the plantation and waterways. Also, restrictions apply to the use of pesticides and fertilisers in PDWSAs.

The WRC or its agent endorses the Plantation Management Plan prior to site works commencing.

Site preparation Site preparation includes those activities associated with soil preparation, installation of roads, tracks and firebreaks, all aspects of drainage, and the removal of unwanted vegetation and infrastructure. Thus the objective of site preparation is to provide the best environmental conditions in which to establish and protect newly planted trees.

The removal of existing competitive vegetation prior to soil preparation has been shown to improve cultivation and reduce the need for post-planting applications of herbicides (Fremlin, unpublished). There are important interactions between the type of cultivation and the method of controlling weeds.

It is usual practice and beneficial to the growth of trees to cultivate the soil in some way prior to planting the trees (Attiwill *et al.* 1984). However, cultivation may change the weed spectrum, increase phytotoxic effects of herbicides or, in the case of bedding, extend the residual life of some herbicides.

Ripping the lines into which trees will be planted is usual practice and beds are commonly formed over the rip-line to improve the efficacy of herbicides and prevent phytotoxicity. Ripping agricultural soils breaks the 'traffic pan' and tends to reduce cross-surface flow of water by encouraging infiltration. This also reduces the opportunity for herbicides to move off-site. Ripping always follows the contour.

However, any disturbance of the soil is accompanied by some risk of erosion and herbicides may move off the site into drainage lines, either attached to soil particles or in solution. Erosion events are associated

with heavy rainfall events, particularly when the soil is saturated.

Any restrictions on site modification that is intended to prevent any risk of turbid or herbicide-contaminated water entering streams or rivers, will have a significant impact on tree growth and the efficacy of herbicides. The risk of increasing water pollution associated with ripping and bedding needs to be quantified.

Weed control Managing competition from unwanted vegetation (weeds) for moisture and nutrients is essential to ensure the survival of newly planted trees and protect the economic viability of plantations grown for timber products (Jack 1970, Nambiar and Zed 1980, Woods *et al.* 1992, Butcher 1980).

It is usual practice to use knockdown and residual herbicides to control weeds when establishing plantations. Knockdown herbicides provide control of existing vegetation while residual herbicides maintain the site free of weeds. The silvicultural expectation is to provide a weed-free environment for the first two years in the life of a plantation.

Atrazine, simazine and hexazinone are the most widely used residual herbicides in forestry. Atrazine has been the subject to international and national scrutiny in recent times. The final draft report of the Atrazine Review, conducted under the Existing Chemicals Review Program by the National Registration Authority for Agricultural and Veterinary Chemicals (2002), endorses the continued use of this herbicide in forestry. However, restrictions on its use apply, necessitating the plantation industry to modify its practices.

In Western Australia, the use of herbicides in PDWSAs is administered by the Health Department under the Health Act, 1911. The WRC advises the Health Department in relation to risk of herbicides contaminating water supplies through a Statewide Policy (WRC 2001a). This policy provides general guidelines for the use of pesticides in PDWSAs. A framework for the use of pesticides in PDWSAs is being developed and will be published in the form of a Code of Practice.

Currently, under a Health Department directive, the only residual herbicide permitted for use in PDWSAs is hexazinone. This herbicide is suitable only for the establishment of *P. radiata* on heavy-textured soils.

Cultivation as an alternative to herbicides to control weeds has generally been ineffectual, logistically difficult and increases the risk of erosion.

Vegetated buffers The Code of Practice for Timber Plantations in Western Australia stipulates a 30 metre

vegetated buffer between a stream (intermittent or permanent) and the plantation boundary. However, in PDWSAs the width of the buffer can be altered at the discretion of the WRC and the tree grower may be required to revegetate the buffer with local endemic species at the grower's expense. Also, it is common for a 200 m non-treatment buffer to be stipulated from the high water mark of a reservoir.

The WRC has the authority to stop operations that it considers might impact on the integrity of water in the catchment. These conditions apply to new and re-established plantations.

Drainage Cross-surface flow of water increases when weeds are controlled on a site. Also, trees will not establish satisfactorily on sites subject to seasonal waterlogging and some form of amelioration is necessary. The containment of water on the site or the orderly transfer of excess water from the site is the objective of a plantation drainage strategy.

A study conducted by the Forest Herbicides Management Group (Bubb and Barnes 2001) showed that much of the atrazine that moved off a plantation area into waterways originated from firebreaks that had been sprayed. This finding demonstrated that off-site movement of herbicide could be managed by the implementation of an appropriate drainage system. These studies also showed that high concentrations of herbicide in run-off water was associated with heavy rainfall events, particularly when the soil was saturated.

Drainage systems for plantations located in PDWSAs must be designed to minimise the risk of waterways becoming contaminated with herbicides.

The effect of not using pre-emergent, residual herbicides on the economics of growing plantations in PDWSAs It is estimated that restrictions on the use of pre-emergent, residual herbicides in PDWSAs may reduce the productivity of *P. radiata* plantations by no less than 18% (Fremlin unpublished). This includes losses due to early mortality and the opportunity cost of foregoing growth. This has an effect of reducing the net present value by \$503 ha⁻¹. However, the impact on the economic outcome of a plantation may be far greater in dry seasons or on sites infested with particularly competitive weeds. The internal rate of return is negative for a plantation that has been replanted due to mortality of trees in the first year.

DISCUSSION

For the FPC to fulfil its obligation for supply of softwood timber under State Agreement Acts, the existing plantation estate must be maintained and managed to provide maximum timber volume output. Best management practices need to be developed and demonstrated that will enable plantations to provide maximum output without impacting on the integrity of water sources.

There are no feasible alternatives to herbicides for controlling weeds in plantations. In order to continue to manage the risk of using herbicides in PDWSAs, regimes for application need to be developed that minimise the risk of water contamination while maintaining the productivity and economic integrity of plantations.

A system developed by McGuire (pers. comm. 2002) where residual herbicides are applied late in the

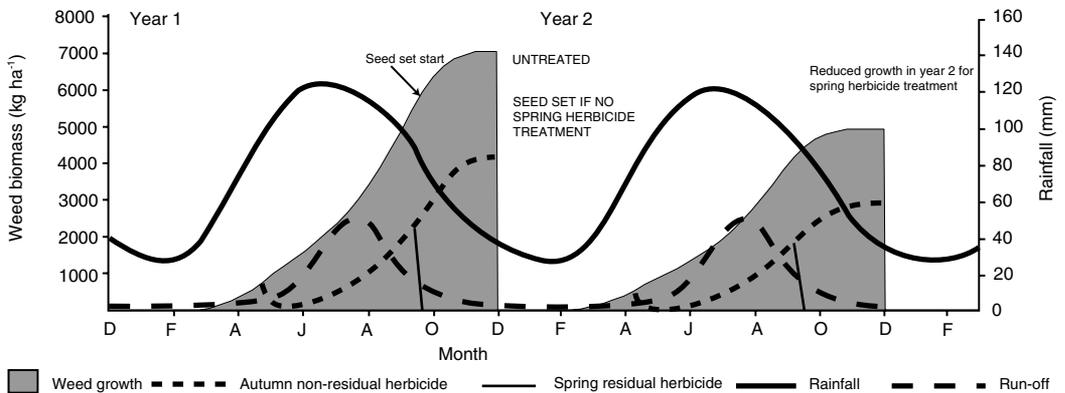


Figure 1. Timing of herbicide applications relative to weed growth and the potential for off-target movement.

season, when soils are not saturated and the likelihood of significant rainfall events occurring have passed, suggests one theory of best practice (Figure 1). However, due to the logistic difficulties of deploying wheeled machinery late in the wet season, this system relies on herbicides being applied by air, after trees are planted, and as such the overall logistics and safety of this system will need to be demonstrated, as well as the risks associated with off-site application.

There is an awareness amongst herbicide manufacturers that new technology must be environmentally benign. Chemicals are appearing on the market that are less soluble and readily adsorb to soil.

The obligation is on the plantation industry to screen new chemicals for their fitness for use in tree cropping systems and move to register candidate herbicides for plantation use.

A concerted effort by the plantation industry to develop integrated weed management systems is needed. Such systems must move to improve the efficiency of herbicides, thus reduce use rates, but also to develop strategies to minimise off-target movement.

It is imperative that the Code of Practice for the Use of Pesticides in PDWSAs provides flexibility for the use of agricultural chemicals through the application of best management practice and risk assessment.

The viability of plantations located in PDWSAs is at risk unless the plantation industry is able to demonstrate that its practices are compatible with the water values of these catchments. At the same time, agencies responsible for the management of water sources should recognise the basic operational and economic requirements of commercial plantations and consider the application of a demonstrated risk management strategy rather one of than risk avoidance.

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