VOLUME 1

PROCEEDINGS OF THE 6TH BIENNIAL NOXIOUS PLANTS CONFERENCE 1991

Hovercraft use on aquatic weeds

"Weed Management for a Stable Environment"

Leeton, May 1991

The gas gun

NSW Agriculture & Fisheries

PROCEEDINGS

OF THE

6TH BIENNIAL NOXIOUS PLANTS CONFERENCE

VOLUME 1

LEETON SOLDIER'S CLUB

6TH - 10TH MAY 1991

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CONTENTS

6th BIENNIAL NOXIOUS PLANTS CONFERENCE

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Peter Gorham
Peter Gray
Geoff Keech
Hugh Milvain
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Du Pont (Australia) Ltd

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Sandoz Crop Protection

SIXTH BIENNIAL NOXIOUS PLANTS CONFERENCE

PROGRAM

Monday 6th May 1991

8.30 Late Registration
9.15 Welcome to delegates
Cr Peter Woods - President Leeton Shire Council
9.30 Opening Address
Hon. Ian Armstrong - Minister for Agriculture and Rural Affairs

10.00 Morning tea

10.30 Sustainable Agriculture
Len Banks - Principal Officer - Sustainable Agriculture
11.30 Legal requirements
Allan Russell - Chief Legal Officer and
Sally Pearman - Legal Officer

12.30 Lunch

1.30 Legal requirements - open forum
2.30 Rice Weeds - John Fowler, District Agronomist.

3.00 Afternoon tea

3.30 The Sensitivities of Natives to Herbicides
John Toth - Special Research Agronomist
4.30 Use of hovercraft
Graham Ingles - Hawkesbury River County Council
5.00 END day 1
7.30 Elected members workshop

Tuesday, 7th May

8.30 Total Catchment Management
Steve Jensen - TCM Coordinator
9.30 Forests and Weed Control
Hans Porada - Research Forester

10.00 Morning tea

10.30 Herbicides Application and the Environment
Don Matthews - Du Pont (Aust) Wodonga
11.30 Pasture Weeds Control
Mike Keys - District Agronomist

12.30 Lunch

1.30 Victorian Weed Control Programs
David McKenzie - Project Manager - Pest Plants
2.30 Weed Control Programs - Cost and Operation
Paul McPherson - Weeds Officer - Tumbarumba Shire

3.00 Afternoon tea

3.30 Weed Control - Rural Lands Protection Boards
Barney Matthews - Ranger, Wagga Wagga RLP Board
4.00 Victorian Control (Subject to be advised)
David McKenzie - Project Manager - Pest Plants
4.30 Division of Plant Industries Restructure
Dr Leon Smith - Principal Agronomist (Weeds)
5.00 END day 2
7.30 WEEDS OFFICERS ASSOCIATION MEETING

Wednesday, 8th May

8.30	Tree Herbicides Hugh Fisher, Senior Inspector (Pesticides)
9.00	Tableland Woody Weed Control Max McMillan - Special Agronomist (Weeds)
9.30	Field Study Trip
5.00	END day 3

Thursday, 9th May

8.30	AVCA accreditation and those who need accreditation Leonie Day - Accreditation Manager AVCA
9.15	Safety Issues - David Kidd - Work Cover Authority
10.15	Morning tea
10.45	Herbicide resistance - John Sykes - Agricultural Consultant
11.45	Water Hyacinth Control Peter Popovic - Noxious Plants Advisory Officer
12.30	Lunch
1.30	Bio control - The Latest - Dr Jim Cullen, Division of Entomology CSIRO (presented by Sharon Woodward) - St John's Wort - Dr Jim Cullen, Division of Entomology CSIRO (presented by Paul Jupp) - Scotch Broom, Dr John Hosking - Entomologist - Biological Control
3.00	Afternoon tea
	- Bio control - Bitou - Royce Holtkamp - Entomologist Biological Control - Common Heliotrope Dr Ernest Delfosse - Division of Entomology CSIRO
4.30	Parthenium Weed Ian Kelly - Chief Weeds Officer, Castlereagh-Macquarie County Council
5.00	New Legislation Barry Buffier - Executive Director (Regulatory)
5.15	END day 4
7.00	Conference Dinner

Friday, 10th May

8.30	The introduction of Epiblema into western NSW Peter Gray - Noxious Plants Advisory Officer
9.00	Sifton bush - Jim Dellow - Special Agronomist (Weeds)
9.30	Report on Parramatta Grass Campaign Greg Fenton - District Agronomist
10.00	Morning tea
10.30	The use of Consol to control Spiny Burr Grass Dick Honeyman - Weeds Officer - Jerilderie Shire
11.00	Blue Heliotrope Jim Dellow - Special Agronomist (Weeds)
11.30	Evaluation
12.00	Lunch

END OF CONFERENCE SAFE JOURNEY HOME

NOXIOUS PLANTS AND SUSTAINABLE AGRICULTURE

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SUSTAINABLE AGRICULTURE

There are many definitions of sustainability including environmental or ecological sustainability, economic sustainability, industrial sustainability and even political sustainability. The approach I wish to take is that **in all agricultural activities consideration must be given to the economic, social and environmental costs and benefits.**

This means a whole farm and a whole catchment approach to agriculture and related activities.

We are striving to optimise productivity, product quality, profitability and social conditions as well as improving the resource base for the future. In rural areas particularly, the resource base depends heavily on natural resources like the soil, water, air, flora and fauna.

The need to consider the impact of agricultural activities comes from an appreciation that a farm (or any piece of land) is not operated in isolation. There are outside influences (climate, other land users, markets) and the activities of the farm influence others in both the short and long term. For land use to be viable and flexible in the future, resources need to be available; natural resources are therefore an important part of rural sustainability.

In this paper I will highlight a few thoughts on how noxious plants are important in a discussion on sustainability, including:

- the process of weed invasion,
- the impact of the weeds themselves,
- the impacts of the control measures, and
- the options we must consider in developing and planning weed control strategies to ensure sustainability.

WEED INVASION

The initial appearance of noxious plants on agricultural and common land may be due to:

- careless practice such as introduction on machinery or domestic livestock, or
- natural spread by water, wind, birds or feral animals.

However, the subsequent spread of weeds and their increase to economic importance is generally a consequence of unsustainable practices. Practices such as severe grazing, continuous monoculture cropping or simply ignoring weed invasion may be undertaken consciously - with the aim of being extremely productive and profitable in the short term, but those practices are not sustainable and they allow weed numbers to become a liability.

Inappropriate weed control practices along with otherwise "good" land management practices will enable weeds to turn a potentially sustainable system into an unsustainable one. These may include:

- not recognising the weed
- poor training in weed control practices
- inappropriate weed control methods
- poor farm hygiene
- poor drainage allowing encroachment of swamp weeds.

Strategies may then have to be implemented which are more expensive, more labour intensive or more involved and which preclude the land use options that are most favoured by the land user.

Weeds may therefore be the result of unsustainable practices and also result in unsustainable land use systems.

IMPACT OF NOXIOUS PLANTS

The importance of the impact of weeds on the Australian economy was expressed in 1986 by Harry Combellac who reported an estimate of over $2 billion as being the financial losses due to weeds. This included $1.271 billion losses in agricultural crops. In 1988, a report to the Australian Wool Corporation estimated losses from the wool industry for individual weed species and groups of weeds. The major costs, based on direct and indirect costs (costs of the impact of the weed itself, its control strategy and Research and Development activities), were from:

Vegetable fault in wool	$184.9 m
Barley grass/ratstail/Brome	$151.7 m
Wiregrass/speargrass	$112.3 m
Capeweed	$ 32.8 m

and lesser losses from 16 other groups of weeds.

In considering the role of weeds in sustainable agricultural systems, discussions have to be made at both the farm and catchment levels about the potential impact of the weed itself if it remains uncontrolled, and the potential impact of the control measures available for each weed and each situation.

(a) The weeds themselves

The weeds alone may:

- Occupy otherwise productive space in competition with pasture or crop plants. This is particularly evident in woody weed invasion of pastoral lands.

- Use otherwise productive natural resources (nutrients, water) which limits their availability to crops and pastures. Grass weeds in annual crops are a common problem.

- Reduce the potential production of crops, pastures or animals, through the displacement of productive plants and the use of nutrients and water.

- Reduce the quality of agricultural produce as in contamination of forage with unpalatable species, downgrading of grain or fibre with weed seeds and tainting of milk or meat

- Harbour pests and diseases of crops and pastures. Many weeds are closely related to crop or pasture plants and are therefore hosts to the same pests and diseases. It may be more effective to manage the weed than the pest.

- Impede water flow and reduce water quality in water courses and dams, especially where drainage is poor, nutrient levels in the water are high and cropping practices prevent timely water weed control.

- Be toxic to livestock causing staggers, rock fern poisoning and other diseases.

- Impact severely on natural ecosystems and thereby reduce floral biodiversity in native vegetation areas. Blue heliotrope invasion in the Warrambungles is an example of a weed blanketing the natural flora.

The implication for production is particularly the direct competition between the weeds and the crop or pasture plants. This reduces economic returns. The decisions therefore are <u>when</u> to control the weed and <u>how</u> to control the weed. The timing of control in the cycle of weed invasion and regeneration depends on the level of competition it is creating and the costs of control measures versus the costs of no action being taken. However in considering sustainability, the costs cannot be measured in loss of production alone. If the weeds are allowed to remain uncontrolled until they build up to more serious or even uncontrollable levels, they reduce the soil fertility, encourage pests and diseases, may alter land use options, increase costs of production and further reduce productivity.

The decision on <u>how</u> to control the weed is an important issue for sustainability. It may have far reaching ramifications.

(b) <u>Control Measures</u>

In NSW alone in 1989-90 $4.25 m was provided to local governments under the Local Government Act for noxious plant control and this was matched by a similar figure from the councils themselves. Other agencies such as Railways, Forestry, National Parks and Rural Lands Protection Boards would have also spent about $2 m on weed control. Chemical sales Australia wide amount to around $200 m per year and there are application costs and other control measure costs (cultivation) on top of that. The cost of controlling weeds is significant in the Australian economy.

While economics have traditionally driven most business decisions, be they in primary, secondary or tertiary industries, there is now a need in agriculture to consider the wider spectrum of implications in the decision making process.

Weed control is a prime example and many options are becoming available or being researched to enable decisions to be made based on sustainability rather than short term economics alone. The options for weed control include :

- Cultivation
- Chemicals (knockdown or residual)
- Natural predators (biological control agents including insects, fungi and livestock)
- Crop management (rotations, plant density, timing of operations)
- Livestock management (grazing strategies, stocking densities)
- Irrigation water and drainage management (timing of irrigation, removal of excess water, channel and dam maintenance)

The impacts vary with the control measure and the issues to be considered when selecting control strategies are the soil condition, residual chemical activity, the whole farm and catchment planning process and the need to adopt new technology.

(i) **Soil Condition**

Land degradation is a greater issue than noxious plants in the public arena at the present time. It includes the very visual erosion and salinity issues and the less obvious problems of gradual decline in soil structure, fertility and biological activity.

Weed control, especially in preparation for cropping, will enhance soil degradation if handled incorrectly such as cultivating the soil too wet or too dry, using machinery that produces hard pan layers, or leaving weeds to deplete soil nutrients. The weeds themselves can also contribute to soil degradation as in the increase in woody weeds in rangelands where bare soil under the shrubs is prone to more rapid erosion.

Inappropriate use of chemicals, cultivation or farming practices to control weeds may also reduce soil biological activity, which is generally enhanced by reduced cultivation, increased organic matter and reduced chemical use.

On the other hand, timely and appropriate cultivation or use of chemicals to kill weeds while retaining a surface cover of plant debris will enhance soil productivity in most situations.

Sustainable agriculture depends on soil improvement (physical, chemical and biological) and is severely hampered by soil degradation.

(ii) **Residual Chemical Activity**

The benefit of many herbicides is their residual activity to ensure protection from weed invasion throughout the life of a crop (especially during crop establishment), the duration of an irrigation season (for channel and bank maintenance) or for long term control in non-agricultural areas (roads, yards, railways). While these attributes are beneficial, they may also impact on the subsequent land uses or restrict options for future land use. The mobility and uptake of some herbicides by non target species, especially trees, is a danger in some situations and the impact of using such chemicals needs to be considered before application.

It is imperative that the whole agricultural system, especially on a farm, is planned in advance so that these issues can be considered and appropriate options adopted.

(iii) **Whole Farm Planning**

The impact of one activity on another is the basis of whole farm planning and management. Decisions cannot be taken in isolation. The questions of soil condition and chemical residues have been mentioned, but decisions on weed control measures also need to include crop and pasture rotations, use of livestock, irrigation management and drainage, farm layout, movement of livestock, slope and natural water courses. Together, these options affect the efficiency and adequacy of weed control and need to be considered along with the farm financial planning.

The species of weed must also be understood so that the most appropriate strategy for its control can be implemented at the most appropriate time. After all, profitable production is the cornerstone of sustainability.

(iv) **Catchment Planning**

Total Catchment Management (TCM) is the current strategy for resource management on a catchment basis. It relies on community and government involvement through Landcare and regional catchment management committees to develop an overall perspective of the impacts of activities in the region.

Weed management is one such activity which requires input from all levels of the industry to ensure that its operation is successful. Activities on one property influence others through weed spread, drainage water, soil erosion or chemical drift. The catchment management process aims to enhance sustainable productivity through better integrated management. It is not intended to regulate or dictate, but rather consider management options on a river catchment basis through community consultation. This group approach to resource management allows the best options to be derived from open discussion across the whole spectrum of catchment requirements.

Within some catchments, special committees have been established to address the weeds issues. A good example is the Macquarie Valley Noxious Plants Advisory Committee and the community's involvement in eradicating Johnson Grass from the Valley. While Johnson Grass was not seen as a universal problem, there was little chance of successfully controlling it along fencelines, roadways and grazing areas. However, on a catchment basis, sustainability was in jeopardy and a co-ordinated strategy was successfully implemented. Serrated tussock control on the Southern and Central Tablelands is another example of total community involvement.

(v) **Adoption of New Technology**

The process of selection of a weed control strategy in itself impacts on the farm business planning process. In an effort to reduce the impact on the natural resources, there may be a need to:

- adopt new technology
- learn new techniques, or
- purchase new equipment.

These costs may be considered by farmers or councils to be too great compared with traditional weed control strategies. However the additional environmental or long term "sustainability" costs of using methods which have a detrimental impact on natural resources need to be considered as well. These costs are difficult to value in dollar terms but should not be dismissed as a zero cost when considering weed control strategies.

This then leads to how we can address the question of weed control in sustainable agricultural systems.

TOWARDS SUSTAINABILITY

Much of what has been done by individuals, governments and industry in the development of weed control strategies has helped sustainability. The approach now is to pull all those efforts together to have a more integrated approach to weed control and a better understanding of the impact of weeds and weed control on others. Options are available through regulation, research and advisory services.

(a) <u>Regulation</u>

The standards for noxious plant control are laid down by the Minister for Agriculture and Rural Affairs on the advice of the Noxious Plants Advisory Committee. There are several pieces of legislation that impact on weed control through registration of herbicides, standards for chemical application and handling, pollution and crop protection. They include:

- Local Government Act 1919
- Pesticides Act 1978
- Occupational Health and Safety Act 1983
- Aerial Spraying Control Act 1969
- State Pollution Control Commission Act 1970
- NSW Seeds Act 1982
- Drug Misuse and Trafficking Act 1985

This indicates that administrators and bureaucrats over the years have been concerned enough about how weeds are controlled to create mechanisms to enforce the safe use of herbicides and to ensure the effective control of weeds.

The new Environmental Protection Act and the creation of an Environmental Protection Authority (EPA) will have wider implications in rural areas than the administration of current pollution legislation. I expect that the EPA will be interested in the whole spectrum of environmental protection, including native flora and fauna, diffuse pollution of land, water and air and the influence of one form of land use on another. This will reinforce the need to consider sustainable practices in all agricultural activities.

Regulation of activities can also be a result of market forces, especially the demands of the consumers. Current consumer thinking, in broad terms, is a preference for an abundance of cheap, wholesome, unblemished food and fibre with no chemical residue. While most agriculturalists will say that those demands cannot be met, we all know that viability depends on satisfying market demands. Therefore through research and advisory activities we are striving towards those demands.

(b) <u>Research</u>

Achievements in research by chemical companies, governments and universities on a global basis have been outstanding. They have brought us from the end of a chipping hoe to the control panel of computerised spray rigs and selective herbicides. Research organisations are now concentrating their efforts on safety in weed control (safety for the operator, safety for the crop and safety for the environment) as well as the development of new products and new techniques.

For this reason, there is a large research effort into integrated control and biological control using insects, micro-organisms and vertebrates. The issues in developing biological control agents are similar to those for chemicals - target specificity, effectiveness, persistence and safety. These issues are especially important for insects which may be extremely mobile; from the point of application to other plant species and other localities.

Two major advantages of biological control agents over chemicals are:

- that they usually act more slowly, giving time for useful replacement plant species to emerge in the place of the weed as it dies, rather than having a rapid kill and a period of bare ground; and

- that in some instances they can have a very long term effect (over many years) without impacting on any other part of the environment. The classic example is the cactoblastis control of Prickly Pear.

A feature of mycoherbicide research, in particular, is that the selection of fungi is from those already occurring on plants in Australia. This means that no new agent is being introduced into the environment and those being tested are already adapted to the conditions in which they will operate as weed control agents.

Similarly, research into the use of goats for woody weed control on the tablelands is not introducing a new agent into the environment. The added advantage of goats is their production of fibre and meat as well as controlling weeds. But care needs to be taken, of course, in increasing the population of goats or other weed controllers, that damage is not done to the environment in other ways (soils, trees) and that it is economically viable (additional management).

Research into the use of strategic crop and pasture rotations for sustainable agriculture is also showing advantages for weed control compared with monoculture continuous cropping. The ability to control weeds or suppress seed production in one enterprise has benefits to the next.

In all weed control work it is important to understand the ecology and physiology of the weed to determine how it gets its competitive advantage and where its weakest link is. Consequently studies of sensitivity to herbicides, palatability to livestock and insects, seeding ability and seed reserves are all being given consideration in research. This will then lead to a better understanding of how control measures can not only be more effective against the weed but also fit into sustainable agriculture systems and protect native vegetation.

The investment in weed research by the livestock industries (through the Australian Meat & Livestock Research and Development Corporation and the Wool Research and Development Fund) is directed largely to biological control measures. The grains industry on the other hand is concentrating on identifying new crop varieties that show enhanced resistance to herbicides already on the market to target weeds of the respective crops.

(c) <u>Advisory Services</u>

The network of advisory agronomists, noxious plant officers, chemical company representatives and others throughout Australia provides landholders with an abundance of good information on how to control weeds with the latest chemicals, biological agents and techniques. There are books (such as the Weed Control Handbook), leaflets (Agfacts), videos, computer programs and demonstrations to extend the latest technology.

What is needed now is for all those advisers to extend their thinking beyond the destruction of the weed and consider all the implications of the weed and the various control options for agriculture, the community and the environment. That information is not as well documented as the technical weed control data but it is within the advisers' capability to think laterally and consider the recommendations in the widest sense. This will be achieved by drawing on experience and by discussing the concept with other advisers in related disciplines.

Our advisory role must include education in its widest sense - school education to community education - and education is about communication. There needs to be communication between governments, the community and farmers and there needs to be a complete interaction in the planning and regulation process for weed control. We all need to appreciate the community's concerns about the use of chemicals in food and fibre production and we need to educate the community about agriculture's role in the national economy, natural resource management and the consumer's well being. The message that has to be transmitted to the market place is that sustainable agriculture is good practice; it is market oriented and it provides for the needs of the community and the environment. This is particularly important in relation to the strategies we adopt to control noxious plants.

CONCLUSION

Weed control is part of a whole farm planning and operational process. It will affect other farm operations and future options for land use. The problems of weed control have to be considered in the whole farm planning process so that management strategies are appropriate for the whole farm and the catchment.

There is a balance that needs to be struck between the impact of the weed, the effectiveness of the control measure and the impact of the control measure on other farm and catchment operations and resources. Sustainable agriculture can only be achieved when that balance is struck so that agriculture is profitable and natural resources are not degraded.

REFERENCES

Combellac, J.H. (1986). "Weed control pursuits in Australia". Abstract for Society of Chemical Industry Symposium, Belgrave Square, London.

Sloan, Cook and King Pty Ltd (1988). "The economic impact of pasture weeds, pests and diseases on the Australian wool industry." Report to the Australian Wool Corporation, Sydney.

RICE WEEDS

John Fowler
District Agronomist
Deniliquin

INTRODUCTION

Rice is an aquatic summer cereal crop of significant economic importance to the irrigation areas and districts of southern NSW.

A total of nearly 100,000 ha of rice is grown in the Murrumbidgee Irrigation Area (M.I.A.), the Coleambally Irrigation Area (C.I.A.) and the Murray Valley (M.V.) Irrigation Districts.

PART 1 - AN OVERVIEW OF WEEDS AFFECTING RICE

Rice weeds are usually divided into two categories: grass weeds, and broadleaf and sedge weeds. The relative importance of these two categories depends on several factors, particularly the method used to sow the rice crop.

The two main methods of rice sowing are: aerial sowing of pre-germinated seed into ponded water, and drill sowing into dry soil.

Drill sowing is further divided into two categories: combine sowing into a prepared seedbed, and sod-seeding direct into undisturbed soil (either pasture or rice stubble).

Generally, grass weeds are less vigorous and broadleaf weeds more abundant in aerial sown crops than in drill sown crops.

With drill sowing, grass weed populations are higher after combine sowing into a cultivated seedbed than after sod-seeding into undisturbed soil.

Grass Weeds

The most important grass weeds affecting rice are the barnyard grasses (*Echinochloa spp*). *Echinochloa crusgali* is by far the most common, but at least three other species, *E. colona*, *E. microstachya* and *E. oryzoides*, are also prevalent.

Barnyard grass is the most important weed because of its ability to cause yield reduction and because of the amount of money spent annually on its control. About 80% of rice crops are routinely sprayed for barnyard grass control.

Another grass weed of increasing importance is the indigenous species silvertop (*Diplachne fusca*), which is widespread throughout the rice growing areas. Silvertop is not as vigorous a competitor with rice as barnyard grass nor is it as prolific.

The perennial grass, watercouch (*Paspalum paspalodes*) can also form dense stands in rice crops and in supply and drainage channels. It is mainly of concern in sod-seeded crops.

Sedge and Broadleaf Weeds

The most important non-grass weed of rice is the annual sedge *Cyperus difformis*, commonly called 'Dirty Dora'. It is particularly suited to establishing itself in aerially sown crops. Unsprayed aerially sown crops are prone to invasion by populations as high as 5,000 plants per square metre.

The most widespread broadleaf aquatic weed found in rice is starfruit (*Damasonium minus*). This plant is less prevalent than Dirty Dora but, when present, competes strongly with rice seedlings.

The perennial *Cyperus eragrostis*, or umbrella sedge, is a weed of increasing importance, particularly in crops sod-sown into pasture. It normally builds up in the pasture phase of the rotation, and is only adequately controlled by cultivation. Seedlings can be successfully controlled by herbicides.

The main chemical applied for Dirty Dora control also controls starfruit and most other broadleaf and sedge weeds.

Other non-grass weeds in rice are: alisma *(Alisma lanceolatum)*, water plantain *(Alisma plantago-aquatica)*, dock *(Rumex spp)*, cumbungi *(Typha spp)*, arrowhead *(Sagittaria montevidensis)*, swamp lily *(Ottelia ovalifolia)*, spike rush *(Eliocharus spp)*, pinrush *(Juncus spp)*, nardoo *(Marselia drummondii)*, elodia *(Elodia spp)*, waterwort *(Elatine gratioloides)* and many others of minor consequence.

Changes in Weed Control

Prior to 1988, the control of sedge and broadleaf weeds in aerial sown crops was dependant on the use of M.C.P.A. Agronomically, this chemical had several distinct disadvantages:

I. it could not be applied until the mid-tillering stage of the rice, and even then it still caused some phytotoxicity.

II. this later than desired application of herbicide allowed significant weed competition to occur before the weeds were adequately controlled.

III. crop water levels had to be lowered for herbicide applications.

IV. spray drift was of concern in areas where broadleaf horticultural and summer crops were growing close to rice.

In 1988 a sulfonylurea herbicide, Londax® (bensulfuron methyl) became commercially available. This herbicide was used on about 75% of aerially sown crops in its first year of release, and about 98% in subsequent years. It has been a major contributor to the rise in popularity of aerial sowing to become the preferred establishment technique.

This herbicide overcomes the major disadvantages associated with M.C.P.A. use. It also has proven far more effective in the field, leaving crops almost entirely weed free.

Londax®'s spectrum of control is much wider than M.C.P.A.'s, giving good results on the major weeds, as well as controlling seedling cumbungi, pinrush, spike rush, dock, nardoo and possibly many others.

Future Concerns

While the advent of Londax® is perceived to have been a great success by ricegrowers, it could produce some undesirable effects.

The early and almost complete removal of broadleaf and sedge weeds, provides an opportunity for another, currently insignificant weed, to invade rice crops. This has not happened yet in the NSW rice industry, but has already been observed in California.

The second concern is possible development of weed resistance to herbicides. This has already been found when sulfonylurea herbicides have been used widely in other crop types (e.g. winter cereals). The selection pressure resulting from huge populations, particularly in the case of Dirty Dora, may lead to the development of resistant weed biotypes.

PART 2 - A WEED OF SPECIFIC CONCERN

Alisma (*Alisma lanceolatum*)

Alisma is an introduced, summer growing, perennial, aquatic plant. It is a native of southern Europe, where it is also a weed affecting rice crops.

It has been in Australia for over 50 years, occurring in isolated infestations in Victoria and South Australia.

It was first recorded in rice at Coleambally in 1983, but had been observed as early as 1980.

Sizeable infestations now occur in the C.I.A. and the Murray Valley, and it has been detected in one M.I.A. rice field.

Alisma has the ability to vigorously compete with rice, and there are currently no registered means of satisfactory in-crop control.

The Coleambally infestation has developed quickly, as shown by table one:

Year	Degree of Alisma detected
1983	Recorded in rice
1985	12 rice farms, two channels
1987	14 rice farms, four non-farm
1989	30 recorded infestations

Table 1. The spread of Alisma (*Alisma lanceolatum*) in the Coleambally Irrigation Area since 1983.

In the Coleambally Irrigation Area, Alisma is a serious rice weed. Open ponded water provides the stimulus for the germination of seed and for regrowth from the previous season's corms. Corm plants grow very rapidly, gaining a considerable size advantage over rice seedlings. This causes a substantial yield loss. The high intensity of irrigation (particularly of rice) in the C.I.A., plus the frequent movement of machinery between properties appear to be the main reasons for Alisma's proliferation.

The Murray Valley infestation is in the Deniboota Irrigation District, south-west of Deniliquin. It was first recorded in this area in 1985, primarily as a road and rail side infestation. There were also on-farm sightings, in a drainage channel and a stock dam. The weed presented few in-crop problems.

Since 1985 the Deniboota infestation has continued to spread along roadsides, particularly along stock routes. It has also been detected growing extensively in one Rural Lands Protection Board stock reserve, about 35 km south of the original 1985 site. The plant is believed to have been carried to the reserve by stock travelling from Victoria, where it is a common roadside weed in areas around Echuca.

Unlike Coleambally, the Deniboota infestation has not developed into a serious rice crop weed problem. The reasons for this are thought to be the more extensive nature of irrigation in this location, the practice of rotating rice crops each season, and the low level of movement of machinery from property to property. In this location travelling stock and road maintenance machinery are probably the main means of spreading the weed.

The widespread adoption of the herbicide Londax® in 1988 renewed concerns about Alisma. Londax® quickly removes all other sedge and aquatic broadleaf weeds. This provides an opportunity for Alisma seedlings to take over. Alisma is not controlled by this herbicide.

In response to this threat, the NSW Rice Industry has funded a spraying program in the Murray Valley to control all known road and rail side infestations. The Rural Lands Protection Board has also co-operated by spraying the major infestation on their travelling stock reserve. This program was commenced
in 1989, with the actual spraying being conducted by the Central Murray Weeds County Council.

Eradication is not considered a possibility, so the future of this off-farm program needs to be widely discussed. I believe the rice industry has acted very responsibly in reducing infestation levels to a minimum.

Efforts to date to have Alisma declared noxious in the Murray Valley have not been well received. The main argument against taking this course of action in the past has been the concern that it may prove to be counter-productive.

There is currently excellent land-holder co-operation with both the locating and the spraying of Alisma infestations. The declaration of Alisma as a noxious weed may lead to a lower level of farmer co-operation because of the associated legal requirements, and because of the stigma of having 'noxious weeds' on their property.

The time is right, however, to re-appraise the value of such a declaration.

The spread of Alisma in the C.I.A., and the crop damage associated with this, demonstrates that there is a need for action. The threat of damage from Alisma has greatly increased since the widespread adoption of Londax® herbicide.

Control is possible in non-crop situations and it will be a considerable benefit to the community if this weed can be prevented from spreading.

SEASONAL DIFFERENCES IN TOLERANCE OF GLYPHOSATE AND METSULFURON BY BITOU BUSH AND FOUR PLANT SPECIES INDIGENOUS TO COASTAL N.S.W.

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INTRODUCTION

John Toth previously reported the use of glyphosate and metsulfuron to control Bitou bush (*Chrysanthemoides monilifera* (L.) T Norl, subspecies *rotundata*) on sand dunes at several locations on the South Coast of NSW (Toth, 1989). The report also documented the herbicide tolerance of a group of seven native plant species which are important components of the invaded dune communities.

The experiments were undertaken to test the hypothesis that herbicides could selectively control Bitou bush in such plant communities. If this proves correct it will provide an environmentally acceptable, cost-effective means of controlling much of the extensive Bitou bush infestation along the eastern seaboard of NSW (Love, 1984).

Since that report we have continued experiments at Jervis Bay Nature Reserve using the rates of application of glyphosate (Roundup, 1:30) and metsulfuron (Brush-off[R], 1 g/L) which previously controlled Bitou bush when applied in the summer. Again the chemicals were sprayed onto the foliage of individual plants using an LPG powered handgun; however, the time of application was changed from summer to winter.

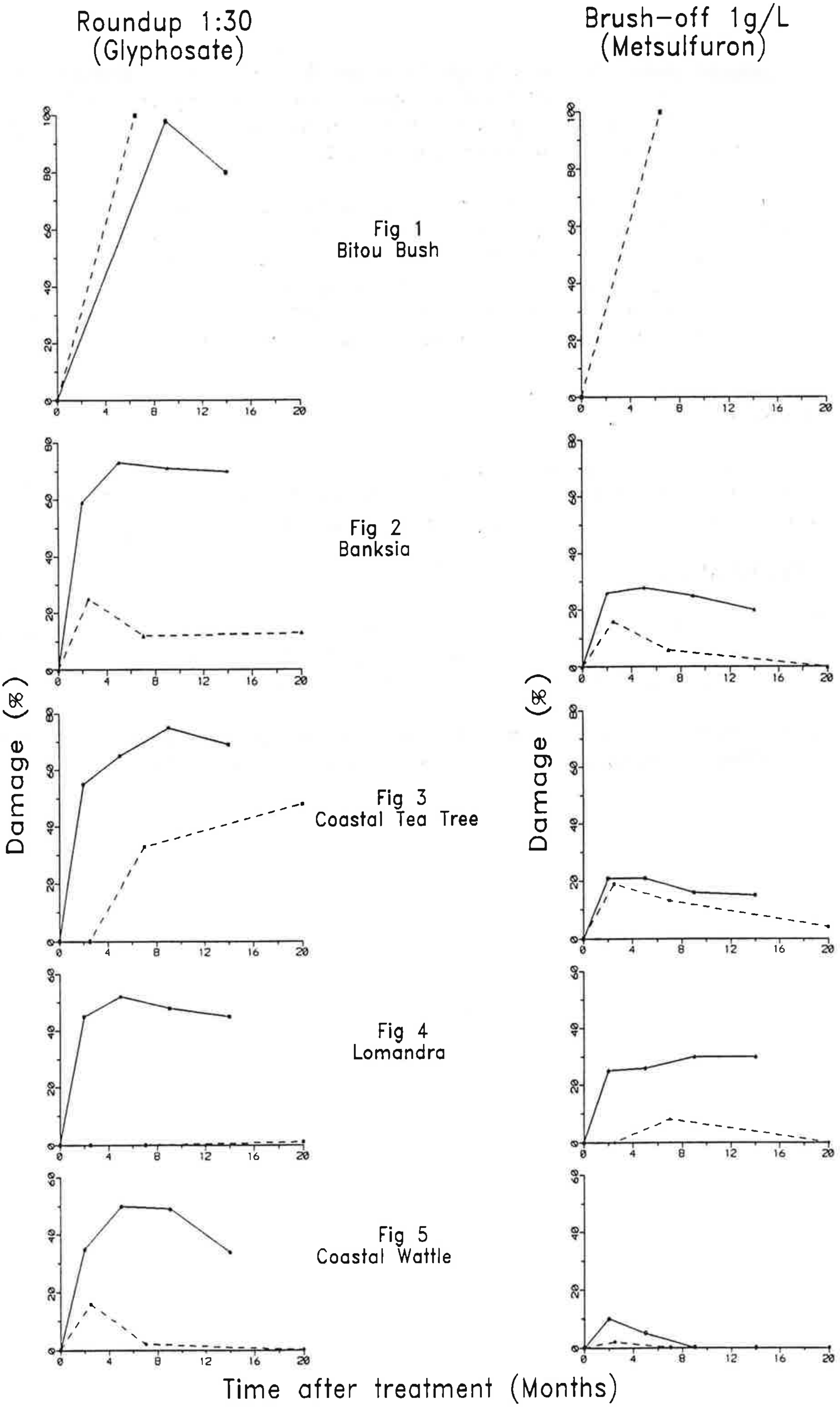
EXPERIMENTAL

The native plant species studied were Coastal Tea Tree (*Leptospermum laevigatum*), Coastal Wattle (*Acacia longifolia*), Banksia (*Banksia integrifolia*) and Lomandra (*Lomandra spp.*). Casurina (*Casurina glauca*), Coastal Heath (*Leucopogon lanceolata*) and Beard Heath (*Monotoca elliptica*), which had been examined in some previous experiments, were excluded because they occurred rarely on the site.

Herbicide damage was assessed by comparing the density and appearance of the foliage of treated and untreated plants. A score of 0% was given for 'no effect' and 100% for complete defoliation with no regrowth.

RESULTS AND DISCUSSION

The results confirm the large interspecific differences in herbicide tolerance reported previously, i.e., for both herbicides tolerances typically increase in the order: Bitou bush (Fig. 1) < Banksia (Fig. 2) ~ Coastal Tea Tree (Fig. 3) < Lomandra (Fig. 4) < Coastal Wattle (Fig. 5). Since biochemical tolerance of the two herbicides is unlikely to be so highly correlated, the correlation is presumably caused by physiological factors. This suggestion is supported, at least for the native species, by the fact that their tolerances rise and fall in concert between winter and summer.



Figures 1 to 5. **Foliar damage caused by summer (solid lines) and winter (dashed lines) herbicide treatments on different plant species.**

The seasonal differences in interspecific herbicide tolerance are also particularly interesting: the tolerance of the native species being much higher in winter, while that of Bitou bush is not (Figs. 1-5). This seasonal effect is of immense practical significance; however, it remains to be confirmed.

The data clearly support the hypothesis that selective chemical control of Bitou bush is possible using either glyphosate or metsulfuron. Furthermore, it appears that winter applications may prove more selective than those made in summer and that lower rates of application may be effective during winter. The optimal combination of these factors could reduce the damage to native species to environmentally acceptable levels, opening the way to aerial control of Bitou bush.

Acknowledgments

We thank Du Pont (Australia) Ltd. and Monsanto Australia Limited for supplying chemicals and the management of the Jervis Bay Nature Reserve. Without their support continuation of this program would be impossible.

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TOTAL CATCHMENT MANAGEMENT - COMMUNITY AND GOVERNMENT WORKING TOGETHER TO MANAGE OUR NATURAL RESOURCES

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INTRODUCTION

Total Catchment Management (TCM) has been operating informally in New South Wales for several years. The "Catchment Management Act 1989" gazetted on 7 March 1990 provides a formalised framework for implementing TCM policies.

BACKGROUND OF TCM

Under the Act, the Murray Darling Basin in New South Wales has been delineated into six inland catchments, these being;

- Murray
- Murrumbidgee
- Lachlan
- Central West
- North West
- Western (now split into two geographic areas).

Responsibility for these catchments have been allocated to respective Regional Catchment Management Committees.

The Act defines TCM as "the co-ordinated and sustainable use and management of land, water, vegetation and other natural resources on a water catchment basis so as to balance resource utilisation and conservation".

Regional TCM Committees have been given the tasks of:

- Co-ordinating TCM
- Achieving active community participation
- Identifying and rectifying natural resource degradation
- Promoting the sustainable use of natural resources
- Providing stable and productive soil, high quality water and protective and productive vegetation within our respective water catchments.

The Catchment Management Committee members have been selected to ensure that Community/Landholder representatives are in a majority. The Murrumbidgee Catchment Management Committee, for example, has nineteen members:

- 10 Community/Landholder representatives
- 6 Government Department representatives
- 2 Local Government representatives
- 1 Environmental interest representative.

The Regional Catchment Management Committees also have Sub-Committees and working groups established to identify problems and begin addressing these in a co-ordinated manner.

CO-ORDINATION

One of the key performance areas for TCM is the co-ordination of natural resource management within our respective valleys.

It is becoming evident that generally there tends to be limited co-ordination and uniformity of purpose within natural resource management activities. This has led to inefficiencies in resource allocation, excessive expenditure, duplication of effort and conflicts across territorial boundaries rather than co-operation towards common goals.

NOXIOUS PLANT MANAGEMENT AND TCM

This situation applies somewhat to noxious plant management. In the Murrumbidgee Valley there are at least five Government agencies, several Rural Land Protection Boards and over thirty Local Councils with responsibilities relating to aspects of noxious plant management.

Research undertaken for the Murrumbidgee Catchment shows that the noxious plants issue concerned more people within the valley than for any other natural resource issue. Of the four regions, namely:

- Headwaters
- Tablelands
- Slopes
- Riverine plains

noxious plants rated 1, 6, 2 and 2 respectively for the issues of most concern to the community. (McNamara, R et al, 1990).

McNamara, et al (1990) suggest that current noxious plant management practices in the Murrumbidgee should continue, however, a collective strategy for specific areas would be appropriate.

STRATEGY DEVELOPMENT

A further requirement of each TCM Committee is the production of a regional vegetation management strategy. This strategy will be a working document outlining specific actions, responsibilities and deadlines. For it to be effective though, it requires the active participation of all key government and community groups in their respective areas of management.

In the case of noxious plants, a co-ordinated, co-operative approach (ie a collective strategy for specific areas would seem to be a cost effective, efficient means of delineating responsibility, identifying common goals and through joint venturing achieve these goals. Planned packages of linked projects would also appear to be a means of attracting increased funding from sources such as Natural Resources Management Strategy and National Soil Conservation Program.

CONCLUSION

The keys in any natural resource management issue and in this case, noxious plant management, is the co-ordination and co-operation, and resource, technology and information exchange.

TCM is not about to enforce co-ordination or actions, rather we would encourage facilitating the production of regional and local noxious plants strategies which should ideally be incorporated as part of a regional vegetation management strategy and ultimately a regional catchment management strategy.

REFERENCE

McNamara R, et al (1991) Catchment Management Issues in the Murrumbidgee Drainage Basin, NSW Government Printer pp 15-19.

PASTURE WEED CONTROL

Michael Keys
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What is a weed? The term, purely from a human or landholders perspective, denotes a plant that is "out of place" and has undesirable qualities. These include burrs, extremely low nutritional value (serrated tussock), the presence of poisonous substances and so on. In reality, however, a weed is a plant very much in its place i.e. it is well adapted to the prevailing environment and so flourishes.

1. REPLACE WEEDS WITH A COMPETITIVE PASTURE

This is the crux of pasture weed control. There is no point in simply removing a weed (by whatever means) and then doing nothing. Unless the land management is changed and the weed species is replaced by a competitive but useful pasture species there will be nothing to prevent its reinvasion.

2. START CONTROL WHEN THE PROBLEM IS SMALL

Decide what undesirable weeds (or that there are very few of) and be relentless in their control. This is best done by chipping but needs to be a 365 day a year job. This is no big deal, costs little, does not take a huge amount of time but it does mean one has to make a commitment and be prepared to carry out control measures through the normal course of work on the property every day.

3. TACKLE NOXIOUS WEEDS / 'ECONOMIC' WEEDS FIRST

I had it put to me recently that when owning a property the problem is always having enough time or money to do all the things you know should be done. Successful farm managers however, select targets which either cause the greatest economic loss or produce the greatest return from dollars spent. Now dollars are in quite short supply due to the recession, we must be mindful of this and try to recommend control measures as a good farm manager would.

Two examples: The first involves a small property near Braidwood that, after the 1982 drought was severely overrun with 6-8' high scotch thistle. The owner had just purchased the property and after 12 months the wool from his crossbred sheep was sold at auction and fetched a total of $1100. After the second year, however, despite very similar seasons, the same amount of wool cut per head a and price per kilo the equivalent of the previous year, his wool return was $1700 - a 55% increase. This was due solely to a lack of vegetable fault in his clip.

The old thistles had been slashed, the new rosettes sprayed with 1.5L/ha MCPA and the paddock fertilised. His total costs amounted to approximately $12/ha for spraying and herbicide in this first year of control. However, the pasture was not persistent and vigorous being based on ryegrass, and would not have controlled the thistle well in future years. In the third year part of the area was direct drilled to a fescue/phalaris pasture (at a considerably greater cost).

The second example involves the use of superphosphate to improve the vigour and carrying capacity of a pasture. At Sutton, near Queanbeyan, two paddocks having a phalaris subclover based pasture had seen no super for over ten years. Saffron thistle and barley grass were major weeds within the pasture and the very meagre and poorly growing clovers resulted in less and less lambs able to be finished before Christmas each year. The application of 375kg of superphosphate per ha over two years to this pasture resulted in an additional profit of $21.11/ha/annum from wool and fat lambs despite the fact that 17 of the 26 months received less than average rainfall..

4. METHODS OF WEED CONTROL IN PASTURES

Eradication should be the aim for noxious weeds whereas suppression may be satisfactory for less troublesome species. However, there are three main methods of control: -

i. chemical

ii. mechanical

iii. biological

4(i) Chemical Control Measures

Herbicides form an important method of control for noxious weeds but care needs to be taken that they are not the automatic first choice. The growing environmental lobby and general public awareness of chemicals generally (including herbicides) necessitates that thought be given to other methods or a combination of methods.

In choosing herbicides one should consider several factors:-

A. **Its hazard rating** - both to you the operator, the landholder, his family, his stock and to the environment generally.

B. **Residual effects.** Velpar R is extremely effective in controlling eucalypts and a number of other woody weeds. However, even on gentle slopes and using the injection technique, I have seen runs up to five metres long where all pasture is killed and which persist for 18 months or more.

C. **Selectiveness.** The aim with regard to selectiveness is that it have the minimum effect on non-target species, especially the perennial grasses which are more difficult to establish then legumes, eg, when spraying serrated tussock use Frenock (selective) rather than Roundup (less effective on serrated tussock and kills all sown grasses.

Selectivity can also be obtained by the choice of the method fo application. Obviously spot spraying is somewhat selective but when general herbicides such as Roundup are used for spot spraying some killing of the adjacent pasture plants must occur.

An even more selective technique is the use of wiper-type equipment which achieves selectivity by smearing a concentrated solution of herbicide (usually Roundup) on to taller growing weed species while the well grazed pasture

WEED CONTROL PROGRAMS - COSTS AND OPERATION

P. McPherson
Noxious Weeds Inspector
Tumbarumba Shire Council

Mr Chairman, thank you for the invitation to address the 6th Biennial Noxiosu Plant Conference being held here at Leeton. For those people whom I have not met my name is Paul McPherson and I am employed as a Noxious Weeds Inspector with the Tumbarumba Shire Council. Just briefly Tumbarumba Shire is located on the western side of the Kosciusko range and is commonly referred to as the Western Gateway to the Snowy Mountains. This shire has an area of 437,967 hectares with a population of approximately 4,500 people.

The topic for my talk today is weed control programs, their cost and operation. I will endeavour to cover this topic under three main headings; A: the programs, B: the cost of these programs and C: how you instigate these programs to achieve the best results within the financial restraint placed upon us.

1. **Programs**

It is imperative that every Noxious Weed Inspector undertake an identification survey of noxious weeds within his area of jurisdiction. This survey will reveal the location of noxious weeds and the degree of infestation. Investigation should include all public and private land and land that comes under the control of other organisations e.g. Forestry. Having identified the type and location of the noxious weeds you then prepare a program of control and eradication. This program must be a long term project with the end result being the eradication of declared noxious weeds.

In order to have a day to day program a yearly program should be established to ensure that work goals are created and an achievable aim is predicted.

These programs are to be reviewed regularly as situations and the "course of direction" do change due to variables and outside influences.

A well organised program will ensure a "flow" rather than a disjointed approach to the problem of weed eradication. It enables the inspector to advise rural residents of his whereabouts and when he will be operating in their neighbourhood.

Designing a Program - How best to design a Program?

A program of work is established to ensure daily, weekly and monthly work pattern flows without undue delays, especially in the area of travelling. It outlines the direction the Council and the inspector are taking for the control of noxious weeds and enables those people who may wish to have private work undertaken to plan for the operation.

Designing a program is time consuming and can be complex. This is due mainly to the variables that exist e.g. weather and the outside influence that can be applied to a Noxious Weeds Inspector.

Items that require consideration in the preparation of a program

* The suitability of chemicals to achieve the best result - this topic is important and I understand that it will be covered by other speakers.

* The growing period of the noxious weed - this is self explanatory and will also be covered by another speaker.

* Weather conditions - this is an important consideration especially in the Shire of Tumbarumba as the winters are relatively severe and of long duration. There are however variations due to the topography of the shire. Some sections have a higher altitude than others and this does affect the growing period of the noxious weed.

* Maximum coverage of the shire - when designing a program you do not design just for public roads, reserves or Council owned land, but you must take into account the adjacent rural land. It is imperative that rural land owners or occupiers are aware of your program and know when you will be in the district. It is quite common for Council's Noxious Weeds Inspector to liaise with farmers and a joint eradiction program can be undertaken in one operation. The situation of Council inspectors undertaking of private works in conjunction with roadside reserve spraying is common practice and results in an organised method of eradication of noxious weeds.

* Utilisation of chemicals - it is advisable to select a chemical that has the ability to eradicate different types of noxious weeds. This saves both time and expense as different weeds can be covered during the initial run. Time is money and the greater the area covered in a period of time the more cost effective the program will be.

* Re-sprays - it is important that a three year program includes the re-spraying of previously sprayed land. It is unusual for an initial spray to achieve a 100% result. With this in mind it is imperative that a re-spray program of previously sprayed land is incorporated in the overall and yearly plan. Total eradication is our objective, however it is questionable whether we will achieve this in the short term. Re-sprays are necessary as they ensure that the noxious weed is curtailed and the spread reduced to zero.

  It has been my practice to include the cost of a follow-up spray when quoting for private jobs. This is explained to the land owner and is generally accepted.

2. COSTING THE PROGRAM

With the increased demand being placed on State and Local Governments for cost effectiveness the Noxious Weeds Inspector now finds himself/herself burdened with this added responsibility. On the surface it may appear demanding, however with the aid of computers and accurate cost programs it is still achievable.

At the beginning of each financial year the proposed program of works are costed. This is vitally important as a yearly program needs to be obtainable both in site coverage and be within the financial budget.

To monitor the cost effectiveness of the program, Tumbarumba Shire Council produce a computer printout on a monthly basis. This program detailed below indicates:-

(a) the budgeted amount for each item for the year;

(b) the amount spent on the program to date;

(c) the overall percentage spent of the budget;

(d) includes a column for any remarks that may be required.

SHIRE OF TUMBARUMBA
WORKS COST REVIEW

PAGE:
DATE: 00/00/91

LEDGER NO.	DESCRIPTION	VOTE 1/1/91	COST TO DATE	% SPENT	REMARKS
	NOXIOUS WEEDS				
	Destruction				
	Administration Charges				
	Depot Expenses				
	Blackberry				
	Sweet briar				
	St John's wort				
	Tree of Heaven				
	Bathurst burr				
	Noogoora burr				
	Paterson's curse				
	Sundry expenses				
	Inspections private property				
	Training program				
	Publicity				
	Vacant Crown Land				
	Noxious Pest - Destruction				
	Legal Costs				
	SUB TOTAL				

This costing program will be initially produced to reflect the direction the eradication program will be initially produced to reflect the direction the eradication program will take e.g. if the Council's objective is to eradicate blackberry growth along the main entrance roads to town then the budget allocation for blackberries would reflect this direction.

For the program to be accurate and hence successful, the inspector must be aware how the system works and allocate time and money spent correctly. At Tumbarumba Shire this is achieved by the allocating of time worked and chemicals sprayed to particular job numbers. These figures are processed on a fortnightly basis and an accurate, up to date costing is readily available.

Advantages of this system

* It enable the inspector to establish if he is operating within the confines of the financial allocation to the control of noxious weeds i.e. his/her budget.

* The inspector can determine if the work undertaken is in accordance with the eradication program.

* It enables the inspectors and supervisors to reflect on the works undertaken to date and what direction has been taken.

* It assists in the updating or amending of the existing program.

* The system can be used as a basis for formulating policies on the eradication of noxious weeds, by this we mean it is easy to determine how much a particular program will cost.

* It can assist the inspector and supervisor to determine if the method currently used to eradicate noxious weeds is cost efficient.

OPERATION OF THE PROGRAM

Once a program is established and costed the operation of that program is the responsibility of the Noxious Weeds Inspector.

To ensure the satisfactory implementation of a program the inspector must have:-

* a detailed knowledge of:-

  - the noxious weeds that need to be eradicated;

  - the types of chemicals that must be used to achieve the best results;

  - safety factors that need to be adhered to.

* reliable equipment that is capable of being used for long periods without breakdowns.

* a knowledge of the area and terrain that is likely to be encountered. Note: This should have been established during the initial survey of the district.

* the ability to make a decision on site.

* the ability to work without being constantly supervised.

a) Timing of the Program

As we are all aware the timing of a noxious weed eradication program is critical. Generally speaking spraying is undertaken at a time when the best results are achieved. This is not always possible and the following are a few factors that can affect the timing of a program.

* Growth patterns of Noxious Weeds - in Tumbarumba Shire we experience great differences in climatic conditions for various parts of the shire. In some districts the growing pattern may vary by as much as two months from one district to the next e.g. alpine areas to the flat country.

* Travelling Stock - These do affect a program of roadside spraying and must be taken into account when designing a program. We are lucky in that legislation has been introduced to ensure landowners do get approval from local authorities via Government departments for permission to have travelling stock on a road reserve.

b) Financial Constraints

The amount of money available will certainly dictate the extent of the program to be undertaken. It would be foolhardy for an inspector and supervisor to design or attempt to implement a program without the financial backing that may be required. In these times of economic hardship, Councils and Government departments are finding it increasingly difficult to obtain finance for programs that you all here would deem important and necessary.

Another area that is of major concern to Council is the situation where State and Local Governments operate on a different financial period. I am sure all of you have had to complete the returns required by the department would agree with this point and the problems it causes.

It is imperative that inspectors be involved in the financial management of their portfolio. The inspector must be aware of the allocation of funds and monies to be expended on each individual item as designated in the costing program. By being aware of these figures the inspector can implement a program that is within the constraints of the financial year's allocation.

c) Adjacent Land Usage

It is important for the inspector to have respect for the different types of rural pursuits that may be undertaken adjacent to road reserves. An example of these includes; vineyards, orchards and the like. Whilst no harm from spray drift may occur on these properties it is policitically sensible to avoid these areas during the delicate period of their growth.

d) Road Programs

It is important in organising a program that the road program is obtained from the engineering department to ascertain when major works are contemplated.

Outside Influences

There are outside influences that do affect the operation of a works program. These influences are normally variable influences and are ones that are not known at the time of forming the program.

If a Noxious Weeds Inspector is efficent and effective in the control of noxious plants within his jurisdiction, then private works on rural holdings will flow on. It is impossible to fully plan for these programs as they are normally requested and expected to be completed within a short period of time. This harps back to previous points that have been raised by advising the rural owners of your proposed location and then it may be that private works programs may then be corporated into your existing works program. It will mean an amendment to the program, however if sufficient time is allowed these alterations are possible without affecting the overall eradication program.

Another example of outside influences would be the presence of grasshoppers. Grasshoppers have not been a major problem in this shire, however I understand that other shiresw may have had difficulty in grasshoppers affecting their spraying program.

In conclusion I would just like to say that a weed control program, cost and operation of such is detailed and complicated, but it must be one that is undertaken by the inspector in conjunction with his supervisors. The program should have two major parts, being a three year plan and a twelve month plan. These programs will detail and highlight the direction the council chooses to go in the control and eradication of noxious weeds. These programs should include costings for each program and the method of operation and achieving the objectives as set out in the plan. It is accepted that these programs will be changed from time to time due to political interference or re-assessing the initial program. Whatever the case I cannot emphasise too strongly the importance of being organised, know where you are going, what you are doing and what it is going to cost the Council. Thank you for your time Mr Chairman and guests.

RURAL LAND PROTECTION BOARDS AND NOXIOUS PLANT CONTROL

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When I was asked to talk at this Conference I was not informed that I would be required to prepare a paper for the conference which would be published with the Conference Proceedings. After getting over the initial shock I realised that there would be present several highly qualified experts in noxious plants, so decided I had better consult the Oxford Dictionary to make sure the eminent people would not sit back and chuckle and think this poor old ranger is really a bit of a dill. Noxious plants! What really do they mean? Well, according to the Oxford it comes from the Latin word NOXA, meaning harmful, unwholesome, weed. At this stage I checked Oxford again for weed and discovered possibly why so many eminent people are involved in this field. Oxford for weed: Herbaceous plant growing where it is not wanted (erch) tobacco: (sl) marijuana. Interesting I thought, this research is getting better. Plant: living organism capable of feeding wholly on inorganic organs of sessation or digestion, member of the vegetable kingdom. After these interesting revelations I thought maybe I should devote more of my time to noxious plants.

Rural Lands Protection Boards throughout the State have Travelling Stock Reserves and Stock Routes under their control. These parcels of land are Crown land, owned by the Crown and administered by the Boards. Under the Crown Lands Act and the Rural Lands Protection Board Act Boards have the responsibility to 'take measures to control and eradicate noxious plants', Section 81(1) part D. This section clearly states the Board's responsibility. In most or all Boards these Reserves and Stock Routes are scattered over a very large area taking in three, four or more Shire districts. Wagga Wagga Board for example has 180 odd reserves stretched out from Barmedman in the north to 10 kilometres south of Mangoplah, a distance of about 160 kilometres. There are also of course reserves and stock routes stretched on either side of this line in about a 100 kilometre east west direction. Looking at this type of situation it does not take much imagination to realise Boards have a very big task facing them each year. Programs are formulated by the Board Ranger or Rangers to carry out noxious plant control measures. Like noxious plants, the methods of control and eradication varies from Board to Board. From enquiries I have made throughout the State during the past few weeks, certain noxious plants in one district may be treated like the plague and every possible effort is made to completely rid the district of the offending plant, whereas another district may very well choose to live with the plant and only do enough control work to keep people, the Shire or Council Inspector happy. I believe this is a human nature problem and the finger cannot be pointed at any one person or authorised body.

How do Boards fund noxious plant control? I can assure you with great difficulty. Boards have a very big drain placed on their Reserves Improvement Fund annually and with constant rising costs a very large slice of this fund is eaten away each year. I think it would be fair to say that we receive little or no assistance from the New South Wales Government by way of a grant or subsidy except in circumstances where a weed such as parthenium weed is discovered. By making this statement I may well raise a few hackles but it is a free country and we can have our say. Drovers and travelling stock have for years been blamed for spreading noxious plants throughout the country. I have had reservations about this and over the years ahead when there will be less and less stock walking the roads and routes I wonder will the spread of noxious plants subside? I don't think so. Vehicles, machinery and carted goods on trucks will spread noxious plants far wider and more rapidly than stock ever did.

To summarise, Boards have a responsibility to control noxious plants on stock routes and reserves. Board rangers generally enjoy a good relationship with Shire and Council Weed Inspectors in an endeavour to carry out control measures which coordinate with the Shire and Councils' programs. It is my belief through observation made in many areas that Rural Land Protection Boards, Shire Councils and County Councils carry out a good and worthwhile noxious plant control and eradication program. I also believe that a far greater effort can be made by individual landholders to carry out work on noxious plants. Too often do we see reserves and roads being sprayed with herbicides and over the fence on private property no control measures are being carried out at all. It's no wonder the reserves and roads become reinfested in the following years and will continue to become reinfested as long as there is a problem over the fence.

WEEDS SECTION AND THE DIVISION OF PLANT INDUSTRIES' NEW STRUCTURE AND OPERATIONAL PROCEDURES

Leon W. Smith
Principal Agronomist (Weeds)
SYDNEY

Changes in the environment in which organisations operate require changes in their structure and/or operational procedures to ensure they remain relevant, efficient and effective. In the case of the Division of Plant Industries, changes during the 1980s included regionalisation, a substantial change in the attitude of the community to environmental matters and particularly the use of pesticides in food production and soil degradation, a considerable tightening of the Department's budget, increased expectations from the farming community, and increased accountability to Government for the funds allocated.

However there is still considerable improvement required in the integration of our research, advisory and regulatory activities. In this era of smaller Government and hence tighter budgets, we cannot afford to have barriers between these three main aspects of our responsibilities. While the Department and the Division have made substantial progress towards integration, we still have a way to go before we can say we're all pulling in the same direction and making the most effective use of our resources.

KEY FEATURES OF CHANGE

The two key features of the changes are:

* to develop working parties of front line officers, convened by Principals, which have the role of developing the broad, statewide strategic direction of research, advisory and regulatory programs, and their integration;

* the formation of four branches to coordinate the programs developed by the working parties.

The structure is outlined in Figure 1. The four branches are Resource Management, Field Crops & Pastures, Horticulture, and Regulatory.

FIGURE 1

BRANCH	RESOURCE MANAGEMENT	FIELD CROPS & PASTURES	HORTICULTURE	REGULATORY
WORKING PARTIES	SOILS	GRAINS	PERENNIAL	EXPORT INSPECTION
	WATER	FIBRES, OILS	VEGES/ORNAMENTAL	QUARANTINE
	AG. SYSTEMS & ROTATIONS	PASTURES/ RANGELANDS		STATE ACTS
	RESOURCE INFORMATION	WEEDS		
		PLANT MULT.		

PROJECT TEAMS, TASK FORCES, INDUSTRY LIAISON COMMITTEES, REGIONAL WORKING GROUPS ETC. PROVIDE INPUT ON ISSUES, INDUSTRY CONCERNS TO THE APPROPRIATE WORKING PARTY.

WORKING PARTIES

The working parties will be composed very largely of front line research, extension and regulatory officers, and will be convened (mostly) by a Principal. They will also have officers from other Divisions and Institutes where appropriate, to provide direct links into the other disciplinary areas of the Department, and ensure that their perspectives are considered by the working party.

The role of the working parties will be to:-

* develop the broad, statewide directions for the Division's research, advisory and regulatory programs in their area of responsibility;

* ensure the integration of all aspects of the programs, especially between research, advisory and regulatory.

Membership will rotate, with a term being something between two and three years.

People nominated to the working parties will not be representative of any particular group i.e. they will not be representing the views of the district agronomists in Region 5, or the views of the researchers at Tamworth ARC for example, nor will they represent particular commodities.

We are asking people to bring a very broad perspective to the working party, to think ahead to the needs and opportunities of all the industries or resource areas which are the responsibility of the working group, and work out how the Department should respond to assist the development of those industries. We want people to think laterally, and well ahead, so that the Division can adopt proactive programs.

We also ask those on the working parties to consult widely in their network of contacts, and to extend their networks, to ensure they bring a broad, balanced and far-sighted perspective to the working party. We want their advisory, or research, or regulatory perspective, not a narrow, excessively representational or dogmatic view of the issues.

PROJECT TEAMS

It is not the intention for the Division to "take over" the development of project teams in the Department. They will remain almost entirely a Regional responsibility. However it is important to outline how they fit in with this new structure and method of operation of the Division.

Project teams, task forces, regional working groups or parties, industry liaison committees etc. should consider detailed technical issues and ensure regional coordination of programs, and develop local industry liaison. They will continue to be formed and managed at the initiative of regional people.

OVERALL

This new structure and method of operations for the Division is intended to achieve:-

- * direct input into Divisional policies and programs by front line officers;
- * better integration of research, advisory and regulatory aspects of Divisional programs;
- * greater advisory input into research programs and vice versa;
- * better overall management of Divisional programs and evaluation of outcomes;
- * substantial downward delegation of authority.

FIELD CROPS & PASTURES BRANCH

Weeds Working Party

Convenor	**Leon Smith**
Members	**Andrew Leys**
	Dick Medd
	Neil Griffiths
	Dick Gammie (to be replaced)
	Hugh Milvain

Weeds Strategic Plan

Objective

Develop and have adopted, improved integrated methods of weed management.

Strategies

Implement research/advisory programs which increase understanding/ adoption of:

- integrated weed management techniques including use of rotations and grazing.
- weed management under reduced tillage.
- optimum usage of herbicides.
- herbicide resistance.
- biological control techniques for economically and ecologically significant weeds.
- population dynamics/ecology of weed species.

Weed Section Advisory Program Plans 1991/92

1. Noxious Plant Control Programs using TCM principles

    Objective

    To encourage councils and public authorities to undertake noxious plant control management strategies using TCM principles wherever possible.

2. Urban Weeds

    Objective

    To liaise and cooperate with urban (metropolitan) councils and other environmental groups to foster awareness of weeds and related human health problems and to offer advice on control techniques.

3. Noxious Weeds - Noxious Weed Legislation

    Objectives

    To arrange educational and training programs for local government, public authorities and others regarding proposed legislation (the Noxious Weeds Act).

4. Weed Management in Crops/Pasture Rotations

    Objective

    To encourage producers to adopt sustainable rotations and weed management practices (in crop/pasture systems rotations for their area) including strategies to avoid herbicide resistance.

5. Adoption of Minimum Tillage (Conservation Tillage)

    Objective

    To facilitate greater adoption by producers of information on herbicide use in relation to minimum tillage (fallows).

6. Integrated Management of Weeds in Permanent Pastures and Rangelands

    Objective

    To promote integrated management as a sustainable weed control method involving the use of herbicides, fertilisers, pastures, biological control agents and grazing livestock.

7. Optimising Herbicide Use

    Objective

    To encourage producers and growers (all users of herbicides) to understand the need for the improved efficiency of herbicide usage and reduction through the integrated approach. To adopt practices which optimise herbicide use.

8. Biological Control of Weeds

    Objective

    To have growers and general public understand the principles, potential and limitations of classical, inundative and augmentative biological control.

AVCA ACCREDITATION PROGRAM SUMMARY

Leonie Day
AVCA
SYDNEY

PERSONNEL ACCREDITATION

Industry personnel are eligible for accreditation if they handle, sell, recommend, advise or take responsibility for the safety of farm chemical products which are classified as Dangerous Goods.

The accreditation of industry personnel is achieved as a result of the following:

- successful completion of the Accreditation Training Course;
- at least one year of experience in the farm chemical industry; and
- a formal commitment of compliance with the obligations relating to Accreditation which are outlined in the AVCA Code of Conduct.

The Accreditation Training Course

AVCA's Accreditation Training Course is managed by an independent Management Board. The Board contains nominees from the following organisations:

- The Agricultural and Veterinary Chemicals Council;
- Worksafe Australia;
- Federal Bureau of Consumer Affairs;
- Chemicals Assessment Section of the Department of Arts, Sport, the Environment, Tourism and Territories;
- Queensland Rural Industry Training Council;
- SA TAFE;
- NSW TAFE;
- NSW TAFE;
- Sydney University, Faculty of Agriculture;
- NSW Dangerous Goods Inspectorate;
- WA Dangerous Goods Inspectorate;
- NSW State Pollution Control Commission;
- NFF; and
- AVCA.

The Course Management Board is responsible for course standards (maintained by the control of assessment standards and processes), overseeing the modes of course delivery, and the course content and quality.

Courses are available from a number of organisations, which include:

- Universities;
- TAFE Colleges;
- Independent course providers; and
- Training Departments of farm chemical companies.

The course can also be completed by private study or correspondence. The standards are maintained by focussing on the course assessment rather than by constraining the method of course delivery. However, course providers are required to be appropriately trained.

PREMISES ACCREDITATION

This part of the Accreditation Program proposes the accreditation of premises at which potentially hazardous farm chemicals are handled or sold. Storage premises will be required to comply with relevant Federal and/or State regulatory requirements outlined for the purpose in the "Industry Standard for the Safe Transport, Handling and Storage of Potentially Hazardous Farm Chemicals". Staff in these premises will be required to become accredited if they handle, advise or sell the potentially hazardous farm chemicals.

The Accreditation Program applies to all manufacturing, warehouse or retail premises which store and/or handle farm chemicals in quantities which require licensing or registration by the relevant authorities for the storage of dangerous goods in the State or Territory where the premises are located;

These quantities vary from State to State and over time within each State, according to variations in the regulations. Information regarding current licensing/registration quantities for all States is available from the AVCA Secretariat.

By linking accreditation of premises to the regulations AVCA is maintaining a program based on existing legal requirements. Consequently, the farm chemical industry and retail outlets are being required only, essentially, to observe the law. The training and accreditation of personnel will ensure that staff are able to observe the law by being acquainted with regulations and proper safety practices.

ACCREDITATION TARGET DATES

June 30, 1991	In all States **except** Queensland, 30% of staff to be accredited in all storage premises targeted by the Accreditation Program.
December 31, 1991	Queensland to meet the above target.
December 31, 1992	All eligible storage premises to be accredited by self-assessment, using the checklist contained in the Appendix of the Industry Standard and 75% of eligible staff to be accredited.
December 31, 1994	All eligible storage premises to be accredited by independent assessment and 100% of eligible staff (those who handle, advise or sell farm chemicals in companies with storage premises targeted by the premises accreditation program) to be accredited, except for staff working under direct supervision of an accredited person.

SANCTIONS

The AVCA Code of Conduct contains the following:

> **"Under an authorisation granted by the Trade Practices Commission, personnel and premises accredited by AVCA must refuse to supply and/or decline to purchase from organisations which do not have personnel and/or premises appropriately accredited".**

Accredited premises and/or personnel who do not comply with the AVCA Code of Conduct or other conditions of the Accreditation Program will have their accreditation status intially suspended and finally withdrawn, if the non-compliance is not satisfactorily corrected.

In the event of any organisation, which is deemed to require accreditation, being found to be in breach of the Code of Conduct or the conditions of the accreditation scheme, prior to sanctions being imposed, the following sequence of events will be set in train.

- AVCA will write to the organisation involved seeking a written undertaking to both correct the breach and ensure its non-repetition. A response, to correct the breach, will be required within 14 days;
- In the absence of a satisfactory response within 14 days, AVCA will request the organisation to show cause why it should not be subjected to denial or suspension of its accreditation until the breach is corrected;
- In the absence of a satisfactory reason why the accreditation should not be denied or suspended, and if the breach continues, denial or suspension will be introduced, subject to the appeal provisions (see below);
- In the event of either a further breach (where accreditation has previously been granted) or a continuation of an existing breach, the organisation will be advised that, unless non-compliance is immediately rectified, its accreditation will be withdrawn;
- If the organisation is also a member of AVCA, denial or withdrawal of premises accreditation would simultaneously result in loss of AVCA membership;
- AVCA is required to inform its membership and all accredited organisations of such denial or withdrawal of accreditation status or membership status within 7 days of denial or withdrawal;
- AVCA will inform all interested or affected organisations (should an organisation, at some later date, correct a breach and hence comply with the conditions of accreditation) of the reinstatement of accreditation or compliance with accreditation.

APPEALS PROVISIONS

AVCA proposes the following procedures for handling complaints:

Conditions for an Appeal

(1) Any AVCA member, accredited person, accredited premises, or person or

premises seeking accreditation when advised in writing of denial, suspension or withdrawal of membership of the Association or of accredited status may appeal against this determination, within 14 days of receiving notification;

(2) Any organisation or individual (**regardless of its accreditation or membership status**) may take action through the appeals process if AVCA fails to act in dealing with non-compliance with either the Code of Conduct or the conditions of the accreditation program by any accredited organisation, accredited person or AVCA member. AVCA is to provide evidence that it has dealt with the issue of non-compliance within 14 days.

Mechanism of the Appeal

The appeal shall firstly be lodged with the AVCA Accreditation Manager who shall immediately inform members of the Accreditation Committee of the existence and nature of the appeal. The Accreditation Committee and the Accreditation Manager shall seek a suitable resolution to the problem.

If a solution acceptable to both parties is not found within 14 days of receipt of the appeal, the appeal will be referred to the Board of AVCA. The appeal shall be lodged in writing with the Executive Director of AVCA, who must immediately inform the Directors of AVCA of the existence and the nature of the complaint.

The Directors of AVCA and the Executive Director shall be obliged to seek a suitable resolution to the problem.

If a solution suitable to both parties is not found within 14 days, the appeal will be lodged with the Industry Conciliator.

The Conciliator will determine the manner in which the appeal will be considered, for example:

- Hearings in the capital city of the State in which the dispute occurs;
- On-site inspection of storage premises;
- Telephone conferences; or
- Exchange of submissions, documents and information by facsimile and mail.

Subject to the conditions of the Accreditation Program, the Conciliator shall determine his own procedures.

Parties shall not be allowed legal representation before the Conciliator. The complainant and the other party to the dispute may appear personally or be represented by an employee.

The parties will be required to agree that:

- Everything which occurs before the Conciliator shall be in confidence and in closed session;
- The discussions are without prejudice;
- No documents created for the purpose of the conciliation process may be called into evidence in later litigation by either party.

The conciliator shall:

- Act fairly, in good faith and without bias and shall treat matters brought before him in confidence;
- Give each party the opportunity of adequately stating his case;
- Ensure that relevant documents used by the Conciliator are disclosed to the parties to the dispute, subject to their acquiescence;
- Make appropriate recommendations for resolution of the disputes between the parties.

The parties shall report back to the Conciliator on actions taken on the Conciliator's recommendation within a period of time determined by the Conciliator.

The Conciliator shall deal with matters referred to him as expeditiously as possible but not later than 14 days after the matter has been referred to him.

Appointment of the Conciliator

AVCA proposes to appoint an independent Conciliator to serve for a term to be set by the Accreditation Committee. The Conciliator will be a person of recognised integrity and stature who will command respect from all sectors of the industry. During the term of office, the Conciliator shall be neither an officer, director, employee nor hold any pecuniary interest in the farm chemical industry that could conflict with the proper performance of his or her functions. The Conciliator shall be required to disclose the interest prior to appointment and to disclose any subsequent acquisitions to the President of AVCA.

Role of the Conciliator

The Conciliator's role is to facilitate constructive discussion between the parties on the causes of a dispute and, if possible, to assist the parties in reaching agreement on a mutually acceptable solution. In the event of a mutually acceptable solution to the dispute not being found, the Conciliator shall resolve whether there has, or has not, been a breach of the conditions of Accreditation and whether Accreditation status should be restored or withheld.

Cost of Appeal

The cost of an appeal which involves the use of the Conciliator shall be shared equally by the parties involved.

PROPOSED INSPECTION PROCEDURES FOR PREMISES ACCREDITATION

AVCA proposes to recruit approximately thirty part-time self-employed assessors who are based throughout the States of Australia. The work of these assessors will be coordinated by a Supervisor of Assessors who will be based in the Accreditation Section of the AVCA Secretariat. The assessors will be people with considerable experience in the farm chemical industry and will, therefore, be conversant with all aspects of handling farm chemicals. Prior to commencing assessment work, they will be given comprehensive training on assessment techniques.

During 1991/92 work in Accreditation will focus on expanding the current self-assessment checklist (contained in the Industry Standard) into a checklist suitable for on-site inspection. The purpose of this checklist will be twofold; firstly, it will be designed to comprehensively check all storage and handling regulatory requirements and, secondly, it will be designed to minimise personal variation in judgment of situations.

MECHANISM FOR INSPECTION OF PREMISES IN ORGANISATIONS WHICH ARE NOT MEMBERS OF AVCA

AVCA anticipates that organisations which are not members of AVCA will usually cooperate in this endeavour to raise safety standards through regulatory compliance and that their storage premises will be inspected in the same manner as those of AVCA members. However, in the event of an organisation declining AVCA's invitation to join the Accreditation Program and refusing permission for on-site premises inspection, the following actions are proposed:

- AVCA will request that the organisation provides a statement or certificate which has been issued in the previous six months by an appropriately authorised inspector of dangerous goods, that premises meet the requirements of licensing;

- Such a document, indicating compliance with regulations, together with proof that staff meet appropriate training requirements, would indicate that the premises comply with the conditions of premises accreditation;

- Should the site be in breach of relevant regulations, AVCA would impose the proposed sanctions in the manner outlined above.

THE DEVELOPMENT OF STRATEGIES FOR MINIMISING RESISTANCE IN CHEMICALS USED TO COMBAT NOXIOUS AND RECREATIONAL WEEDS

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SUMMARY

Herbicide resistance represents a major threat to the long-term use of chemicals to control weeds but it is a problem that can and should be avoidable. The key to maintaining effective weed control and minimising the development of resistance is to use all the methods of control and to rely on chemical methods only when no alternatives exist. When considering chemical control all possible opportunities should be taken to rotate the available herbicides that can be used against a particular weed to minimise the chance of resistance development. The use of non-selective herbicides (Glyphosate and Paraquat) and other herbicides not associated with the development of resistance (2,4D) or mixes is also recommended. Methods of developing strategies are also discussed.

INTRODUCTION

One of the many threats facing the long-term use of herbicides for the control of weeds is the development of resistance to herbicides. It becomes one more factor the modern, environmentally aware, weed control official must take into account when deciding on strategies for controlling the weeds growing on the public areas and farms of New South Wales. Also the risk must be taken into account when giving advice about control to others. Yet of all the challenges facing weed control in this decade resistance is the one most authorities agree is avoidable. Simple steps taken before resistance develops should ensure that the problem does not occur.

This paper briefly outlines the history of resistance in the world and Australia, describes the problem, discusses strategies to minimise the problem and suggests ways to help to stop the development of the problem.

HISTORY OF RESISTANCE

Resistance in plants has been slower to develop than resistance in insects or other pests. Indeed in the 1970's it was popularly believed that resistance would not develop in plants. Yet within a few years resistance had developed mostly along rights of way, orchards and monoherbicide monocultures of maize.

There are now some 90 - 100 species of plants in the world that have developed resistance to herbicides. By far the majority of these cases are plants resistant to the triazine group of herbicides which includes the herbicides Atrazine and Simazine widely used along roadsides and for industrial weed control as well as in pastures, broadacre and horticultural crops. Almost all resistance is due to site specific mutations that don't occur outside particular paddocks or roadways but over the years the problem has become widespread particularly in the United States and

Europe. In France and Germany it is estimated that over 2 million hectares now have resistant weeds.

Australia

In Australia the species that is demonstrating the most resistance is ryegrass (*Lolium rigidum*). Wild oats (*Avena* spp.) that are resistant to Hoegrass have also been confirmed in NSW, Victoria and Western Australia but so far only in isolated occurrences. Other species where resistance has occurred in Australia are barley grass (*Hordeum glaucium*) and capeweed (*Arctotheca calendula*), but these are extremely isolated cases.

PLANT RESISTANCE - METHODS, TYPES AND CASE HISTORIES

Methods of Resistance and its Development

It must be assumed that all species subjected to herbicides and other weed control methods will develop tolerance or resistance as the species and individuals best adapted to survive the control treatment become more abundant. For example, road graders select the low growing species best able to cope with their blade. But to be truly resistant a species must acquire an immunity to a particular rate of pesticide.

Basically two types of resistance exist:

a) Single Resistance. This type is where a plant or group of plants is no longer controlled by a particular herbicide at a particular rate that previously controlled the plant. The rate most commonly involved is the registered agricultural rate and it is common that plants acquire an immunity to 5-15 times the rate.

Single resistance is the most common type of resistance and the problem is usually overcome by selecting alternate weed control chemicals and strategies.

b) Cross Resistance. Is resistance where the development of resistance to one herbicide also confers resistance to other chemicals and chemical groups to which the species was not exposed. In the world this type of resistance is rare but it has developed commonly in Australia.

Usually cross resistance only confers resistance to other herbicides in the same chemical group (table 1) as the herbicide to which the resistance developed, but in extreme cases all herbicides can become inactive.

c) Selection and Mutations. It has yet to be confirmed whether mutations are more important than selection in the development of resistance. I suspect this will be an individual case by case matter. However an understanding of whether the resistance is natural within the population or is induced by a mutation will make a difference to the general strategy developed to combat further resistance in non resistant populations. If a mutation is required to start the resistance process, using light rates of herbicides will help to speeed that rate at which resistance develops. However once the mutation exists, or if it exists naturally, higher rates will select and establish the dominance of the resistant type more quickly.

Tolerance

Certain species exhibit increasing tolerance to particular herbicides. The weed wild radish was successfully controlled by 500-700 mls/ha of 2,4D in the 1960's but by 1990 2.0 l/ha is usually recommended against it and there is little control at 700 ml/ha.

What Herbicides are involved

All herbicides have the potential to select individual plants or groups of plants from a species that are not controlled by the herbicide. These plants are then called a biotype. However some herbicides are more likely to develop resistance than others. The herbicides with very narrow sites of activity like glyphosate are less likely to develop resistance as are the ones with many sites of activity like 2,4D. This is because resistance to these herbicide types is difficult to develop and resistant individuals are usually less competitive than the non resistant types. The herbicides that are deactivated by single enzyme systems in the plant such as the Aryloxyphenoxypropionates (AOPP e.g. Hoegrass) are the most likely to develop successful resistance mechanisms. However it is well to remember that glyphosate resistance has been developed at least in the laboratory and that 2,4D resistance exists in New Zealand.

The Use of Mixes

Mixes also offer the opportunity to lower the risk of the development of resistance to single groups or herbicides. This is particularly advantageous if products from distant chemical groups can be used in the mix.

A mix that may be used against many broadleaf weeds is Sulfometuron-methyl (Ally or Brushoff) and 2,4D or glyphosate. These come from different groups and may help to minimise the chance of resistance development. It may be wise to rotate the products in the mix.

The spread of resistance in Seed

This may represent a major problem in the future. There is always a risk of buying seed from resistant stands and spreading resistant biotypes onto untreated land. It is rumoured that many of the professional seed growers have resistant ryegrass after many years of spraying perennial grass crops but these rumours are hard to confirm.

CASE HISTORIES OF PROBLEMS

Three are considered.

Cross resistance of ryegrass to many herbicides on railway lines in Western Australia

In Western Australia about 5000 kilometres of railway line was treated annually for 10 years with an Amitrole and Atrazine mix for total weed control. Eventually this mix selected a cross resistant biotype of ryegrass that showed resistance to Amitrole and Atrizine and all other herbicides in the groups from which the herbicides belong including Simazine. In addition many herbicides to which the population was never exposed were also found to be inactive against the biotype. These included all the

AOPP's, the Cyclohexanediones (e.g. Grap, Sertin), many Sulfonylureas (Glean, Logran) and the Phenylurea including the commonly used herbicide Diuron.

The railways reaction was to change away from Amitrole and Atrazine to mixes of glyphosate and sulfometuron-methyl (Ally or Brushoff) but to continue with continuous use of the same mix. This is not desirable in preventing further resistance development.

This case is also significant because it highlights the care that must be taken to avoid unintended consequences of spraying. If this biotype escapes from the rail reserve it can infest much of the crop land of Western Australia and practically render useless every herbicide used to control ryegrass in crop.

<u>Barley Grass and Capeweed resistance to Paraquat and Diquat.</u>

Near Ararat in Victoria a stand of lucerne that has been continuously sprayed with the Bipyridyle herbicides Paraquat (Gramoxone) and Diquat (Reglone) now has barley grass and capeweed resistant to these chemicals. In this case other herbicides like Fluazafop-butyl (Fusilade) and Diuron are available to control the weed so the resistance has been of little consequence except to the grower.

<u>Nodding Thistle Resistance to Phenoxy Acids</u>

In New Zealand a biotype of the weed nodding thistle, *Carduus nutans*, has developed resistance to the herbicide MCPA and also tolerant to 2,4D and MCPB. This is the first time in the 40 year use of these types of herbicides that resistance to this group has occurred.

STRATEGIES FOR OVERCOMING RESISTANCE

To minimise resistance use must be made of all available control methods rather than relying on a single method. Excessive reliance on herbicides must also be avoided. Indeed the rule should be that when you find a good chemical try to use others.

Specific strategies have been developed for only one species in NSW but as resistance develops and becomes widespread there will be a need to develop more. The Agricultural and Veterinary Chemicals Association of Australia (AVCA) has developed guidelines which outline how such a strategy may be developed. This publication should be consulted if a resistance problem is encountered or a strategy to minimise the development of resistance is being developed.

A Case history - Ryegrass in cropping soils

The most common plant to display acquired resistance in Australia is ryegrass. Around 300-600 cases of resistance have been reported in the last three years mostly from the wheat belt of southern Australia. The resistance is usually related to continuous use of the product Diclofop-methyl (Hoegrass) and other herbicides from the AOPP group of herbicides. Many ryegrass stands show resistance to herbicides from other groups of herbicides by cross resistance. The resistance seems to occur naturally in most plant populations and it is assumed that some resistant individuals exist in the majority of populations in Australia and will become the dominant type if sufficient herbicide is applied.

A strategy was thus needed to check the development of the resistance biotype and to help farmers overcome the problem once it develops. A committee of workers from industry and Government departments was set up to draft a strategy. This was presented for review to AVCA and others with an interest in resistance management. The strategy for southern NSW is divided into three parts.

a) **Pasture Strategy to minimise resistance**

On the Tablelands it is unlikely that herbicides will be used continuously because cropping is not practiced extensively. Therefore the likelihood of selection of herbicide resistant ryegrass is low. The use of all herbicides in whatever combination should result in little selection of ryegrass that is resistant to herbicides.

In pastures on the slopes of southern NSW there is a risk that ryegrass resistant to herbicides will be selected and this selection will interfere with cropping operations on the farm. This would particularly be the case if grass-free farming methods become popular. The strategy involves using herbicides that are not usually associated with resistance in pasture. The herbicides that have the greatest effect upon controlling the grasses are saved until they are of most use which is usually just prior to cropping. The use of the AOPP herbicides is also avoided in pasture if possible or associated with other techniques that will help control any resistant species that may survive the use of the AOPP.

b) **Crop strategy to minimise resistance**

The strategy for farmers who don't have resistance is to rotate both the crops and the herbicides to give a high yielding, high returning, sequence with minimum chemical use. Where chemicals are used a range of herbicides from a variety of chemical groups are selected for use in each crop. An example of this strategy is summarised in Table II which illustrates a number of commonly recommended, high yielding rotations in southern NSW and gives recommendations about herbicide use and cultivation methods.

Another important factor in minimising resistance development in crop rotations is to shorten the length of the rotation thus reducing the selection pressure to select resistance biotypes. As a guideline 5-7 years should be a maximum. Many farmers using good rotations and direct drilling are cropping for periods longer than this and they will have to be made aware of the risk of continuing this practice.

c) **Strategy for farmers with resistance**

The strategy for those with a resistance problem is to confirm its existence by observation, recording, discussion and full laboratory testing. Then to return the area to pasture as quickly as possible. If an opportunity can be taken to destroy seed of the resistant grass by burning or topping this is desirable.

The pasture paddocks should then be managed to avoid flowering and seeding of ryegrass using heavy spring grazing, mowing and chemical topping. After some years it may be appropriate to commence a short crop rotation after fallowing. In this crop rotation use should be made of the chemicals that were confirmed as having activity after the testing carried out to confirm the problem's existence.

TABLE I. THE CHEMICAL GROUPS OF COMMONLY USED HERBICIDES

1.	**Aromatic**		
	glyphosate	-	Roundup
2.	**Sulfonylureas**		
	chlorsulfuron	-	Glean
	triasulfuron	-	Logran
	sulfometuron-methyl	-	Ally or Brushoff
3.	**Triazines**		
	simazine	-	Many
	metribuzin	-	Sencor/Lexone
	cyanzine	-	Bladex
4.	**Phenoxy Acid**		
	2,4-D	-	Many
	MCPA	-	"
	MCPB	-	"
5.	**Phenylureas**		
	diuron	-	Many
6.	**Aryloxyphenoxypropionate**		
	diclofop-methyl	-	Hoegrass
	fluazifop-butyl	-	Fusilade
	fenoxaprop-ethyl	-	Puma
	haloxyfop-methyl	-	Verdict
	quizalafop-ethyl	-	Assure
	propaquizafop-ethyl	-	Correct
7.	**Cyclohexanediones**		
	sethoxydim	-	Sertin
	tralkoxydim	-	Grasp
8.	**Bipyridyle**		
	paraquat	-	Gramoxone
	paraquat/diquat	-	Sprayseed
	diaquat	-	Reglone
9.	**Dinitroanilines**		
	trifluralin	-	Many
	oryzalin/trifluralin	-	Yield
	pendimethalin	-	Stomp
10.	**Thiolcarbamates**		
	triallate	-	Avadex BW

* Consider chemicals from group 6 and 7 as the same as they act on the plant in a very similar manner.

TABLE II. A STRATEGY TO MINIMISE THE DEVELOPMENT OF RYEGRASS TO HERBICIDE IN CROP IN SOUTHERN NSW

Situation	Preferred Strategy and chemical used	Other Strategy or Comment
1. Year prior to cropping	Spraytop or mow. Chemical fallow in Aug.	Winter pasture clean with AOPP.
2. 1st crop	Use as alternative to wheat. Preference Canola then lupins or field peas. Use minimum tillage. Herbicide choice Trifluralin.	Wheat after pasture cleaning or fallowing. Oats following cleaning or fallow.
3. 2nd crop	Direct drilled or minimum tillage wheat. Herbicide choice Hoegrass or Glean. Nitrogen if necessary.	Lupins.
4. a) 3rd crop Finish the rotation	Undersown direct drilled cereal and no herbicide.	
b) 3rd crop in a continuing rotation (1)	Minimum tilled (lupins) Herbicide choice Simazine or Simazine + Trifluralin.	
5. 4th crop Continue from 4 b) 2.	Direct drilled wheat Hoegrass or Glean.	

NB. These are abbreviated tables meant as examples only. For full information consult the original tables.

RELEVANCE OF THE STRATEGY

This strategy shows

a) The importance of using all methods of control. This should be put into practice in the development of strategies in all situations.

b) The necessity of defining all constraints and the other needs of a strategy before the development of weed control strategies. Don't just develop a strategy to minimise resistance by itself and don't just consult authorities in the field of resistance in strategy development. For instance if the alterntive to a commonly used herbicide is unsuitable on environmental or cost grounds it may not be possible to use in the rotation. If necessary employ the services of independent experts or the Department of Agriculture to develop specific strategies.

CONCLUSION

All professional weed managers need to take account of the problem of resistance when attempting to control plants or giving advice on control to others. It is unfortunate that many chemical users and advisers continue to persist in using the same product year after year rather than taking advantage of the range of products and control methods that may be available to them for the control of weeds.

However the threat of resistance is real enough to make the development of an integrated control package a priority for the management of most weed systems. Developing these packages should not be delayed until resistance develops to specific weeds but should be a regular part of the practice and advice given by a professional weed manager.

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THE WEEVIL *NEOCHETINA BRUCHI*: A NEW BIOLOGICAL CONTROL AGENT IN THE BATTLE AGAINST WATER HYACINTH

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THE WEED

Water hyacinth *Eichhornia crassipes* (Mart.) Solms) is a freshwater aquatic plant native to South America. Commencing in the 1880s it was spread by man throughout the tropics and subtropics and is now regarded as the world's worst aquatic weed (Holm *et al*, 1977). The weed reached Australia in about 1894 and by 1900 was well established in Queensland and New South Wales. (Anon. 1901). As elsewhere, problems caused in Australia include choking of water-bodies, increased water loss, degradation of water quality, harbouring of disease vectors and physical damage to property during floods.

Water hyacinth sets viable seed and also reproduces vegetatively. Populations can therefore quickly re-establish following droughts, floods and "eradication" by herbicide treatments. With a plant doubling time as low as 7-10 days, a rapid return to the original infestation size is common (Forno and Wright 1981).

CONTROL METHODS

From the early 1900s, chemical and mechanical methods were used to control water hyacinth. The development of 2,4-D in the 1940s provided an effective and widely used herbicide which was far safer than some used previously, such as sodium arsenite, (Pieterse 1978). However herbicides have come under intense public scrutiny through fears of damage to health and the environment. In the 1970s and 1980s several countries wishing to achieve long-term control of water hyacinth without associated environmental dangers commenced research into biological control programs of the weed.

The United States Department of Agriculture (USDA) initiated research on biological control of water hyacinth in the late 1960s, and by the early 1970s were concentrating the program's research effort on two weevils, *Neochetina eichhorniae* and *N. bruchi*, and a moth *Sameodes albicuttalis* (Center 1982). CSIRO commenced research into biological control of water hyacinth in the early 1970s. Information available at the time suggested *N. eichhorniae* and *S. albiguttalis* should be given highest priority for Australian research and releases commenced in 1975 and 1977 respectively. Liberations of the insects and monitoring of their effects continued until 1985 when the program was terminated due to lack of resources. Although the insects had proved to be safe and valuable control agents, there were still many sites where there had made little or no impact on infestations or where better control was desired.

IMPORTANCE OF *N. BRUCHI*

During the 1980s results in the USA and the Sudan suggested there was a greater impact on the weed when both weevil species were present than when either was present alone. In central Florida, examples of water hyacinth being effectively controlled by the weevils appeared in canals where treatment with herbicide had ceased (T.D. Center, USDA, personal communication). In the Sudan the weevils prevented the annual buildup of water hyacinth behind the Jebel Aulia Dam near Khartoum where for many years a floating mat of over 100 km² used to collect (Beshir and Bennett 1985). In Louisiana the weevils reduced the total water hyacinth infestation by an estimated 800,000 acres (Goyer and Stark 1981, 1984; Cofrancesco *et al* 1985).

Besides such evidence which strongly indicated *N. bruchi* would complement existing agents of water hyacinth in Australia, results from Houston, Texas (Cofranco 1984) and Bangalore, India (Jayanth 1987), showed *N. bruchi* by itself could also control the weed. Houston and New Orleans have climates matching the cooler regions of the weed's distribution in Australia and where improved levels of biological control are required (Wright and Stegeman 1990).

Support for recommencing the biocontrol program on water hyacinth and the introduction of *N. bruchi* to Australia was given by the Australian Centre for International Agricultural Research. As part of this program, *N. bruchi* would also be introduced to Thailand, and the effects of the insect in both countries monitored. In August 1989 the CSIRO Division of Entomology in Brisbane obtained adult *N. bruchi* from the USDA Aquatic Weeds Laboratory in Fort Lauderdale, Florida for importation into quarantine.

Following successful completion of host specificity testing, approval for liberation in Australia was granted in September 1991 by the Australian Quarantine Inspection Service (AQIS) follwing approval by state and federal agriculture and conservation authorities. Mass rearing commenced immediately at the CSIRO Long Pocket Laboratories in Brisbane and starter colonies were provided to the NSW Agriculture & Fisheries Research and Advisory Station in Grafton and the Queensland Department of Lands Tropical Weeds Research Station at Charters Towers.

First liberations of a very limited number of adults occurred in December 1990 and were performed by student members of the Double Helix Club at seven infestations between Townsville and Sydney. Most of the liberations of *N. bruchi* in Australia are expected to occur in the summers of 1991/92 and 1992/93. Stocks of the insects have already been supplied by CSIRO to both Thailand and Malaysia and additional overseas shipments are anticipated.

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BIOLOGICAL CONTROL OF BROOM (*Cytisus scoparius*)

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INTRODUCTION

Cytisus scoparius (L.) Link ssp. *scoparius* (*Sarothamnus scoparius*) is commonly called broom, Scotch broom and English broom in Australia. This species occurs in all states of Australia (Parsons 1973). Broom is a major weed problem in the Barrington Tops region of NSW where it covers c. 10,000 hectares (Waterhouse 1988), mostly in State Forests and the Barrington Tops National Park. Broom is also a problem in other areas of New South Wales as well as in Victoria (Parsons 1973), South Australia (Adelaide Hills) and Tasmania (mainly conservation areas). Overseas, broom is a weed in New Zealand, U.S.A., Canada, South Africa and India.

Broom is native to Europe where it has a wide distribution, occurring from Ireland to west central Ukraine and from southern Sweden to southern Spain. Plants are common in areas such as the western side of London, the Massif Central of France and a number of alpine areas in Spain (areas of the Pyrenees, Picos de Europa, mountains north west of Soria and mountains in the south west of Spain). Broom does not like calcareous soils or shaded areas. It is readily grazed by sheep and can be controlled by them but is not controlled by cattle.

In Australia, *Cytisus scoparius* is often confused with *Genista monspessulana* (L.) L. Johnson (Montpellier broom). The latter species appears to have a wider distribution but has not become as great a problem as *C. scoparius* at the Barrington Tops.

INSECTS, MITES AND DISEASES OF BROOM IN EUROPE

Many species of insects, mites and diseases are present on broom in Europe. Waloff (1968) records information on many of the insect species that occur on broom in the Silwood Park area to the west of London. There are many additional species that occur on broom in other areas of its range. Some of species only occur on broom while others mainly occur on other members of the same plant tribe as *C. scoparius*, that is the tribe Genisteae. This tribe includes *Cytisus*, *Genista*, *Chamaecytisus* and *Ulex* although there is still considerable debate as to the relationship between species in this tribe (Bisby 1981).

In the past, a number of insect species have been considered for biological control and some of the more promising species have already been used as biological control agents in the U.S.A.

AMERICAN PROGRAM

In the U.S.A. broom infested some 100,000 hectares in California by 1960 (Frick 1964) and was also a problem in Oregon and Washington.

The U.S.A. carried out a broom biological control program from 1951 to the late 1960s. Two insects were introduced to the U.S.A. but the impact of the agents is not well documented. The main aim of the biological control program was to control broom in California. The program ceased, in part, because of increasing concern over the value of woody legumes as ornamental or landscape plants (Andres 1979).

While the program was in operation two insects were released for biological control of broom. These insects were released following host specificity tests (tests to determine the host range of biological control agents). The first insect to be released was a twig mining moth, *Leucoptera spartifoliella* Hübner. This moth was found to be already present in California at the time of release of *L. spartifoliella* from France. One area where *L. spartifoliella* was already present was Marin County, California. This area had been surveyed for broom insects around 1957 and *L. spartifoliella* had not been found at that time (Hawkes 1963). The second insect to be released was a seed feeding weevil, *Apion fuscirostre* (Fabricius). Both species established but according to Julien (1987) both have negligible impact. A number of other insects of European origin, largely restricted to broom and related species, have also been accidentally introduced to the U.S.A. and Canada. These include a seed feeding bruchid, *Bruchidius villosus* Fabricius (Bottimer 1968) (= *B. ater*); a psyllid, *Arytainilla spartiophila* Foerster; a membracid, *Gargara genistae* Fabricius and three mirid species, *Asciodema obsoletum* Fieber, *Orthotylus concolor* (Kirschbaum) and *O. virescens* (Douglas and Scott) (Waloff and Richards 1977).

NEW ZEALAND PROGRAM

Broom is a major weed problem in New Zealand. A National Water and Soil Conservation Organisation report (1979) estimated that broom was present on 173,516 hectares of the South Island and 14,447 hectares of the North Island. Broom has continued to spread since these figures were compiled.

New Zealand began a broom biological control program in 1981 but concentrated efforts commenced in 1984. This program is continuing. C.I.B.C. (CAB International Institute of Biological Control) at Silwood Park in England is carrying out initial host specificity testing on a number of insect species for New Zealand. Further testing is carried out in New Zealand by D.S.I.R. (Department of Scientific and Industrial Research). If insects are sufficiently specific they are released and their impact evaluated.

A few European broom insects have been tested in Europe and in New Zealand for host specificity. The first species to be tested was a leaf feeding beetle, *Gonioctena* (=*Phytodecta*) *olivacea* (Förster). This species could be reared on species other than broom including tagasaste (*Chamaecytisus palmensis* (Christ) Bisby & K. Nicholls) and lupins and adults fed on a wider range of leguminous plants (Syrett 1989). For these reasons this species was considered unsuitable for release. Another insect, a seed feeding bruchid, *B. villosus*, has been tested and found to be host specific and initial releases have been made (Syrett 1989). A further seed feeder, the weevil *A. fuscirostre*, was brought into quarantine in New Zealand but failed to oviposit. Attempts are still being made to adjust this insect to southern hemisphere seasons. As was the case in the U.S.A., *L. spartifoliella*, has been accidentally introduced to New Zealand. This moth was first recorded from Taupo (central North Island) in 1950. Mining caused by this moth can cause severe damage to broom (Scheele and Syrett 1987). The most abundant and effective parasite of *L. spartifoliella* in Britain is a eulophid wasp, *Tetrastichus evonymellae* (Bouché) (Waloff 1968). Levels of *T. evonymellae* parasitism, recorded in Britain, varied from 13.7% to 57.7% over a three year period (Waloff 1968). This wasp also parasitises *L. spartifoliella* in California (Frick 1964). No parasites of *L. spartifoliella* have been recorded in New Zealand and this moth is probably exerting greater pressure on its host in New Zealand than in Europe or in North America (Scheele and Syrett 1987).

Many of the insects that have been tested for New Zealand have been found to feed only on plants of the tribe Genistae. A major problem in New Zealand is that *C. palmensis* is a member of this tribe and is considered to be a beneficial species. A number of the insects being tested fed on *C. palmensis*. New Zealand has no native members of the tribe Genistae.

AUSTRALIAN PROGRAM

The first steps toward a broom biological control program began in 1987 (A. Yates personal communication). The Barrington Tops Broom Council was formed at this time and one of its charters was to stimulate the initiation of research into biological control of broom (Waterhouse 1988). As a result of Broom Council activity C.S.I.R.O. was asked to prepare a report on possible biological control of broom with some indication of the cost of the program. It was then decided that the project should commence with a study into the feasibility of biological control of broom. The biological control program became a joint NSW Agriculture & Fisheries and C.S.I.R.O. program with additional financial inputs from the Forestry Commission of New South Wales, National Parks and Wildlife Service (New South Wales) and a local landholder. The feasibility study commenced in February 1990. This study involved trips to New Zealand (three weeks) and Europe (three months) by the author. Following these trips a number of recommendations were made. Firstly that Australia should conduct a biological control program for broom and secondly that this program should be closely linked to the New Zealand program. These recommendations are being acted on at present. The program will increase funding to the C.I.B.C. program being carried out for New Zealand. In addition a recommendation was made that the broom twigminer, *L. spartifoliella*, be brought into quarantine in Canberra as soon as possible for host specificity testing with the hope that it can be released in the summer of 1991/1992. Checks of Australian insect collections and field collections of insects on broom in New South Wales and Tasmania did not indicate that *L. spartifoliella* has been accidentally introduced to Australia.

L. spartifoliella was imported into quarantine in December 1990. Two thousand pupae were sent to C.S.I.R.O. Canberra by staff of D.S.I.R., New Zealand. The insect has one generation per year and New Zealand material is in phase with Australian seasons. No parasites were found on material reared in quarantine at C.S.I.R.O. The twigminer is at present being tested for host specificity by Peter Hodge of NSW Agriculture & Fisheries under the supervision of Jim Cullen (C.S.I.R.O.). Fortunately the U.S.A. program carried out host specificity tests for this insect on a number of plant species (Parker 1964) so the amount of testing to be carried out in Canberra is reduced compared with insects not used as biological control agents elsewhere.

PROSPECTS FOR BROOM BIOLOGICAL CONTROL IN AUSTRALIA

In Europe broom appears to be less vigorous and not as long-lived as in Australia (J. Smith personal communication) although it is still a common plant in disturbed areas. It is not common in shaded areas. Unfortunately, areas of the Barrington Tops where broom occurs are in either open forest or grazing land, both areas where a lot of light reaches the ground.

Following biological control, broom should be less vigorous and broom stands less dense although the species will probably remain a common component of the vegetation on the Barrington Tops. Damage caused by biological control agents in Australia should be greater than occurs in Europe as parasites of the agents will be excluded in quarantine.

As mentioned earlier many of the potential biological control agents that occur on broom are specific to the tribe Genisteae. There are no Australian species in this tribe. Australia may run into the same problems as New Zealand as *C. palmensis* is also used as an agroforestry plant in Australia. If potential broom biological control agents that damage *C. palmensis* are excluded, only on the basis that they damage *C. palmensis*, then the potential for successfully controlling broom will be significantly reduced. There is a need to address this problem early in the program so that host specificity tests can be conducted with the knowledge that *C. palmensis* is either an allowable host or not. If *C. palmensis* is not an acceptable host then a rapid screening test based on agent development on *C. palmensis* can be developed. This species is more likely to be a host of potential agents than species more distantly related to broom.

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BIOLOGICAL CONTROL OF *CHRYSANTHEMOIDES MONILIFERA*

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INTRODUCTION

Chrysanthemoides monilifera ssp. *rotundata*, bitou bush, is a weed of South African origin. It currently infests coastal areas of southern Queensland, New South Wales and Lord Howe Island. In N.S.W. it is common in areas north of the Hunter River (Love 1985). Bitou bush was first recorded in Australia from Stockton near Newcastle in 1908. Another subspecies of *C. monilifera*, also of South African origin, ssp. *monilifera*, is known as boneseed. It occurs extensively throughout southern Australia and is present in coastal areas of N.S.W. as far north as Sydney. It is also present at Menindee Lakes near Broken Hill. Boneseed was first recorded in Victoria in 1858 (Gray 1976).

CHRYSANTHEMOIDES MONILIFERA IN N.S.W.

During the early 1950's bitou bush was used as a sand stabilising plant (Mort & Hewitt 1953) and to revegetate coastal areas mined for mineral sands (Barr 1965). The capacity of bitou bush to invade native vegetation had been recognised by the early 1970's and its recommendation for coastal planting was withdrawn. However, by 1976, Gray reported that bitou bush was naturalised along much of the N.S.W. coast. Boneseed occurs together with bitou bush south of Sydney and replaces it in southern N.S.W.

C. monilifera is a serious weed of conservation areas (Adair & Scott 1989). In invaded vegetation, plant diversity is reduced and structural alterations occur as native plants are displaced (Dodkin & Gilmore 1985). This displacement probably has a detrimental effect on native fauna (Dodkin & Gilmore 1985).

Aerial surveys of the N.S.W. coastline were conducted by the N.S.W. National Parks and Wildlife Service in 1981 and 1982. These indicated that *C. monilifera* was distributed along approximately 60% (645 km.) of the coast and was the dominant species along 230 km. Its range has expanded since these surveys and Love (1985) predicted that it could spread to occupy over 90% of the N.S.W. coastline by 2010 and that it would dominate the native vegetation along two thirds of the coastal fringe.

C. monilifera is largely an environmental weed as it is easily controlled by stock grazing and cultivation. It is primarily restricted to non-agricultural areas such as national parks, coastal dune ecosystems and other recreational land. In the past, physical and chemical control have been used to reduce infestations and limit spread of *C. monilifera*.

Physical control is usually carried out by volunteer groups such as National Parks Associations or the Soil Conservation Service's Community Dune Care Program. These groups mainly organise working parties to hand pull *C. monilifera* plants. The groups are particularly effective in controlling this weed in small areas of high conservation significance. Larger scale control using this method is not practical because it is too labour intensive. The possibility of removing *C. monilifera* in areas infested for many years is compounded by large soil seed banks. Weiss and Milton (1984) recorded a soil seed bank of 2030 seeds per m^2 near Moruya on the south coast of N.S.W.

Chemical control of *C. monilifera* is possible. However, various problems such as access to sites arise. The most effective method of application is the use of aerial spraying, but this is extremely costly. Cooney *et al.* (1982) evaluated the herbicide glyphosate (Roundup®) on *C. monilifera* infestations and found that it was effective on the target plant and gave acceptable levels of damage to native species in the same area. However, only five native species were tested in these trials. Unfortunately, as the large *C. monilifera* plants died, there was prolific growth of newly germinated seedlings. This necessitated re-treatment of infested areas. The probability is that re-spraying would need to be carried out regularly until the soil seed bank is exhausted or the surrounding native vegetation out-competes the emerging *C. monilifera* seedlings. Re-treatment on this scale would also be extremely costly.

BIOLOGICAL CONTROL

Biological control programs against *C. monilifera* commenced in 1987. Surveys in South Africa have indicated that there are in excess of 100 species of phytophagous insects associated with the *Chrysanthemoides* species complex (Scott & Adair 1990). Several of these appear to be potential biological control agents and preliminary studies have been conducted on these in South Africa. To date, five species of insects have been imported into Australia for host specificity testing. These are a geometrid moth, *Comostolopsis germana*, and four species of chrysomelid beetle, *Chrysolina* sp. aff. *progressa*, *C. picturata*, *C. oberprieleri* and *Ageniosa electoralis*. A further three species are considered specific enough to proceed with host specificity testing in Australia and import permits for these will be sought in the near future. These are another chrysomelid beetle, *Cassida* sp., a tortricid moth, *Tortrix* sp. and a tephritid fly, *Mesoclanis* sp.

Host specificity testing for *Chrysanthemoides* insects is being conducted at Keith Turnbull Research Institute (KTRI), Victoria. These tests so far have resulted in the release of two species, *C. germana* and *C.* sp. aff. *progressa*. The results of these releases are detailed below. *A. electoralis* is able to develop on a number of plant species and has been rejected as a possible biological control agent. The other two chrysomelid beetles which are at present in quarantine, *C. picturata* and *C. oberprieleri*, are undergoing testing and hopes are held for their release in mid and late 1991 respectively.

Of the two insects currently released in Australia *C. germana* has been the most successful. This species only develops on *Chrysanthemoides* spp. (Adair and Scott 1989). *C. germana* was released at three locations. The first release of 400 larvae and 160 adults was made at Hastings Point (N.S.W.) in March 1989. The second release of approximately 2600 pupae and 41 adults was made at Port Macquarie (N.S.W.) in December 1989/January 1990. A third release of approximately 3000 larvae was made at Arthurs Seat (Vic) in December 1989/January 1990. The only evidence of establishment is at the Port Macquarie site. Here the moth has spread up to 1 km from the original release point. Larval densities of up to 30 larvae per m^2 have been found. Detailed monitoring of this infestation is currently being carried out. The insect has not established at the other release sites. Further importations from Cape

Town (South Africa) have been made and more releases are planned for 1991. *C. germana* is still being mass-reared at KTRI and Alan Fletcher Research Station (AFRS), Queensland.

The second insect to be released, *C.* sp. aff. *progressa*, has been released at eight sites in southern N.S.W. (as far north as Jervis Bay) and Victoria. Around 80,000 eggs and adults have been released and some feeding damage has been observed. They continue to persist at the You Yang Range near Melbourne but there is no evidence of establishment. The larvae of this beetle appear to be particularly prone to predation by ants and spiders (Adair pers. comm) and this may limit their potential as biocontrol agents. The adults and larvae of *C.* sp. aff. *progressa* have a habit of dropping from the plant when disturbed and in some situations, especially on boneseed (an erect species), have difficulty regaining the host plant. It is hoped that *Cassida* sp. may overcome this problem. When disturbed this insect seems to hang on to plants more tightly. Mass-rearing of *C.* sp. aff. *progressa* is continuing at KTRI, AFRS and Tamworth Agricultural Research Centre and further releases are planned during 1991.

Biological control of *C. monilifera*, if successful, will reduce this weed to a minor component of the vegetation in the areas in which it occurs. However, it must be remembered that biological control will not eradicate *C. monilifera*.

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BIOLOGICAL CONTROL OF COMMON HELIOTROPE

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INTRODUCTION

There are over 40 current biological control of weeds projects in Australia (Cullen and Delfosse 1989). Most of these are classical/inoculative programs, where both the pest weed and its natural enemies are exotic (Wapshere *et al.* 1989). Many of these projects are collaborative ventures between Federal and State groups, and farmers are often active partners in the research.

One of these weeds is common heliotrope, *Heliotropium europaeum* L. (Boraginaceae), a summer-growing, annual Mediterranean species (Delfosse and Cullen 1981), which causes damage in excess of $46 million p.a. (Delfosse and Cullen, unpublished data). This paper summarizes the work on this project .

Since 1979 there has been extensive collaboration between CSIRO and relevant State Departments on this program. In particular, in 1988 a cooperative program of release, monitoring and evaluation of agents with CSIRO and the Western Australian Department of Agriculture (WADA) was started.

EARLY BIOLOGICAL CONTROL ACTIVITIES FOR COMMON HELIOTROPE

In 1971 the Australian Weeds Committee rated a small group of introduced plants as priority weeds for biological control. Among these was common heliotrope, a noxious weed in the same family as Paterson's curse, *Echium plantagineum* L., but, unlike *Echium*, a weed without friends.

This was not the first time that common heliotrope had been rated highly as a weed. In fact, in the 1950s CSIRO conducted surveys in Mediterranean Europe and North Africa to determine if there were any natural enemies of common heliotrope which had potential as biological control agent species. A few potential agent species were found. These and other candidate agent species were found during subsequent surveys conducted in the mid-1970s.

Host-specificity testing of the potential agent species began in the late 1970s. Three agent species have been tested (two of these have been released and release of the third is expected next year); testing for the fourth is in progress; and a rearing procedure has just been developed for the last agent species (Table 1). The five species found during the surveys which have greatest potential as biological control agent species for common heliotrope are discussed below.

Table 1. Biological control agents for common heliotrope, ***Heliotropium europaeum*** L. (Boraginaceae).

Scientific Name	Taxonomy	Common Name	Status
Longitarsus albineus (Foudras)	(Coleoptera: Chrysomelidae)	heliotrope flea beetle	Released, but not effective
Uromyces heliotropii Sredinski	(Uredinales: Pucciniaceae)	heliotrope rust	Released in summer 1990-91; establishment likely
Pachycerus cordiger Germar	(Coleoptera: Curculionidae)	heliotrope weevil	Testing completed, release application pending
Cercospora heliotropii-bocconi Scalia	(Hyphomycetes)	heliotrope leaf-blotch fungus	Testing underway at the CSIRO Biological Control Unit, Montpellier, France
Ethmia distigmatella (Erschoff)	(Lepidoptera: Ethmiidae)	heliotrope bud-feeding moth	Rearing system developed; testing started

POTENTIAL COMMON HELIOTROPE BIOLOGICAL CONTROL AGENT SPECIES

The heliotrope flea beetle, *Longitarsus albineus (Foudras) (Coleoptera: Chrysomelidae)*

The first agent for common heliotrope approved for release in Australia is a flea beetle, L. albineus. It is the most common and widespread of the natural enemies found on common heliotrope in its native range. Adults of this beetle feed on leaves of common heliotrope, creating small "shot holes"; the larvae (grubs) feed on the rootlets of the weed, and cause more damage than do adults.

The first field release of this species was made on 28 December 1979 near Jugiong, New South Wales. Recoveries were made at the release site the following season (indicating that *L. albineus* successfully overwintered in the field). However, the three-year drought that began in 1980 produced very little common heliotrope in the field, and it is likely that the beetle died out for lack of food. Further releases were made in 1981 near Jugiong, Urana and Corowa, New South Wales, and again small numbers were found the following season, and it appeared that the beetle would become established. Unfortunately, the following season was also a poor common heliotrope year, and there were no more recoveries at release sites (Delfosse 1985).

The flea beetle did not become established after these extensive efforts, so further large releases were made in 1986 and 1987 in New South Wales and Victoria, and in 1989 in cooperation with WADA. Though recoveries have been made at eastern sites, results have been disappointing. Further European and Australian ecological studies of soil type, fertility and plant growth are underway to try to explain the insect's unexpected poor performance.

The heliotrope rust fungus, Uromyces heliotropii Sredinski (Uredinales: Pucciniaceae)

U. heliotropii is the most promising of all the known potential agent species for common heliotrope. It is extremely damaging to common heliotrope, causing death of the plant and massive reduction of seeding (Hasan 1985). The infective stages of the rust are wind-borne spores. Infection by the spores sets up a disease in common heliotrope which causes it to die prematurely, thus preventing or lessening seed production.

A six-year host-specificity testing program for *U. heliotropii* was completed in late 1988. The rust was imported to quarantine in Canberra in March 1990.

This was the first time that quarantine and wildlife officials allowed importation of a fungus for biological control before permission for its release had been given, and was possible because of the highly-sophisticated CSIRO High Security Quarantine Facility in Canberra. The rust was mass-cultured under strict quarantine conditions until January 1991, when approval for its release was given.

The first two releases of *U. heliotropii* were made on farms near Jugiong, New South Wales (on 18 January) and near Gnowangerup, Western Australia (on 22 January), in cooperation with WADA.

By mid-April, the rust had moved naturally to new plants at the Jugiong site, > 20 m from the point of release, and had killed one of the inoculated plants. Hundreds of plants in the area of release are very heavily infected, with many leaves bearing hundreds of sori. The fungus appears to be developing less well at the Gnowangerup site due to less favorable conditions after release, but many plants are heavily infected. Thus, chances for establishment of *U. heliotropii* are very good, and research on its establishment, spread and efficacy have begun.

The heliotrope weevil, *Pachycerus cordiger Germar (Coleoptera: Curculionidae)*

Adults of *P. cordiger* feed on leaves of common heliotrope, creating large, oval, holes. Larvae (grubs) feed in the crown of the plant, and, like the flea beetle, cause more damage to common heliotrope than do adults.

It was very difficult to assess its host-specificity: it attacks a wide range of Boraginaceae under cage conditions (Huber and Vayssieres 1990), but distinguishes between different *Heliotropium* spp. in the field. Testing of Australian native Boraginaceae under field conditions in Europe, the first time this was done in an Australian program, resulted in a decision to apply for its release. It was imported to quarantine in Australia in Canberra in February 1987 and is currently being mass-reared.

The heliotrope bud-feeding moth, *Ethmia distigmatella* (Erschoff) (Lepidoptera: Ethmiidae).

Permission has been received to import *E. distigmatella* to quarantine for host-specificity testing. Larvae (caterpillars) of this species feed on buds of common heliotrope, and thus have potential to reduce seeding directly. Adults of the moth do not feed.

Three collections of this species were made in Turkey in late summer 1988-9. This material was heavily parasitized, and insufficient material was found to develop a rearing colony.

A new colony was thus collected earlier in the season in Turkey in 1990, and sent to quarantine in Canberra. A successful rearing procedure has been developed. If the colony can be continued, which appears likely, host-specificity testing will begin in quarantine in Canberra in April 1991. This is expected to take about three years.

The heliotrope leaf-blotch fungus, *Cercospora heliotropii-bocconi Scalia (Hyphomycetes)*

Another promising potential agent is a common heliotrope leaf-blotch disease, caused by *C. heliotropii-bocconi*. Host-specificity testing for this species began at the CSIRO Biological Control Unit in Montpellier, France, in late 1988, and is expected to take several years.

A recent discovery of major significance (S. Hasan, personalcommunication, 1989) is that this fungus appears to kill seeds produced on the plant and after they drop to the soil. If this is confirmed, this would be the only agent species which kills dropped seeds.

DISCUSSION AND CONCLUSIONS

The unreliable, almost ephemeral occurrence of common heliotrope from season-to-season and from paddock-to-paddock suggests that it would be a difficult target for classical biological control with arthropods. This is illustrated by the disappointing performance of *L. albineus.*

However, prospects for successful biological control of common heliotrope remain high, because the natural enemies discussed above attack the plant at all stages of growth, are very damaging, and have the capacity to build up large numbers quickly.

It is clear that it will take several years more basic research before the impact of the agent species can be determined.

This will include release and evaluation of all agent species if found to be safe for release, and possibly, additional surveys. For example, species are known from the home range of the weed (particularly in North Africa) which need to be studied in more detail. Some of these may be tested in the future to determine if they are safe to release and have potential to damage significantly common heliotrope.

Bringing a weed under control is ultimately a matter of reducing its density and/or size, which is a function of the population processes of reproduction and survival, either of whole plants or its component modules. Management of insect pests usually involves research on their population ecology, but this is not necessarily true for weeds. The extent to which this is seen as a valuable basis for management programs is increasing, and particularly so in biological control, but considerably more development is needed. It is to be hoped that the knowledge being gained in some biological control projects might influence the wider acceptance of this approach.

There is currently an increased demand for biological control of pests. While this trend is to be encouraged, some caution must also be exercised. Biological control is not a panacea. It cannot be used in all situations. However, society cannot afford not to exploit biological and integrated control, using natural enemies as the lynchpins, to the maximum. This requires a solid ecological foundation, and the ability to conduct proactive rather than retroactive programs.

ACKNOWLEDGMENTS

Due to severe shortages in central funding, biological control of common heliotrope would not be possible without generous support from the Australian Meat and Live-stock Research and Development Corporation. The generous assistance by landowners and managers at research sites, and officers of local Shire Councils, Departments of Agriculture and similar bodies is gratefully acknowledged.

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PARTHENIUM WEED IN THE CASTLEREAGH MACQUARIE COUNTY COUNCIL DISTRICT

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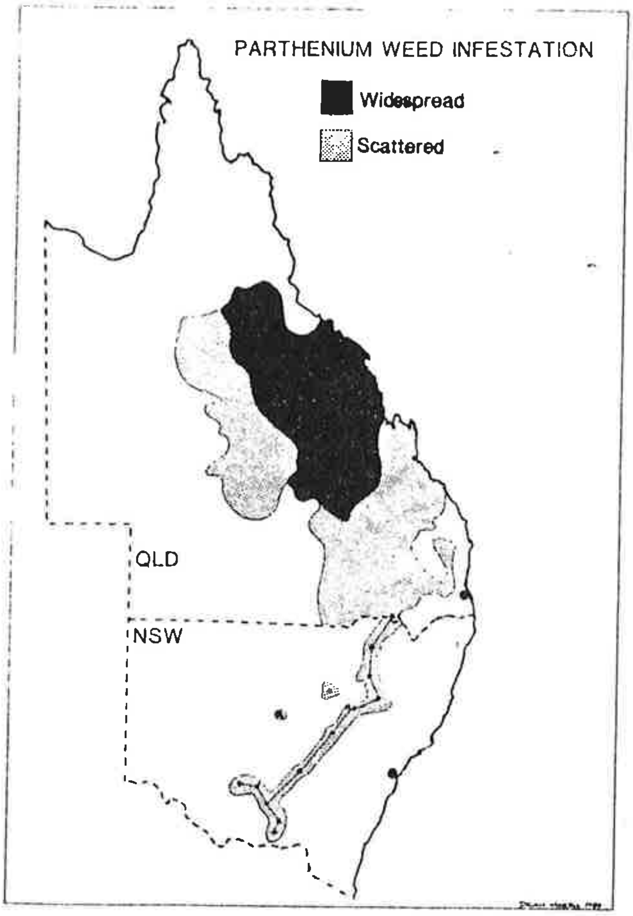
Parthenium weed *(Parthenium hysterophorus)* is a very serious weed in Queensland. It is thought to have been accidently introduced in 1958 although the first official recording was in 1962.

Parthenium weed is a problem to both agriculture and human health. In addition to causing substantial reduction in carrying capacity it affects the health of both livestock and humans. Once established its prolific seeding makes it very difficult to contain.

The main area of infestation in Queensland is the central highlands with lesser infestations occurring over much of the State. The weed has continued to spread with new infestations being found regularly in spite of vigorous control campaigns.

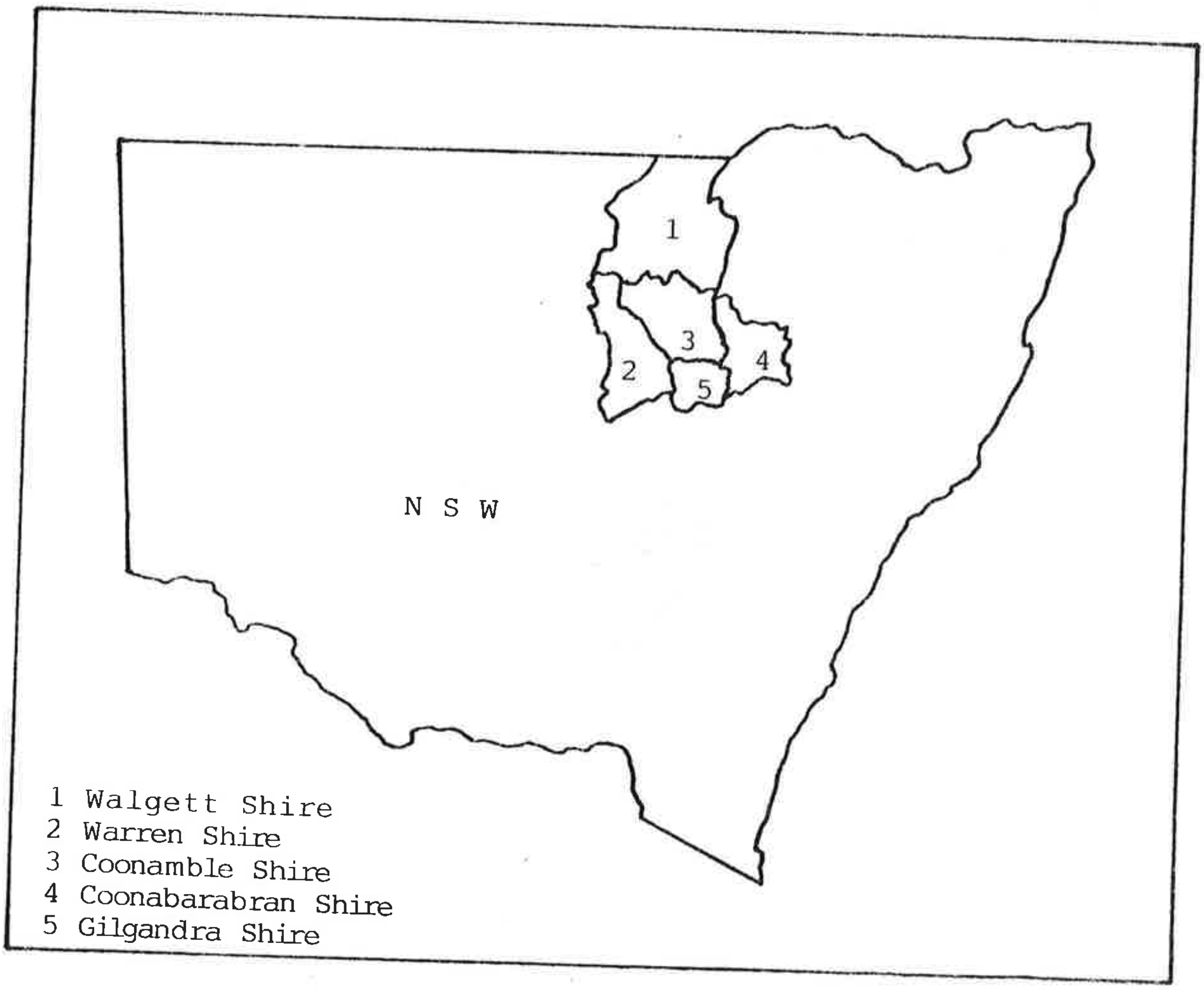
Fig 1. Parthenium Weed Distribution



Authorities in New South Wales have instituted a concerted program to keep parthenium weed out of the State and it was proclaimed a statewide noxious plant in 1978. It can be spread by seed in agricultural machinery, particularly harvesting equipment, seed, hay, livestock and vehicles. The increasing mobility of people involved in agricultural pursuits has increased the potential of the weed being introduced into New South Wales.

The Castlereagh Macquarie County Council which is the largest noxious plant control authority in New South Wales comprises the Shires of Coonabarabran 767,400 ha, Warren 108,500 ha, Walgett 2,200,700 ha and Coonamble 995,500 ha, a total of 5,530,300 ha. The County district extends from the north-western slopes to the far-western plains and from the central-west of New South Wales to the Queensland border with drainage into the Namoi, Barwon Darling, Castlereagh and Macquarie River watersheds.

Fig. 2 Castlereagh-Macquarie County Council.



CASTLEREAGH MACQUARIE COUNTY COUNCIL

The geographical position and extent of the Castlereagh Macquarie County Council makes it extremely vulnerable to the introduction of parthenium weed and the County is, together with other Councils in the northern border area, in the forefront of the fight against parthenium weed.

The Castlereagh Macquarie County Council has actively participated the statewide parthenium weed awareness campaigns first instigated by NSW Agriculture & Fisheries in the late 1970's and has been very active at the local level.

The impact of the awareness campaign however diminished over time as people in general became complacent about a danger they had never seen and only affected people somewhere else i.e. "'out of sight, out of mind".

Impetus for the awareness campaign was provided by the first discovery of parthenium weed in the county district in 1984. Two ladies cutting burrs on a road that ran through their property north of Coonamble found one plant and reported it to the County Council.

A subsequent search of the roads in the area by officers of the Council and NSW Agriculture & Fisheries found another five more plants along the road in the same area.

The discovery received very good media coverage and an extensive awareness campaign was launched by NSW Agriculture & Fisheries including the distribution of 6,000 Agfacts throughout the district.

As a result of the awareness campaign it was established that a header from central Queensland had harvested wheat in the area and had travelled the road several months previously.

The header was traced to a local sharefarmer's paddock on the outskirts of Coonamble where it was parked awaiting the next season. Six parthenium plants were found growing under the header.

The movements of the header at harvesting time were established and a concerted search was implemented. Two more plants on a roadside some 20 km from the first discovery were found and a major infestation of 90 plants was found in a 250 ha cultivation paddock in which the header had worked. The plants were destroyed before they had set seed and atrazine applied to the soil around the base of each plant.

The area was monitored with six plants being found the following season, another one the next and no further discoveries after that.

Since September 1988 isolated parthenium plants have been found on roadsides in the county district by inspectors during their normal road inspections. The majority (12) were found along the road from Mungindi on the Queensland border to Walgett which is the major access route of headers moving from Queensland through the county district. In addition one isolated plant was found 27 km west of Coonamble and two at separate locations in the north of Warren Shire.

An inspection by county inspectors in June 1990 found 18 parthenium plants growing near the border crossing stockyards on the Queensland side of Mungindi. This location is used by some header operators to clean out their machines prior to gaining a permit to enter N.S.W. As it could be reasonably assumed that these plants were caused by headers which were cleaned prior to entering NSW and allowing for the fact that most headers are now cleaned before they leave the property, this discovery demonstrates the potential of grain harvesters to transport parthenium seed if they are not cleaned properly.

The worst infestation yet found in NSW was reported in May 1989 by a Mullaley district landholder. The property is in the eastern extremity of Coonabarabran Shire on the edge of the rich Liverpool Plains.

Once again the report was a result of media coverage of the discovery of parthenium weed, in this case a single plant, in an adjoining shire. The landholder had been concerned about a strange weed growing in his newly planted pasture but on hearing of the other discovery took immediate action to have it identified.

This infestation extended over an area of 400 ha of hilly terrain which drains down onto the Liverpool Plains and ultimately into the Namoi River. The area had been cleared and sown to bambatsi panic and purple pigeon grass which had been grown in the central highlands of Queenlands. A number of seed analyses of the unused portion of the purple pigeon grass (seven bags) found between 300 to 600 parthenium weed seeds per kilogram. When it is considered that 300 kg of purple pigeon grass were sown on the property, the amount of parthenium weed sown is substantial.

Immediate action was taken to treat the infestation. The whole area was searched by men on foot as the steepness of the terrain together with the timber and stones restricted the use of vehicles. The plants found varied from 30 cm to 6 m and from rosettes to the early seed set stage.

The flowering plants were first sprayed with diesel, then pulled, bagged and burnt on site while the younger plants were pulled. The soil around the base of all the plants was treated with atrazine. The initial search and destroy took eleven men four days to complete with 443 plants being found.

A further three searches were carried out in May with another 888 plants being found, none of which had commenced flowering.

In the following season searches commenced in January and lasted until June with a total of 2,184 plants was being found and taking over 150 man days. None of these plants had reached the seed stage.

Isolated plants were found growing in some of areas treated with atrazine the previous season which suggests that at times the amount of atrazine applied to the soil was not sufficient. Much more noticeable however was the ring of plants often found around the edge of the atrazine treated areas of approximately 1 m in diameter which shows that the area treated should have been extended to 1 m from the plant (ie. 2 m diameter).

For the current season, 1990/91, the first search was carried out on the 30th January, 1991 when 86 rosette plants were found. The Macquarie Valley Noxious Plants Advisory Committee initiated a proposal that other weed inspectors in the region participate to give them the opportunity to become familiar with parthenium weed growing in the field. A total of 24 officers from other Councils, Rural Lands Protection Boards and NSW Agriculture & Fisheries participated in the two day search of the property with officers of the County.

To date the cost of the County Councils program on this one property has been $60,143. This cost would be beyond the resources of most landholders and without the provision of special state government funds and the work done by the Council this infestation would have spread extensively in the region.

Inspectors also followed up the subsequent movements of the crawler tractors used to clear and plant the pasture. A further two plants were found on another property some 40 km west of Mullaley near Coonabarabran.

At the time of writing (February 1991) only the one search has been carried on however regular searches will again be carried out until the end of the growing season in mid 1991.

The infestation of Mullaley is under control at the time of writing and given that no further large infestations are discovered in the County district to overload its staff resources the situation should be well contained by the end of the 1990-91 season. Vigilance will be required however for some years to come to ensure that no plants are allowed to seed.

It is fortunate that this extensive infestation was found and fully treated before full seeding had occurred. Given the prolific seeding nature of parthenium it would only need an infestation of this magnitude to remain untreated for one year for the weed to become firmly established.

Apart from surveillance by the Inspectors the County will need to maintain publicity campaigns to ensure that everyone in the county district retains an awareness of the potential problem posed by parthenium weed. Attention must be given to developing new initiatives to maintain public awareness. Merely to keep repeating the same message will loose public attention and new messages and initiatives must be promoted if the Country is to remain free of established infestation of this very damaging weed.

THE INTRODUCTION OF *EPIBLEMA* INTO WESTERN NEW SOUTH WALES

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Noogoora burr (*Xanthium pungens*), a widespread noxious weed in Western New South Wales, occurrs extensively along watercourses where control using herbicides or mechanical means is usually uneconomical and impractical.

The situation is one for which the introduction of an effective biological control agent would be of immense value.

Epiblema strenuana a gall-forming insect, which was introduced into Australia from Mexico as a biological agent for the control of parthenium weed (*Parthenium hysterophorus*) but also readily attacks Noogoora burr and annual ragweed (*Ambrosia artemisiifolia*), was seen as a promising candidate.

The insects were first released in Australia in January 1982 in parthenium weed in central Queensland where the weed occurs extensively causing major problems. The insects had become widely distributed in the region by the winter of 1984 (Rachel McFadyen, 1989).

The first introduction of *Epiblema* into New South Wales was in December, 1984 when it was released in annual ragweed (*Ambrosia artemisiifolia*) on the north coast where it established very successfully (Robert Dyason, 1987). The success is illustrated by the fact that an annual ragweed infestation at Maclean near Grafton from which collections for further releases were made in 1985 and 1986 become so reduced that a new site at Kempsey some 180km further south had to be used for collecting material in 1987.

The distribution of the insect is relatively simple. It consists of collecting plants containing larvae, transporting them to the desired site and placing the material amongst the target weeds.

It requires about 100 good sized plants, which are alive and green, for each release site. The plants should be protected from excessive heat during transport and preferably placed in the new site within 24 hours of collection.

It is important that the release site consists of at least 1ha of suitable plants. The plants should be young and actively growing and there should be adequate moisture reserves for future plant growth.

The distribution is carried out in mid-season, the timing being a compromise between the build-up of insects in their present site and the time needed to build up in their new site before winter. It is important that viable numbers of the insect be released at each site to ensure establishment. Once the insects are established they will spread rapidly with moths being able to fly 20km to find isolated plants (Rachel McFayden, 1987).

The moths lay their small eggs, which hatch in 3-5 days, singly on the leaves of host plants. The young larvae bore into the host plants at the tip or side shoots after which they bore along the inside of the stems eventually causing a gall to form in which the larvae pupate.

Epiblema was next released in western NSW on Noogoora burr in the northeast and perennial ragweed (*Ambrosia confertiflora*) in the farwest. Another consideration was that once established on Noogoora burr the insect could also act as a backup for parthenium weed should that weed become established in the region.

The first releases in western NSW were made in December 1985 when annual ragweed containing larvae collected from Maclean were distributed to sites at Moree, Narrabri, Menindee and the Macquarie Marshes.

A second release was carried out twelve months later in December 1986 at Menindee and the Macquarie Marshes.

On both these occasions the releases in the Macquarie Marshes were of secondary consideration to finding a biological control agent for perennial ragweed, (*Ambrosia confertiflora*) growing in vineyards at Menindee in far western NSW. This infestation has created a very serious problem for the grape growers with there being no effective herbicide that can be used near the vines.

While *Epiblema* has established on perennial ragweed in the lower Hunter (Ken Bunn,1991, pers.com.) there was no evidence of the insects establishing at Menindee, however the perennial ragweed in the lower Hunter is *Ambrosia psilostachya* a different species. While *Epiblema* does not appear to have a great effect on the ragweed in the lower Hunter the plants, being perennial, are providing a permanent host for the insects and should increase the effectiveness of Noogoora burr control.

The first release in the Macquarie Marshes was on the eastern side at a time of excess water flow which receded leaving the site high and dry and the Noogoora burr population did not survive. The second release site on the western side of the marshes appeared to have a good Noogoora burr population with good moisture reserves, however once again no evidence of insect survival could be found.

It was decided to abandon the attempt to introduce the insect to Menindee and give top priority to establishment in the Marshes. The Marshes with extensive permanent infestations of Noogoora burr, would provide an excellent permanent source of insects in the region for both natural spread and for any further collections.

NSW Agriculture & Fisheries, in conjunction with the Castlereagh Macquarie County Council, collected a station wagon load of annual ragweed plants containing *Epiblema* at Kempsey on the mid-north coast in January 1988. Most of the plants were placed on Noogoora burr at a site in the northern Marshes while the remainder were placed in Noogoora burr in the Castlereagh River near Coonamble. However a flash flood within days caused the river to rise over 2m and wash the ragweed plants away.

The first subsequent inspection of the Marshes was carried out in April. Rising waters restricted investigations to a distance of 7km from the release site with most of the Noogoora burr plants inspected containing larvae. It was not possible to determine the full extent of the insect's spread.

An inspection in November 1989 found that 80% of the Noogoora burr plants within 25km of the release site were infested with up to four galls per plant. The upward growth of these plants had been significantly reduced.

A further inspection in December of the area within 70km of the release site found Noogoora burrs containing larvae so it could be expected that the insects spread had exceeded this distance. The insects were also found on isolated plants which supports the Queensland reports that once established the moths are very active in seeking out isolated host plants (Rachel McFayden, 1987).

Noogoora burr plants with up to twelve galls per plant were found on the Barwon River north west of the Marshes however it is likely that these were the result of the insect's spread down the Barwon River from Moree and Queensland.

Epiblema were also found well established in Noogoora burr plants growing on the Darling River at Bourke in early 1990.

Investigations by Inspectors of the Castlereagh Macquarie County Council during the past summer (1990/91) found *Epiblema* throughout the western part of the county district as far south as Gilgandra on the Castlereagh River and the Bogan river south of Nevertire. A parthenium weed plant found north of Walgett contained a number of galls.

In addition two galled Noogoora burr plants were found near the Macquarie River between Dubbo and Narromine in February 1991.

Releases of *Epiblema* in Noogoora burr plants from the sewerage treatment works at Coonamble were made in the Dubbo and Wellington districts during February 1991. It will be interesting to see the extent of *Epiblema* establishment in the central west of NSW where climate conditions are cooler.

For new releases it is important that emphasis be placed on establishing the insects at one favourable site from where they will rapidly spread naturally rather than to attempt to widely disperse the initial release.

The spread of *Epiblema* on the western plains of NSW along the Macquarie and Castlereagh Rivers has been rapid. We will now be looking for a buildup of the insect numbers so as to be able to evaluate its effect on Noogoora burr seed set and further populations in the region.

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SIFTON BUSH

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Sifton bush (*Cassinia arcuata*), also known as biddy bush or Chinese shrub, is a native perennial shrub, occurring in New South Wales, Victoria and South Australia. In New South Wales it is found on the Central and North Coast, Central and Southern Tablelands, Western Slopes and Plains.

NOXIOUS STATUS

In New South Wales sifton bush is declared noxious in 13 local government areas. All these areas are on the Central and Southern Tablelands.

- Cabonne Shire
- Crookwell Shire
- Harden Shire
- Gunning Shire
- Goulburn Shire
- Boorowa Shire
- Young Shire
- Yass Shire
- Yarrowlumla Shire
- Wingecarribee Shire
- Snowy River Shire
- Queanbeyan City
- Mulwaree Shire

Sifton bush is one of the only two native plants which are declared noxious in New South Wales. The other plant is galvanised burr (*Sclerolaena birchii*).

HABIT

Sifton bush is a plant common of low fertility, skeletal acid soils, particularly in areas of over-grazing and where there has been disturbance by cultivation or road construction.

Sifton bush can become more dominant on infertile, acid, stony soils. It also can occur on more fertile soils but is generally not a problem in these situations.

IDENTIFICATION

There are 17 *Cassinia* species in New South Wales.

Sifton bush can be best distinguished from the other species by its small dark green leaves (less than 10mm long and 0.5mm wide) and its pale brown, droopy flower heads. Sifton bush shrubs grow to a height of one to three metres. Flowering occurs from October to May, and the plant is capable of annually producing large quantities of very small seed.

LIFE CYCLE

Seed can germinate any time of the year, with young establishing plants reaching a height of 60cm in their first year.

Plants do not flower until their second season.

The seed is believed to be wind dispersed and also by animals and water. Seed viability declines rapidly; germination of laboratory stored seed is approximately 60% after 1 year and 0.3% after 15 years. (McGowen *et al* 1990 and Semple 1990).

THE PROBLEM

Soil disturbance and overgrazing are the major cause of sifton bush spread.

Sifton bush is unpalatable to all classes of grazing livestock and can reduce carry capacity by up to 90% (Semple 1990). The shrub provides harbour for vermin and makes mustering difficult. It has been the cause of wool contamination.

Sifton bush is extremely drought hardy and is difficult and expensive to control, either by cultural practices or herbicide application.

SIFTON BUSH MAY BE BENEFICIAL

The Soil Conservation Service of New South Wales consider the sifton bush may have some beneficial aspects. Semple (1990) states that:-

* Stands of sifton bush may offer more protection to the soil from erosive agents than native pastures in low fertility situations, though this would depend on pasture types and grazing pressure.
* It has been suggested that shrubs in general are valuable in tableland rangelands because they provide a specialised habitat for predators of insect pests such as those responsible for eucalypt dieback.
* Sifton bush, though relatively shallow rooted, may be more efficient at lowering watertables or reducing ground water recharge rates (and hence the likelihood of downstream salinisation) than native and improved pastures.
* Unlike many useful pasture species, sifton bush is able to establish and persist on bare areas such as roadsides and gravel pits.

CONTROL

There are no cheap "off the shelf" remedies for sifton bush control.

Integrated control based on establishment of perennial pastures is often the only long term answer. This type of program on the scale required for sifton bush control is generally very expensive and long term and consequently not particularly "palatable" to landholders of low value property.

The most realistic policy for sifton bush control at the moment is:

* eradication - where small or isolated infestations by spot spraying, grubbing or pulling.

* control - better class country; pasture improvement coupled with slashing or rope-wick application of herbicide, rolling with heavy rail line, and spot spraying.

* containment - heavy infestations on poor, low productive country (much of which should have never been cleared).

HERBICIDES

Currently the NSW Department of Agriculture & Fisheries has issued Pesticide Orders and Pesticide Permits for herbicides for high volume spot spray application. Sifton bush herbicide trials have been conducted at Orange by the Weeds Research and Demonstration Unit since 1981 (Milne 1981 to 1989). The current herbicide recommendations are solely based on these trials and demonstrations.

Pesticide Order	-	OP-PIL-TRIC-3 Grazon, DS®
Pesticide Order	-	PO-GLYP-13 Roundup®
Pesticide Order	-	Velpar L® (all end users must apply for an individual Permit).

NEW DEVELOPMENTS

Potential for Biological Control by native scale insect (*Austrotachardia* sp)

Heavy infestations of the scale insect *Austrotachardia* sp. are currently occurring on sifton bush infestations 30km north of Orange in the Kerr's Creek area. These scale insects have been reported since 1979. In March 1979, heavy infestations were reported by Dellow in the Hill End area of the Central Tablelands. Again in 1986 Kelso reported infestations, also in the Hill End area. However, attack by the scale insect in this area was not sustained and there was no significant reduction on sifton bush infestations.

More intense investigations of this scale insect as a possible biological control agent have commenced at the Agricultural Research and Veterinary Centre, Orange. To date the insect has had a dramatic impact on the shrub on a large, but isolated property at Kerr's Creek.

Control by Rolling

In the Coonabarabran area excellent long term control of sifton bush has been achieved by a combination of pasture improvement and knocking down regrowth by dragging railway line or a heavy log (Freebairn 1989). The country has the potential to be improved to carry 6 to 10 DSE per hectare, producing 3,000 kg/ha dry matter (namely subterranean clover and serradella).

Following pasture sowing, sifton bush invariably gradually comes back. The better the pasture, the less this will be and the more likely some sifton bush seedlings will be eaten by stock. If a sifton bush problem develops, the plants should be allowed to grow until they are about one metre high. At this stage, they break off easily at ground level and can be controlled by dragging a length of railway line or "wooden sleeper" over them. The pasture remains relatively undisturbed, and productive. The sifton plants are killed. These can be burned later on, but pasture productivity will not be harmed if they are left where they fall.

Freebairn (1979) found in some cases a second pulling may be required in 18 to 24 months. Many farmers have achieved total control with one pulling. The secret is in leaving the pasture undisturbed.

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SPINY BURRGRASS CONTROL USING CONSOL GRASS

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Spiny burrgrass is a problem of sandy type soils and will also colonise on road edges in gravel shoulders.

The weed has a number of features which makes it a particular problem of the Riverina area.

They are:

1) The plant is not easily identified until seed head stage which is too late for effective control;

2) Repeated germinations can occur from November to March requiring fortnightly spraying;

3) Much of the area is grazing area, which is low producing and low carrying e.g., 1 sheep/hectare would be only possible in good years;

4) With the current trend to low labour content on large areas, the ability to patrol properties is difficult;

5) There is usually a sand ridge adjacent to all water courses. These are susceptible to spiny burrgrass.

Other major problems which confronted the Jerilderie Shire were:

1) Coleambally township is built on a sand ridge and most public areas e.g. playing fields, school ground etc. were infested with spiny burrgrass;

2) The township is the major service town for the Coleambally Irrigation Area. Thus most cars and shoes could, and very often did, bring home the seeds;

3) When the Coleambally area was laid out, most farms included a sand area and because this was not irrigable by normal flood systems, it was mostly used for the farm house and sheds.

HISTORY

Although very few sites were known within the Jerilderie Shire area. Council was well aware that the weed was in the neighbouring shires and there was a potential problem on the doorstep.

Investigation revealed the following facts:

1) Necessary spraying was expensive and largely ineffective on a cost v effect basis;

2) The required spraying would be environmentally unacceptable over a long period.

LANDHOLDER APPROACH

A landholder group approached the Council for assistance on a particular road. This road had scattered colonies throughout the length of 6.5 kms and the road reserve was 40 metres wide, including a channel reserve.

The landholders were prepared to carry out cutting and picking, but felt in the general interest of the public, Council could use the site for developing a control method which would be applicable to all roads.

The lanholders favoured spraying by Council with landholders doing "cut and pick" patrols. This plan was of no use to Council on more than a small area because of:

a) cost; and

b) the unlikelihood of other groups being as cooperative.

WORKS BY OTHER PARTIES

Through discussions with Mr Hugh Milvain, Noxious Plants Advisory Officer, Yanco Agricultural Institute, I discovered the work of Bill Johnson (Soil Conservation, Wagga) and Joe Knox (Weeds Officer, Urana Shire) using 'Consol' lovegrass.

Those present at that time will remember looking at trials at the Wagga Conference in 1981, and some of those will remember being suitably surprised that 'Consol' is actually a variant of *Eragrostis curvula*.

CONTROL PROGRAM

It was discovered that 'Consol' has the following properties:

1. Will exist on very low fertility soils;
2. Does not need fertiliser and can be sown into virtually unprepared seed beds;
3. Consol, either by allelopathic properties or ground cover, would control dense stands of spiny burrgrass at the rate of 3 to 4 plants per square metre;
4. Consol will spread naturally and seed into other areas over a period of years to gradually claim a much wider area than originally planted;
5. The grass was palatable to all stock and recovered well after very heavy stocking;
6. Consol is easily controlled in a farm situation.

DISADVANTAGES

Consol has the following disadvantages;

1. Extremely small seed which is difficult to sow on a large area;
2. Seed is not readily available on a commercial basis, although this is improving with a number of seed growers producing seed at the end of 1990.