THE USE OF HERBICIDES IN WESTERN AUSTRALIAN FORESTS

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INTRODUCTION:

By comparison to most other forestry organisations in Australia, forest weed control in Western Australia accounts for only a small proportion of all silvicultural research. Prior to 1983, plantation weed control relied heavily on the use of 2,4,5-T. In anticipation of the withdrawal of 2,4,5-T from the market, trials were commenced in 1982 to find an alternative. This constituted the first major research initiative into plantation weed control for a decade.

Subsequently, the doubt surrounding the occupational safety of amitrole prompted studies of potential replacements. While the doubts appeared unsubstantiated, the studies led to prescriptions that rationalised the use of amitrole, and greatly reduced the probability of phytotoxicity.

Although herbicides play a substantial part in forest weed control, this discussion paper also refers to mechanical and other forms of weed control that are widely used in Western Australia.

Research involvement in providing prescriptions for the use of herbicides in both pine and eucalypt nurseries has been based on need; little routine assessment of new herbicides is carried out. However, there is considerable support within the Forests Department for the appointment of a nurseries manager, part of whose responsibility would be to review nursery weed control in order to improve and maintain efficiency.

The use of herbicides in native forests and control of noxious weeds are discussed. The provision of prescriptions for controlling noxious weeds in Western Australian Forests rests with the Agriculture Protection Board (A.P.B.). While the Forests Department is obliged to control noxious weeds in State Forest, it does not intend to become involved in a research programme.

Reference is made to occupational health aspects.

PRE-PLANTING WEED CONTROL (establishment of pines or eucalypts)

Pastured Sites

Historically, the Forests Department has used proprietory mixes of atrazine and amitrole (eg. "Vorox AA") (McKinnell 1975; McKinnell

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and Butcher 1973). However, recent studies have shown that where late germinating weeds (eg. *Lolium rigidum* and *Lotus minor*) occur, necessitating an increase in the rate of application, amitrole may become phytotoxic on some soil types. Accordingly, prescriptions now encourage field managers to mix atrazine and amitrole in suitable proportions, taking into account weed development, weed composition, soil type and soil moisture.

For pre-plant weed control of pines and eucalypts, at least two weeks between spraying and planting appears necessary. In routine plantings, mortalities have been recorded which could be attributed to herbicide applied at the prescribed rate less than two weeks before planting. Experimental results have failed to confirm this. However, it is likely that the planting technique may influence mortality by the probability of soil contaminated by herbicide being mechanically incorporated into the root zone.

Prescribed rates of amitrole range between 600g ha^{-1} and 2.25kg ha^{-1} while for atrazine the range is 1.5 to 3.0kg ha^{-1}. In experiments, rates of amitrole above 2.0kg ha^{-1} have been recorded as phytotoxic. However, actual mortality has not been recorded below 3.0kg ha^{-1}. Kikuyu grass (*Pennisetum clandestinum*) is a localized problem, and is controlled by a mixture of glyphosate (2.16kg ha^{-1}) and simazine (1.5 to 3.0kg ha^{-1}), applied two weeks before planting. Similarly, the occurrence of bracken (*Pteridium esculentum*), is comparatively scattered, although it can be a serious competitor to young trees. In the past no attempt has been made to control bracken, mainly because the recommended treatments have been ineffectual. However, with prescriptions to agroforestry becoming available which involve lower selection ratios, and hence lower planting numbers, the need to guarantee survival becomes more important. The field prescription for controlling bracken to establish widely spaced pines requires bracken to be slashed in early summer and sprayed with a mixture of glyphosate (2.16kg ha^{-1}) and 'Ulvapron' (10l ha^{-1}), in water, in the following autumn. Trials using hexazinone have shown that while early results were encouraging, bracken ultimately regenerated into an apparently healthier stand. Similarly, spraying over bracken with amitrole/atrazine mixtures appears to benefit the plant and results in increased competition to the pines.

Plantations in the Donnybrook Sunkland are cleared, ploughed and mounded between November and April. Clover is sown in May and

fertilized with 500kg ha^{-1} of superphosphate containing zinc, copper and molybdenum. Trials have demonstrated that a dense sward of clover will inhibit the germination and development of other weeds. When clover and pines are established in the same year, strip spraying along the mounds is usually unnecessary. However, if clover is sown one year in advance of planting pine, strip spraying with a mixture of atrazine and amitrole will improve survival and growth.

Non Pastured Sites

Clearing of native vegetation for conversion to pine plantations occurred in the Donnybrook Sunkland from 1974 to 1983. Apart from the Sunkland, the only clearing of native vegetation occurs on coastal sand north of Perth. The majority of this land is situated over extensive ground water reserves that are utilized for supply to the Perth metropolitan area. Currently there are no guidelines for the use of herbicides in this region. Consequently, control of weeds is by cultivation pending the formulation of policy of the use herbicides. After clearing, the land is burned and ploughed. All sites are furrow lined before planting.

POST-PLANTING WEED CONTROL

Control of Eucalypt Regrowth

There are a number of weeds occurring in Western Australian plantations that have the potential to compete with pines. Eucalypt regrowth, *Acacia spp., Pultenaea spp., Bossiaea aquifolium* and *Viminaria juncea* are the species most likely to affect survival and growth of pines in plantations established on land cleared from native forest. Trees to be established on pastured land need weed-free conditions for the first year for satisfactory survival to be achieved.

Three methods for controlling eucalypt regrowth in plantations have been developed (Fremlin and Jones, 1984). Of these the most efficient is a foliar spray of a 2.3 percent concentration (in water) of glyphosate. The mixture is usually applied by packspray in spring and summer when the regrowth is less than 0.8m in height. This method ensures that regrowth is controlled before the effects of competition are expressed by the pines. The cost of this operation

varies between \$25 ha^{-1} and \$140 ha^{-1} , depending on the amount of regrowth. More advanced regrowth is controlled with glyphosate administered by either the cut stump or stem injection methods. Of these the cut stump method is the most effective. Cost of these treatments ranges between \$70ha^{-1} and \$180ha^{-1}.

Control of Other Woody Weeds

Cultivation plays a major part in the weed control programme in pine plantations. As mentioned previously, interrow cultivation remains the only option available, in plantations north of Perth, while the debate continues on the use of herbicide. Plantations are cultivated in the summer following planting and again two years later. A specially designed cultivator is used which can be operated in both directions. In the first instance soil is thrown towards the planted line while the second cultivation returns the soil to the interrow. Although this is claimed to help reduce weed growth within the lines of trees, it appears to be only partially successful.

While cultivation is effective for controlling weeds between rows, the problem of competition from within the rows has yet to be fully addressed. Until a policy is formulated with respect to the use of herbicides on these sites this problem will remain.

Interrow cultivation is the main method also for controlling woody weeds (except eucalypts) in plantations in the Donnybrook Sunkland. The use of clover to improve soil fertility has precluded the use of residual herbicides (eg. hexazinone). However, 3,6-dichloropicolinic acid is being evaluated. With \$35ha^{-1} being the cost to interrow cultivate, it is unlikely this chemical will compete economically and it would be used only where cultivation is not feasible. Trials in the Donnybrook Sunkland comparing cultivators showed blade ploughs (with coulter) were more efficient and caused less disturbance to the clover than disc ploughs. They also require less maintenance.

WEED CONTROL IN OPEN ROOTED NURSERIES:

***P. radiata* Nursery**

Until the 1979/80 nursery season simazine and nitrofen were the main herbicides used in the *P. radiata* nursery. Persistent use of simazine,

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over a period of years, was having an increasingly detrimental effect on the germination and growth of subsequent crops. With the need to replace simazine, trials were established in 1978 and 1979 (Schuster and Fremlin, 1980). From these trials, propazine appeared to be a suitable alternative to simazine while diphenamid and a mixture of terbumeton and terbuthylazine ('Caragard') were effective oversprays to control late germinating barnyard grass (*Echinochloa crus-galli*) and crab grass (*Digitaria sanguinalis*). The use of propazine and 'Caragard' became operational in 1980 following the withdrawal of nitrofen from the market.

After sowing of seed, a mixture of paraquat and diquat ("Triquat") is sprayed at low rates ($\leq$ 125g ha^{-1}) to kill emerged weeds. Within 14 days of sowing propazine is applied at 2kg ha^{-1}. The germination of barnyard grass and crab grass usually coincides with the commencement of irrigation (October). However, if late rains occur and soil temperatures are high, germination may be earlier. Terbumeton and terbuthylazine (2kg ha^{-1}) is applied immediately following emergence. Control, at this rate, is not effective if plants develop beyond the two leaf stage.

P. pinaster Nursery

This nursery is located on a deep sandy soil at Gnangara, north of Perth. There has been no alteration to the prescription for controlling weeds since 1966. A mixture of paraquat and diquat is applied to emerged weeds after pine seed is sown. To control further germination of weeds chlothal is applied immediately after sowing at 11.25kg ha^{-1}. In some years crab grass is a problem late in the season, in which case it is controlled by hand weeding.

Karri (_E. diversicolour_) Nursery

The karri nursery is located near Manjimup on sandy loam soils. Barnyard grass, crab grass, lotus (***Lotus minor***) and blackberry nightshade (***Solanum nigrum***) are the weeds most difficult to control. For pre-emergence weed control linuron is sprayed at 0.25kg ha^{-1} soon after karri seed is sown. Post-emergence weed control is achieved by shielded sprays of 'Triquat' between the rows, although recent studies suggest that fluazifop-butyl at around 1kg ha^{-1} is safe to spray over karri seedlings and is effective against barnyard and crab grass. Metribuzin and oxyfluorfen appear to have potential

for pre-emergent application.

THE USE OF HERBICIDES IN NATIVE FORESTS:

Thinning

Increasing areas of the native forest are being set aside for purposes of conservation. This has increased the demand on remaining forest to supply timber. Thinning is seen as one way of increasing productivity in native forest, and the use of herbicides to achieve this is expanding.

Successful techniques have been developed and are in wide use. An 18% solution of glyphosate is injected at 15cm intervals around the circumference of the tree. Either 1ml or 2ml are administered at each injection point, depending on the diameter of the tree.

Where culled material is to be utilized the stump is treated with a 3.6% solution of glyphosate.

Control of *Banksia grandis*

Studies by Shea (1982) confirmed the dominant role that *Banksia* plays in the spread of *Phytophthora cinnamomi* in jarrah (*E. marginata*) forests. A hygiene programme to eradicate *Banksia* from forests susceptible to infection by *Phytophthora* has commenced. Glyphosate is used to spray young *Banksia* plants and to treat stumps of felled trees. Rubber wheeled tractors fitted with blades are also used to clear *Banksia* from jarrah forests.

CONTROL OF NOXIOUS WEEDS:

While the Forests Department is responsible for the eradication of declared noxious weeds in state forest, the A.P.B. usually provides information on the best method of control.

The most widespread weed pest in forests is blackberry (*Rubus fruticosus*). A 0.00096% concentration of triclopyr (1 part 'Garlon 480' in 500 parts of water) is sprayed onto plants in summer. This prescription may change in the near future following trials by the A.P.B. using triclopyr/picloram mixtures ('Grazon'). Rates are also

likely to vary depending on the condition of the plant. Other weeds including variegated thistle (*Silybum marianum*), double gee (*Emex australis*) and arum lily (*Zantedeschia aethiopica*) are of a lesser problem and are usually controlled by either 2,4-D or dicamba. In trials, chlorsulfuron has given promising results for the control of arum lily.

OCCUPATIONAL HEALTH:

The use of herbicides in Western Australian forests is regulated according to guidelines approved by the Department of Health. A pesticides committee was appointed within the Forests Department in 1982. This body advises the Department on the use of pesticides, and updates and periodically reviews the pesticides manual. Each pesticide in use by the Department is represented in the manual and information relating to safe handling, first aid, safety equipment, usage etc. is listed. In addition to the pesticides manual, a separate prescription is made available for each situation that a pesticide is likely to be employed. The intention is to reduce the number of pesticides in use by the Department and standardise the method of use.

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