Weed control in establishing native tree species

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Summary

Weed control in plantations is crucial during the first two growing seasons. Competition from weeds for water, nutrients and light can lead to high early mortality and slow growth of surviving trees. Good weed control leads to fast early growth, and trees more rapidly dominate the site, and shade out weeds. Grasses are very competitive along with deep rooted broadleaved weeds, and woody weeds such as blackberry and bracken.

This review paper discusses various approaches to achieve good weed control, in particular different methods of site preparation, and some aspects of chemical weed control.

Introduction

The establishment of native tree species in Southern Australia on any significant scale usually involves the employment of site preparation techniques, the use of herbicides or a combination of both. Whilst large scale plantations, mainly of radiata pine (*Pinus radiata* D.Don), have been part of the landscape for more than 50 years, and sugar gum (*Eucalyptus cladocalyx*) plantings are a familiar sight in Western Victoria, more recent developments include large areas of eucalypt species plantations, and mixed species native plantings along roadsides, on farms and for the repair of degraded land, such as is carried out by Landcare groups.

This paper discusses some of the methods used in both plantation forestry and mixed species plantings.

Methods

A. Site assessment, preparation and planting techniques

Before any site preparation is carried out, the site should be assessed 9–12 months before planting for both weed cover and soil type.

The weeds present may determine that immediate treatment is required. For example, bracken fern is very difficult to treat after trees are planted. It requires pre-conditioning for successful control, either by winter slashing or an initial herbicide application in the spring/summer to stimulate new growth. This should be followed by a further treatment in late summer to mid-autumn before site preparation.

Other woody weeds may require treatment at a specific time of year. The appropriate time to treat blackberry, for example, is December-January, at the early flowering stage.

Summer active grasses such as phalaris, couch, paspalum or kikuyu will also require treatment at an early stage, utilizing the principle that weeds are best treated when small. Seed set control (see below) is also an option.

The type of soil is important when considering the rates at which some residual herbicides are applied either pre- or post-planting. In general, the lighter textured soils (sands) should be treated with lower rates of certain residual herbicides. However, a broadcast treatment is usually applied to sandy or light textured soils which are less water retentive, whereas a strip application may be appropriate for heavier textured loams and clay loams.

Site preparation ranges from the simplest approach of pit-planting through to scalping, ripping and mounding, and planting techniques include direct seeding, mechanical and manual methods.

i. Pit-planting is the term usually applied to digging a hole or opening the soil with a planting tool. The most basic approach for amenities/recovery seedling planting is to apply a herbicide treatment pre-planting then pit-plant. The herbicide treatment is usually either spot or strip, and can include a foliar knockdown, usually glyphosate (Roundup), plus a soil residual herbicide, usually simazine. For amenities plantings, potential browsing by rabbits, hares, wallabies and sometimes birds, may necessitate guards around each plant – a familiar approach along highways, and for Landcare recovery programs for example. If seedlings are not protected, spot treatments are probably a better option, because a strip of dead weed acts like a 'sign-posted road' for the browsers.

ii. Any form of soil disturbance such as scalping, ploughing, ripping and/or mounding can assist in establishment. Soil is broken up and given a better tilth allowing easier water and root penetration, and efficacy of herbicides is improved. Any weeds which do emerge after soil disturbance but before planting are easily treated (small weeds are easier to kill!). Residual herbicides work better if applied to bare soil (dead weeds can interfere with penetration of residual herbicides), and coverage is improved if there is a smooth soil profile. Large clods allow weed escape because herbicide does not reach weeds in the spray shadow.

iii. Scalping techniques vary from narrow scalp lines to one metre or more in width, and are usually used in combination with direct seeding or mechanical planting. With narrow scalping, applications of herbicide usually precede scalping, so that the planting line has the herbicide removed prior to seeding, otherwise seedling germination is inhibited, particularly if a residual herbicide is included.

With wider scalping, organic matter and nutrient can be removed from the surface and pushed to the side.

Direct seeding can be either by hand or by machinery, and usually is employed where mixed species plantings are required. Mechanical planting of seedling trees is more advantageous for monocultures, but is not generally used in large scale plantations of eucalypts or pine for wood production, manual planting usually being preferred.

Direct seeding techniques have been pioneered by Rod Bird (Bird *et al*. 1996, Bird 2000, Bird 2002), David Millsom and others, and have the advantage of allowing substantial areas to be planted rapidly with minimal site preparation. The disadvantages of direct seeding may include erratic spacing and clustering. Some thinning may be required, although very often the plantation is left to self-thin over time. On some sites, such as sparse native grassland, seeding may be successful without weed control (Millsom undated).

iv. Applications of herbicide may commence in the year prior to establishment, with an application of a knockdown herbicide in the spring to prevent annual grass or other annual weed seed-set (spray-topping), with further applications after the autumn germination and again just prior to planting. If grasses in particular are allowed to develop and die off, lignification occurs, decomposition is slower and root mass leads to clodiness in subsequent site preparation.

Ripping and/or mounding, may be used, particularly for eucalypt plantations for wood production. Ripping is usually only required to break up clay pans or compaction layers which would inhibit root and water penetration. For direct seeding, a double rip line is recommended, because roots can be 'boxed' in a single line. For forestry plantations, ripping can improve water penetration and root penetration of the seedlings, leading to more rapid growth. Ripping is usually to at least 400 mm and often to 1 m. Tined and winged rippers may be used, the latter usually providing more shatter of underlying soil layers. Spot cultivation with an excavator also provides a mound, and

removes problems associated with ripping down or across slopes. Narrow rip lines are disadvantageous because subsidence may occur leading to 'wet feet' and residual herbicides may concentrate in the rip line with consequences for tree health.

Mounding may be required on flooding or saline sites, and is usually used in eucalypt plantation establishment. It also has the advantage of bringing organic matter and nutrient up into the mound from the top-soil, and buries some weed seed too deeply for germination.

B. Timing

There are several methods for carrying out preliminary site preparation:

i. Spray topping to prevent seed set has already been noted, but in plantation forestry a complete kill in the spring is often used; weed cover is reduced before further site preparation and the weed spectrum is shifted more to broadleaves.

If annual grasses are allowed to set seed and senesce, grass and grass roots are lignified and take longer to decompose. Roots are cloddy so that mounding produces a poor tilth.

ii. Ploughing in mid-spring can also control annual weed seed set.

iii. Grazing to reduce grass cover is also a useful approach.

iv. A summer cover crop has a similar effect – the soil is more easily cultivated the second time around, and the crop prevents weed growth and seeding.

Ripping is usually carried out in autumn, while soil is still dry, to create maximum shatter.

C. Tree planting

For plantations, this is generally in late autumn to mid-spring, with the winter period preferred. For direct seeding in low rainfall areas, autumn seeding is recommended, but in higher rainfall areas spring sowing may be considered (Millsom undated)

D. Chemical weed control

Classification of herbicides. Herbicides used in plantation establishment are usually systemic, that is, the chemical is translocated throughout the weed. These herbicides can then be described in terms of other properties as follows.

i. Foliar knockdown herbicides. These may be either broad spectrum, i.e. control a wide range of weeds, or specific to particular weed types, for example grasses, or classes of broadleaved weeds. These herbicides act only through foliar uptake by existing weeds.

ii. Soil residual herbicides. Similarly, these may be either broad spectrum or weed class specific. They can act through:

- root uptake by existing weeds
- by pre-emergence or early post-emergence activity, such as contact by the emerging weed with chemical on the soil surface or close to the surface
- some herbicides can be taken up by both foliage and roots.

Application of soil residual herbicides provides ongoing weed control for several months at a time, particularly during the high growth seasons of spring and autumn and during the summer drought, when water availability becomes critical. These herbicides require adequate soil moisture for activation.

In a situation where there is a significant weed cover prior to any site preparation (such as ripping/mounding), a pre-mounding treatment is often applied – usually of a glyphosate product (e.g. Roundup Max) at 0.72 to 1.08 kg ha^{-1} a.i. ± a spike of metsulfuron methyl (e.g. Brush-Off); the latter controls or kills sorrel and clovers at low rates (about 6 g ha^{-1} a.i.). Glyphosate is not effective on some clovers, and only tends to burn off sorrel.

As noted earlier, residual herbicides are best applied to bare soil. However, this could entail more than one application, and if the weed growth following site preparation is sparse, the usual approach is to combine glyphosate with one or more residual herbicides to achieve long term weed control where seedlings are to be planted. If there is no weed, only bare soil, the glyphosate component is omitted.

A common pre-planting prescription that has proved safe to many species is a mixture of glyphosate and simazine, sometimes with a spike of metsulfuron methyl or sulfometuron methyl.

The rates of glyphosate and simazine depend on the amount of weed present (glyphosate) and the soil type (simazine). The glyphosate rate is usually in the range 0.36 to 1.08 kg ha^{-1} a.i.) if there is weed present. Simazine rates vary from about 3–4 kg ha^{-1} a.i. (e.g. 4 kg a.i. could be 4.4 kg ha^{-1} if using 900 g kg^{-1} Simagranz product recently registered for eucalypt establishment) up to 6 kg ha^{-1} a.i. depending on soil type. The heavier textured the soil, the higher is the rate of simazine.

In addition, in order to prevent antagonism between glyphosate and simazine, 2% by volume of spray mix of ammonium sulphate solution (Liase or Boost) is added, and if metsulfuron methyl is added, 0.2% organosilicone surfactant (e.g. Pulse Penetrant) is required for foliar efficacy.

A plant-back period is then applied – roughly 2 days g^{-1} of metsulfuron methyl product or three weeks; usually planting is about 3–4 weeks after the pre-planting treatment.

Spraying treatment either can be spot, strip or broadcast. As noted earlier, for recovery or amenities plantings or direct drilling, spot or strip applications to otherwise untreated sites followed by scalping or pit-planting is the cheapest and quickest approach. However, residual herbicides must be used with care for direct seeding.

If planting seedlings in a monoculture tree plantation, strip or broadcast treatment is advisable, and a much higher level of site preparation is required. For different tree species, there are varying treatments. The above prescription is used for large scale eucalypt plantings on ex-pasture sites, but there is also a product, Eucmix PrePlant, which is used for these. This product is supplied in a 1 kg water soluble plastic bag, and 1 kg treats 1 ha.

The chemicals in Eucmix PrePlant are terbacil and sulfometuron methyl (the latter is the active ingredient in Oust Herbicide). The product is, however, only registered for the establishment of blue gum, shining gum and mountain ash plantations.

There is a second season product, Eucmix GR Granular Herbicide, which is also only registered for the same species. It is applied at a standard rate of 30 kg ha^{-1}, but can be applied by a Weed-A-Metre as a spot treatment, at 2 or 3 g $spot^{-1}$. Trial work at 3 g $spot^{-1}$ has shown this to be safe and efficacious as a pre-planting treatment for amenities plantings of several species (Tomkins 2002). It is not illegal to use it for this purpose in Victoria, but the onus is on the user.

Specific weeds sometimes require treatment. Thistles, for example, are not always well controlled by standard treatments. Clopyralid (Lontrel Forestry Herbicide or Lontrel Liquid) applied at a rate of about 180 g ha^{-1} a.i. provides excellent residual control (pre-emergence) of thistles. Brassica weeds (wild turnip, wild radish, charlock etc.) are easily controlled with metosulam (Clip Herbicide) at 5 to 7 g ha^{-1} a.i. This herbicide also has a residual effect of up to six weeks or so, and is safe to use over most tree species (post-planting). Grasses that develop after planting can be knocked down with grass specific herbicides e.g. haloxyfop-R methyl ester (Verdict 520) is registered for post-planting control of grasses in plantations; an adjuvant – oil or wetter – is required, and the rate varies from 104 to 416 g ha^{-1} a.i.

In direct seeding establishment, research has shown that a number of herbicides can be applied post-planting, with roughly the same survival rates, even though some of these herbicides undoubtedly set back and even kill some trees (Bird 2002). In the second season, a winter application of glyphosate at low rates (0.36 kg ha^{-1} a.i.) may be used to control weeds on direct seeded sites (Millsom undated).

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Mobility of herbicides applied to hard surfaces in riparian zones

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Abstract

Weed control by herbicide application is an effective strategy in the urban environment, but treatment in urban riparian zones is potentially significant with respect to wetting and run off of herbicides after rainfall events on relevant hard surfaces such as concrete or asphalt, drains, channels, and paths. In the literature, the study of herbicide loss from non-agricultural surfaces is only recent, with no such studies recorded as yet in Australia. This short communication outlines a proposed controlled laboratory study to determine the extent to which herbicides are removed from treated surfaces following a rain event, in order to minimise experimental variability frequent in the larger field studies cited. The forthcoming study is made up of the following components: test surfaces, herbicides formulations and their method of application, simulated rainfall, and its collection following runoff. Selection of relevant herbicides for riparian weed control, and laboratory experimental design are discussed.

Introduction

Herbicide use in riparian zones (vegetation communities bordering streams and rivers) presents a challenge separate from its use in other environments (e.g. forest, grassland) since within such zones, land plants border and grow directly adjacent to aquatic systems (MacLeod 2002). Any herbicide treatment within such zones therefore involves high risk of contaminating waterways by direct spray, runoff, and leaching. In urban settings, vegetation control is often undertaken along open stormwater channels, where narrow herbicide-treated strips are created to stop riparian vegetation encroaching directly onto the channel.

In addition to vegetation and soil, other components of riparian ecosystems include rock escarpments and platforms, pebble banks, and gravel. In the urban environment additional hard surfaces comprising concrete and asphalt are relevant, frequently occurring as linings of stormwater channels or surfaces of adjoining roads or paths. These surfaces are likely to receive herbicide treatment when vegetation encroaches on them. Treatment of non-agricultural zones such as paths, road, and drain edges is usually by 'spot spraying' i.e. applying a specific herbicide concentration to wet weeds to the required degree, rather than by applying a defined amount per unit area (Kent and Preston 2000). Handguns attached to tanks on vehicles or knapsack sprayers may be employed. Where spot spraying methods are used, label directions often state that target foliage should be 'thoroughly wetted' in order to ensure effective coverage (AWRC 1985). Judgements of sufficient wetness vary amongst those applying herbicides, and in any case when high-volume application equipment is used it is difficult to avoid over-application in some places that will result in excess herbicide running off. It is also impractical to always avoid spraying where small gaps in the weed cover occur. Where sparse weed foliage occurs over hard surfaces it is inevitable that wetting the leaves sufficiently will deposit considerable amounts of herbicide on the surface below. The environmental fate and transport of herbicides that deposit on hard surfaces is potentially important, and should be characterised in order to complement knowledge of herbicide behaviour after being deposited on vegetation, soil and water. This study will improve knowledge of herbicide fate in riparian systems and will also generate information relevant to roadsides and other situations involving artificial hard surfaces. Results will be used in the development of improved guidelines for herbicide use in riparian zones.

Review of existing literature

Few previous studies have investigated herbicide losses from hard surfaces, in contrast to the large body of work reporting behaviour in soils. Two studies were conducted by researchers from the Soil Survey and Land Research Centre at Cranfield University, UK (Shepherd et al. 1997, Shepherd and Heather 1999). The researchers embarked on an unpublished pilot study in 1997, which investigated the loss of the herbicides atrazine, diuron, glyphosate, isoxaben, oryzalin, and oxadiazon in rainwater runoff collected from a roadside drain (Heather et al. 1998). Although the study produced evidence for herbicide loss achieving 'steady state',