WOODY WEEDS CONTROL IN NORTHERN AUSTRALIA

J. C. SCANLAN*

* Department of Primary Industries, Rockhampton, Queensland 4700.

ABSTRACT

Woody weeds are of major concern to the grazing industry of northern Australia, especially where vigorous pasture growth has not been maintained. Acacia nilotica, Mimosa pigra and Prosopis spp. are potentially very serious woody weeds and the spread of these species should be stopped. Native woody weeds may be poisonous, may directly interfere with stock management, or may severely reduce pasture production because of competition for moisture. The increase of native woody weeds in the Acacia aneura communities of south-western Queensland will continue under current management practices.

The relative importance of mature trees, juveniles and new seedlings varies greatly between communities and their woody weed problem following development. The mode of weed regeneration influences the type of development used.

Factors influencing the success and cost of chemical, mechanical and biological control are discussed. In most cases soil applied residual herbicides and ploughing are the most effective but most expensive treatments.

INTRODUCTION

Woody plants are normally defined as weeds only in the context of a particular land use system. Weeds in one system are not necessarily weeds in another. Some plants are totally useless, but more commonly woody plants become weeds because the problems associated with their presence are greater than the advantages or benefits of the plant per se. An example is Acacia nilotica in north west Queensland. This plant is useful in the short to medium term as it provides shade and is a source of high quality fodder in the dry period of the year, but once it becomes dense, grass production in severely depressed and mustering becomes very difficult. Thus woody weed control must be integrated into the whole property management plan and not viewed in isolation from fencing, provision of water, future use of the land or breed of animal.

Recent articles by Mott and Tothill (1984), Burrows and Scanlan (1984), Burrows et al. (1986) give insight into reasons for woodlands being the dominant vegetation form in much of northern Australia. Swarbrick (1983) has compiled an annotated working list of weeds in 12 regions in northern Australia. Some information on distribution is not accurate and the use of vegetation types rather than regions lessens its value on a regional basis. However, it provides a useful base upon which to work. The overall pasture weed situation of the tropics and sub-tropics has also been reviewed recently by Tothill et al. (1982), while Anderson (1984) has reviewed the weeds of the brigalow region and Scanlan and Pressland (1984) have given a practical guide to woody weed control in western Queensland.

WOODY REGROWTH FOLLOWING DEVELOPMENT

Woody weed establishment

The establishment phase of any plant is the most critical and vulnerable in its life cycle. This is particularly noteworthy with woody weeds because of the longevity of individuals. Noble (1984) indicated that for a tree population to establish, a seed source, germinating rain, establishment rain and low herbivore populations are required. This has important implications when interpreting results, as a particular event that has no apparent effect under one set of circumstances, can produce very dramatic effects under others.

The age of a plant can determine its susceptibility to a particular control method. Thus the population age structure will influence the success of a particular control strategy in the long term. Johnson (1964) showed a dramatic age effect on the control achieved by aerially spraying Acacia harpophylla while Hodgkinson (1983) illustrated the influence of age on the effect of fire on native shrub species in western New South Wales.

There are three "generations" that must be taken into account in any complete weed management programme:-

- mature individuals
- juveniles
- individuals establishing following treatment.

The contribution of these categories to the woody weed problem in three distinct community/development groups is shown in Table 1.

TABLE 1

Relative importance of the three "generations" to subsequent woody weed populations following development of two eucalypt communities and a brigalow community

	Eucalypt Stem injection	Eucalypt Pulled	Brigalow Pulled
	Relative contribution to weed problem*		
Dominant woody species			
Mature	L	M	L
Juveniles	H	H	L
New individuals	M	H	vH
Sub-dominant species			
Mature	L	L	L
Juveniles	M	M	L
New individual	M	vH	H

* L - low, M - medium, H - high, vH - very high

Eucalypts developed by stem injection Since the 1960s, stem injection has become an extremely important and effective means of primary development of pasture lands from woodlands in northern Australia. Most mature trees are killed. Juveniles may constitute half the population (Scanlan 1984) and these will require some follow-up treatment. Small clumps (10-20 trees) or isolated trees are usually left for shade, shelter and timber. However, scattered mature trees act as seed sources and these need only be present at 5/ha to enable seed of these trees to fall anywhere within the total paddock (Scanlan 1984). Given the right combination of factors these seeds germinate, and establish a new generation that must be controlled.

A better clearing strategy is to completely clear areas, while leaving about 20% of the paddock in its virgin state as strips (about 100m wide) or clumps (about 2-5ha) . In this method part of the resource is maintained (for shade, shelter, timber and wildlife) and the potential for seedlings to establish is minimised.

Eucalypts pulled with bulldozers Juveniles are unaffected and many mature trees are merely snapped-off and will regrow from the lignotuber or even from rhizomes (Lacey 1974). This reduces the above-ground woody biomass to a small fraction of its original level but reduction in the number of living individuals is not as great. The associated soil disturbance favours the establishment of seedlings of other species, notably Acacia spp. Robertson and Beeston (1981) indicated that pulling Eucalyptus populnea gave a mean reduction of only 39% in total woody plant density. In half of the observed sites, the density actually increased.

Pulled brigalow community Most species in the brigalow community have the capacity to produce new individuals vegetatively. The pulling and burning operation removes most above-ground material. All individuals are "new" in that the foliage has been produced post-development although these are regenerating from "old" material. Once the regenerating organs of the original plants have been killed there is little chance of further problems from native woody weeds.

Post-development management

A competitive pasture reduces the niches for germination of woody plants, reduces the chance of successful establishment (Harrington et al. 1984) and provides the opportunity of burning to kill small plants (Hodgkinson 1983). Burning can kill very young woody plants or highly fire sensitive ones but, more often fire maintains regrowth in a form acceptable and accessible to stock. It reduces the competitive capacity of the woody plants and the interference with management due to woody weeds is minimal.

The importance of successful pasture establishment following development is demonstrated in the gidgee communities of western Queensland. Areas near Isisford were cleared in the 1950s but were too dry for the establishment of Cenchrus ciliaris and even the native grasses were a very minor component of the overall herbaceous layer. The broad-leaf herbs were not competitive against gidgee seedlings and did not provide sufficient fuel to carry a fire. This district now supports dense gidgee regrowth over most of the cleared areas. By way

of contrast, development of gidgee scrubs into stable productive pastures further to the east is one of the few examples in the world of a low rainfall community being developed to long term sown pasture.

Acacia harpophylla (a similar species to gidgee) rarely regenerates from seed but the root systems of existing mature trees produce many root suckers following any damage to the plant. The initiation of these suckers appears to be dependent on the timing and type of disturbance rather than the post-development management (Johnson 1964, Anderson et al. 1985). Growth of suckers is retarded by good pasture growth but the number of suckers is not affected. Fire has little effect on sucker numbers (Johnson and Back 1973, E.R. Anderson and P.V. Back pers. comm.). Thus, pasture management has little impact on the overall regrowth problem - a great contrast with the gidgee community.

MODE AND RATE OF SPREAD

The mode of reproduction of a species is an important consideration when selecting the most appropriate control methods or development pathway for a community. The two facets that must be considered are an increasing area occupied (spread) and an increasing density within existing stands (regrowth). Generally spread is associated with exotic species whereas regrowth can be important for both native and exotic species.

Exotic woody weeds

The woody weeds that are presently of most concern in northern Australia produce large quantities of seed although some also have the capacity to regenerate vegetatively. Seed is spread by wind and water (Cryptostegia grandiflora, Mimosa pigra), by birds (Opuntia) and by domestic livestock (Acacia nilotica seed ingested by cattle).

Exotic woody weeds become important where a pasture system has been disturbed (e.g. rundown pastures, overgrazed areas) and where there is an unoccupied niche (e.g. Lantana camara and Baccharis halimifolia in the understorey of pine plantations; Acacia nilotica in mitchell grass downs). Exotic weeds are most prevalent in higher rainfall zones where there is more intensive agriculture and as a result, more opportunity for creating suitable loci for establishment. However there are some species that have spread in semi-arid and arid areas (Prosopis spp.). An important feature of many of the dryland woody weeds is that they are leguminous and often possess thorns which protects them from grazing.

Native woody weeds

Many native species interfere with property management in one form or another. These include mustering problems (especially important with respect to disease control programmes), limiting water access (Muehlenbeckia cunninghamii in the channel country), being poisonous to stock (Gastrolobium spp., Cycas, Macrozamia, Erythrophleum chlorostachys) and suppressing pasture production (the eucalypt woodlands). These problems are apparent even in the virgin communities. Native species can greatly increase in density following

development or disturbance with the most important genera being Eucalyptus, Acacia, Eremophila, Cassia and Dodonaea.

CONTROL OF SPREAD AND REGROWTH

A summary of available control options together with factors that influence the success of these options is given in Table 2.

Chemical control

The most widely used herbicides registered for use in woody weed control are 2,4,5-T, picloram, hexazinone and triclopyr. The latter herbicide has come to prominence lately as a result of the controversy with 2,4,5-T. Practically, it resembles 2,4,5-T in species controlled, efficacy, rates of application and mode of action although chemically it is similar to picloram.

TABLE 2
Factors important to the success of killing regrowth

Method	Relative importance* of Biomass	Coverage	Timing	Species	Success	Cost**
Chemical - air						
Spray	H	H	H	H	L-M	L
Granules	L	L	L	M	M-H	L
Chemical - ground						
Soil	L	L	L	L-M	H	M
Stem Injection	M	L-M	L	L	M-H	H
Basal bark	H	L-M	L-M	M	M-H	H
Cut stump	H	L-M	L-M	M	M-H	H
Foliar	H	vH	vH	H	L-M	H
Mechanical						
Pull	M-H		M-H	L	L	L
Stickrake	H		M-H	H	L-M	M-H
Disc plough	H		H	L-M	M	M-H
Blade plough	L		L-M	L	H	H
Other						
Fire	H	H	H	H	L	L
Grazing	H	H	H	H	L	L
Biological	L	M-H		vH	L	L

* L - Low M - Medium H - High
** The cost of application only

The advent of soil applications of liquid (hexazinone) and pellets (tebuthiuron - not registered in Australia at time of writing) has been the most significant progress in chemical woody weed control since the commercial use of picloram products. Ground application of hexazinone serves to replace the basal bark and cut-stump methods and replaces a treatment with a low chemical:high labour cost structure with a high chemical:low labour input. The great advantage of this

method is that application timing is not critical. These products are especially useful in areas with mixed species as they provide the landholder with a non-mechanical option for regrowth control.

Mechanical control

The success of brigalow and gidgee development has established the principle of using big machines to develop woodlands into pasture lands with resulting higher carrying capacities. The large machines which are now available make it realistic to extend this approach into all communities, with that of most concern being eucalypt woodlands. The success of this method will depend on the regenerative ability / mechanism of species in the community being treated and the availability / practicality of regrowth control methodology.

Mechanical treatment is an important primary development option. The overall effectiveness of mechanical regrowth control treatments depends on the damage to the plant, and this depends on soil disturbance, in relation to the regenerative ability of the target and associated species. The cost of treatment is roughly proportional to the amount of soil disturbance. Thus, effectiveness is usually related to how much is spent on the treatment.

Role of management

The possible management options that are available fall into two categories - grazing management and fire. These are the two options that are most readily available to the grazier and require little or no capital outlay.

Direct effects of grazing Comparing goats, sheep and cattle, goats are most effective and cattle least effective in killing seedlings and keeping regrowth within grazing height. Even so, goats are very selective in their diet (Wilson and Mulham 1980) and are not the solution to dense regrowth problems. Apart from selectivity, the other factor to consider is the amount of shrub material available per head. If this is high then cattle and sheep will have very little effect on regrowth, however if this component is relatively small then extreme pressure can be placed on those plants.

Long-term moderate to high stocking rates are not effective for the control of unwanted woody plants. More success has been achieved by using very high stocking rates over a short period (Hardesty 1984).

Direct effects of grazing are more likely to be evident in terms of limiting plant spread or individual plant growth rather than actually killing existing plants.

Indirect effects of grazing There are several ways in which management can alter the environment around the plant and enhance or reduce its chance of survival. Excessive grazing leads to preferential removal of grasses. This results in deeper moisture penetration because the grasses are not using moisture in the surface layers. This in turn favours the woody plants as these utilise the lower layers of moisture (Gillard and Williams 1984). Even greater grazing pressure can cause runoff due to lack of surface ground cover

and this will tend to further restrict the grass layer. Thus, there will be little competition from established grasses when conditions are suitable for establishment of woody plants.

An example of how grazing management could be used to contain a woody weed concerns the use of cattle in Acacia nilotica areas. Seeds of this species are readily eaten and pass through cattle with a significant amount largely unaffected (80%) compared with those that pass through sheep (1%) (Harvey 1981). The seed passed through cattle also has a higher germination percentage (50% cf. 15%). A proposal put forward by W.H. Burrows (pers. comm.) is that cattle should be removed from paddocks with Acacia nilotica during the November pod ripening period so that the seed is not spread around the paddock. Another integrated strategy of management is to manipulate the trees along the bore drains (probably with herbicide) so that they are damaged sufficiently to enable stock to browse them. The combination of browsing and the herbicide damage may be sufficient to prevent seeding in the long term. Alchin and Condon (1983) propose holding cattle from Prosopis-infested areas in small paddocks free of the plant for 14 days before being moved to clean paddocks. This should minimize spread between paddocks although galahs and corellas relish the seed pods and are a significant cause of spread.

Fire This is an important management tool, including woody weed control (Tothill 1971, Mott 1982, Pressland 1982), in most pasture systems apart from improved pastures in high rainfall areas. Two recent workshops have gathered together much of the information on fire in Queensland (Roberts 1980, 1982).

Control with fire means biomass reduction rather than population reduction in most higher rainfall areas, but in semi-arid regions fire will kill shrubs (Pressland 1982). Shrubs are most susceptible to fire during seedling years (Hodgkinson 1983), and burning during this period will be most effective on those species that cannot regenerate from the rootstock. Species which take 3-4 years before seeding can be eliminated by burning on a two-year cycle, while irregular fires can enhance the germination of Dodonaea, Cassia and Acacia. The large supply of seed in the soil, often existing under dense stands, means that there is a strong chance of re-establishment, especially if the soil is disturbed or the pasture competition is removed.

Biological control

This form of control involves the use of living organisms to reduce the population or reduce the spread of undesirable woody plants. When plants that have become woody weeds were introduced into Australia, few of their natural enemies were brought with them. Native woody weeds are not good candidates for biological control because their natural enemies are already part of the environment. Many of these natural pests have their own suite of pests and diseases that check their population.

Insects are the most common biological control agents tested. They include stem borers, leaf miners, leaf eaters, flower eaters, gall wasps and seed borers. Before an agent can be brought into Australia, it has to be shown that it will attack only the target

plant or closely related unwanted species. Where a plant is from a genus native to Australia, extremely thorough testing must be carried out.

Both CSIRO and the Queensland Department of Lands are actively involved in biological control of Queensland's woody weeds. Spectacular success has been achieved with Cactoblastis cactorum on Opuntia while the control of Eriocereus with Hypogeococcus has also been successful. Since 1979, there have been 5 insects released on cactus species, 8 on Baccharis halimifolia, 4 on Lantana camara, and one each on Mimosa pigra and Acacia nilotica (Field 1984). The last two species mentioned are perhaps the most serious threats to productive grazing lands in northern Australia and every effort should be channeled into control of these species.

CONCLUSIONS

Control methods are available for the majority of situations but these may not be practical or economic, especially on land with a low stocking capacity. The most serious current and potential woody weed problems at present in northern Australia are:

* the increase of native shrubs in south-western Queensland and northern New South Wales
* the spread of Acacia nilotica onto the mitchell grass downs
* the spread of Mimosa pigra in the Northern Territory
* management problems with Cryptostegia grandiflora in north Queensland
* the widespread occurrence of Parkinsonia aculeata in northern Australia and its potential threat to frontage lands and black soil plains, and
* localized occurrences of Ziziphus mauritiana and Calotropis procera.

Woody weeds are most vulnerable up to the early establishment phase. Research efforts should be directed towards a better understanding of soil seed reserves, germination and establishment.

REFERENCES

Alchin, B.M. and Condon, R.W. (1983). Proceedings of a workshop on woody weeds of northern summer rainfall areas, Rockhampton, October 1983. (Lands Department: Brisbane).

Anderson, E.R. (1984). In "The Brigalow Belt of Australia" (Queensland Department of Primary industries: Brisbane), 183-92.

Anderson, E.R., Scanlan, J.C., Fossett, G.W. and Russell, F.J. (1985). Pastures under development in central Queensland. Part 2: Northern brigalow region. Queensland Department of Primary Industries, Land Resources Bulletin No. QV84003.

Burrows, W.H. and Scanlan, J.C. (1984). Proceedings of the North Queensland Sub-branch of the Australian Institute of Agricultural Science Symposium, Townsville, October, 1984.

Burrows, W.H., Scanlan, J.C. and Anderson, E.R. (1986). In "Native Pastures in Queensland: The Resources and Their Management", editors W.H. Burrows and J.C. Scanlan, (Queensland Department of Primary Industries: Brisbane) (in press).

Field, R.P. (1984). Proceedings of the Fourth Australian Applied Entomological Research Conference, 333-43.

Gillard, P. and Williams, J. (1984). Proceedings of the North Queensland Sub-branch of the Australian Institute of Agricultural Science Symposium, Townsville, October, 1984.

Hardesty, L.H. (1984). Rangelands 6: 249-53.

Harrington, G.N., Friedel, M.H., Hodgkinson, K.C. and Noble, J.C. (1984). In "Management of Australia's Rangelands", editors G.N. Harrington, A.D. Wilson and M.D. Young, (CSIRO: Melbourne), 41-61.

Harvey, G.J. (1981). Proceedings of the sixth Australian Weeds Conference. Volume 1, 197-201.

Hodgkinson, K.C. (1983). Proceedings of a workshop on woody weeds of northern summer rainfall areas, Rockhampton, October 1983. (Lands Department: Brisbane).

Johnson, R.W. (1964). "Ecology and Control of Brigalow" (Queensland Department of Primary Industries: Brisbane).

Johnson, R.W. and Back, P.V. (1973). Queensland Journal of Agricultural and Animal Sciences 30: 197-203.

Lacey, C.J. (1974). Australian Journal of Botany 22: 29-38.

Mott, J. J. (1982). Tropical Grasslands 16: 97-9.

Mott, J.J. and Tothill,J.C. (1984). In "Management of Australia's Rangelands", editors G.N. Harrington, A.D. Wilson and M.D. Young (CSIRO: Melbourne), 255-69.

Noble, I.R. (1984). Proceedings of the Second International Rangelands Congress, Adelaide, May 1984. (in press).

Pressland, A. J. (1982). Tropical Grasslands 16: 104-11.

Roberts, B.R. (1980) (editor). "Queensland Fire Research Workshop." (Darling Downs Institute of Advanced Education: Toowoomba).

Roberts, B.R. (1982) (editor). "The Second Queensland Fire Research Workshop." (Darling Downs Institute of Advanced Education: Toowoomba).

Robertson, J.A. and Beeston, G.R. (1981). Australian Rangeland Journal 3: 39-44.

Scanlan, J. C. (1984). "Aspects of the Ecology and Management of Eucalypt and Brigalow Communities in Central Queensland". M.Agr.Sc. thesis, University of Queensland.

Scanlan, J.C. and Pressland, A.J. (1984). "Major Woody Weeds of Western Queensland and Their Control" (Queensland Department of Primary Industries: Brisbane).

Swarbrick, J.T. (1983). Australian Weeds 2: 156-64.

Tothill, J. C. (1971). Tropical Grasslands 5: 1-10.

Tothill, J.C., Mott, J.J. and Gillard, P. (1982). In "Biology and Ecology of Weeds", editors W. Holzner and N. Numata, (Junk: The Hague) 403-27.

Wilson, A.D. and Mulham, W.E. (1980). Australian Rangeland Journal 2: 183-8.