

## CONTROL OF SERRATED TUSSOCK – PROBLEMS IN DEVELOPING IWM SYSTEMS

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**Abstract** Serrated tussock (*Nassella trichotoma*) is one of the worst weeds confronting livestock producers in the higher rainfall perennial pasture zone of southern Australia where it currently infests more than one million hectares. Frenock® (fluprofonate) provided an effective means of killing serrated tussock until its recent withdrawal from sale. This has created an opportunity and challenge to develop integrated weed management (IWM) practices using both control methods (e.g. herbicide, fire) and management (e.g. strategic grazing, pasture over-sowing, fertiliser). The CRC for Weed Management Systems is committed to initiate new research and value-add to existing programs to improve our understanding of the ecology of grassy woodlands to facilitate the development of low-cost IWM systems especially for non-arable landscapes. This paper aims to identify the gaps in our knowledge about the ecology and management of serrated tussock and outlines the strategies being implemented by the Weeds CRC to generate the information needed to develop effective IWM systems for serrated tussock control.

### INTRODUCTION

Serrated tussock (*Nassella trichotoma* (Nees.) Arech.) is one of the worst weeds confronting livestock producers in the perennial pasture zone of southern Australia. It is a declared noxious weed in New South Wales, Victoria and South Australia where it currently infests more than 1 million hectares of pastoral land with the potential to invade another 32 million hectares (McLaren *et al.* 1998). Control costs and losses in livestock production from serrated tussock infestations are significant, currently exceeding \$5 million per year in Victoria and \$40 million in New South Wales (Jones and Vere 1998).

Over the past 20 years, Frenock® (fluprofonate) has proved to be the most effective and economical method to selectively remove serrated tussock from both sown and native pastures (Campbell 1997). However, the recent withdrawal of Frenock® from sales has significantly limited the control options available to

producers, especially in non-arable land where Frenock® could be aerially applied without damaging trees.

The loss of Frenock® has had a twofold effect. First, it has focused attention on finding alternative herbicide tactics to at least limit the spread of serrated tussock. Second, it has refocused our attention on the development of IWM practices that combine both control (e.g. herbicide, fire, biological control agents) and management (e.g. strategic grazing, pasture over-sowing, fertiliser) strategies. Initially, the CRC for Weed Management Systems had only a limited R&D program for serrated tussock because Frenock® was providing effective control. However, the changing circumstances with Frenock® provide an opportunity and challenge for the CRC to assist with the development of IWM systems for serrated tussock control.

Inadequate knowledge of the biology and ecology of serrated tussock (particularly in non-arable areas) together with economic constraints of livestock enterprises that preclude the use of current control practices, has limited the development of IWM systems. In much of the area infested with serrated tussock it is either no longer economic to sow a replacement pasture or the potential carrying capacity of the land is below the economic breakeven point for control practices at current wool prices (Jones and Vere 1998). Low-cost tactics that damage existing plants, reduce seed-set, limit recruitment of new tussock plants, and enhance both the productivity and competitiveness of desirable companion perennial grasses need to be developed for effective control of serrated tussock.

The aim of this paper is to identify the gaps in our knowledge about the ecology and management of serrated tussock and to briefly outline the strategies being developed by the Weeds CRC in conjunction with co-operating agencies to address these problems.

## BIOLOGY AND ECOLOGY

As with other weeds where herbicides have dominated as the main control method over a protracted period, there is a dearth of information available on the biology and ecology of serrated tussock. Yet it is this information that underpins the development of effective IWM systems. Some of the more important ecological topics where information is still required include:

- Definition of ecotypic variation within serrated tussock in NSW and Victoria.
- Investigation of the surface soil conditions that serrated tussock seed needs for germination (e.g. mulch or bare ground).
- Definition of the impact of fertiliser on the competition between serrated tussock and desirable pasture species.
- Investigation of the population dynamics of serrated tussock and the effect of control tactics on plant demography and soil seed reserves.
- Investigation of the relative response of serrated tussock and other companion species to fire.

There is a need to define the possible impact of ecotypic variability on the development of serrated tussock control practices. Some data suggest that the difference in susceptibility to glyphosate of serrated tussock populations in NSW and Victoria may be due to ecotypic variation. For example, preliminary information indicates that low glyphosate rates (<3 kg a.i. ha<sup>-1</sup>) controls serrated tussock in Victoria, particularly when applied to tussock regrowth after a strategic burn (Miller 1998), whereas up to 11 kg a.i. ha<sup>-1</sup> of glyphosate was needed to kill tussock in NSW (Campbell *et al.* 1999).

The consequence of ecotypic variation is that delineation of the boundary between possible glyphosate susceptible and resistant populations may be required so that appropriate regional herbicide recommendations can be developed. Morphological differences that distinguish serrated tussock from the two populations will make this delineation possible. A further challenge related to ecotypic variation is that as serrated tussock areas in Victoria are amenable to control with glyphosate in the short-term, they could be re-invaded by NSW ecotype, particularly along the boundary of the two types. This potentially poses such major problems for recommendations for serrated

tussock control in Victoria and NSW that the CRC is supporting honours students and a doctoral program to further investigate ecotypic variation in serrated tussock and its implications for control practices. This also includes biological control agents, as preliminary work by Hussaini *et al.* (1999) suggests that genetic variability also determines the susceptibility of serrated tussock to various pathogens.

Some general information is available on potential plant densities and seed production (Campbell 1998, Gardener and Sindel 1998), but a better understanding of the dynamics of serrated tussock populations is needed to identify the most vulnerable stages in the weed's life-cycle. Since the success of serrated tussock is attributable to its potentially large, long-lived seedbank, research into the fecundity and seed bank dynamics of serrated tussock is an obvious starting point for the development of successful IWM strategies (Gardener and Sindel 1998). The main objective of a CRC-funded PhD program is to provide this basic information on plant demography for both serrated tussock and desirable native companion grasses when subjected to a range of control tactics (including fire) so that appropriate low-cost IWM strategies can be devised for non-arable pastoral land, especially in NSW. The observation that some native grasses (e.g. *Bothriochloa macra*, *Themeda triandra*) resist serrated tussock invasion when maintained in a productive state is seen as a key element for the control of serrated tussock in non-arable grassland by manipulating the system to favour the desirable component.

## HERBICIDE DEVELOPMENTS

The loss of Frenock<sup>®</sup> has created the need to develop alternative herbicide tactics, and most of the current research is focused on the use of glyphosate. Since glyphosate is a non-selective herbicide, the damage to non-target and desirable plant species can be considerable. While this damage may have a positive effect in creating a suitable seedbed for establishing phalaris or cocksfoot on fertile or arable land thereby preventing re-infestation by serrated tussock, it has a negative effect on native grasslands by reducing biodiversity and production of the native perennial grass component. Herbicide research now needs to focus on ways to minimise these negative impacts through:

- better definition of the formulations, application rates, additives and application methods for glyphosate; and
- identification of new herbicides that pose less environmental risks than glyphosate.

In 1998, trials were established in NSW and Victoria by CRC partners to clarify and further investigate the effectiveness of glyphosate on serrated tussock as there are many variations in formulations, adjuvants and recommended rates that needed to be evaluated for efficacy. Preliminary results suggest that glyphosate can be effective at any time of the year provided the tussocks are actively growing, but that effective application rate will depend on location (Campbell *et al.* 1999). Correct application rate is critical as over-use of glyphosate could easily produce unstable pastures dominated by annual weeds. Due to the non-selectivity of glyphosate, there is also a need to test new herbicides as they become available to selectively control serrated tussock, especially for aerial application where glyphosate is unsuitable.

#### BIOLOGICAL CONTROL AGENTS

Early assessments of the potential for biological control suggested that fungal pathogens control serrated tussock populations in South American grasslands. Efforts to identify and develop biological agents for serrated tussock control in Australia were initially stifled by the contention that serrated tussock was “too closely related to native *Stipa* spp.”. However, recent revisions of the stipoid taxa suggest that pathogens from *Nassella* may be more specific than previously thought thereby posing no threat to Australia’s native grasses (Briese and Evans 1998). This, coupled with the identification of suitable fungal pathogens in more recent surveys (Briese and Evans 1998, Hussaini *et al.* 1998) has provided greater optimism in finding a suitable biological control agent for serrated tussock.

The Weeds CRC has been instrumental in facilitating the continued search for serrated tussock control agents both in Australia and overseas through:

- the investigation of the specificity and virulence of endemic fungi previously found on serrated tussock in Victoria (Hussaini *et al.* 1998); and,
- the identification of pathogens in Argentina with demonstrated potential for biological control of serrated tussock and Chilean needle grass.

Hussaini *et al.* (1998) identified fungi resident on serrated tussock in Victoria that had not previously been recorded in Australia. The combination of *Zinzipogon argentinensis* (Spegazzini) Nag Raj attacking the flowering culms and inflorescences, *Fusarium* sp. causing

crown rot, and “smut” spores replacing seeds could potentially kill serrated tussock plants and reduce seed-set (Hussaini *et al.* 1998). If the specificity and virulence of these fungi can be proven, this discovery could reduce significantly the time, expense and risk associated with importing exotic pathogens.

However, since there is no overlap in these potential agents with those found in South America, there is also ample justification to continue the search for other specific pathogens in the rich and incompletely known mycoflora of the Argentine grasslands where *Nassella* grasses are endemic. The Weeds CRC has assisted in funding a comprehensive project to survey the range of pathogens found on *N. trichotoma* and to evaluate potential biological control agents in Argentina. The anticipated end-point of this work is one or two pathogens with epidemiology and impact on population dynamics defined for field populations in areas ecologically most similar to infested areas in Australia. Additional work will investigate the ecology of serrated tussock in its native range to complement similar work in Australia.

#### INTEGRATED WEED MANAGEMENT

IWM practices for serrated tussock need to be developed in a landscape context. Earlier work done by Campbell (1974) developed an IWM system for fertile land that included herbicide use, over-sown pasture seed, fertiliser application and rest from grazing for the first three spring-summer periods after sowing to smother serrated tussock seedlings. However, this package was less effective on poorer non-arable land where sown perennial grasses were not vigorous enough to prevent the rapid re-invasion of serrated tussock seedlings (Campbell 1974). It is now clear that effective long-term control in non-arable areas will depend ultimately on implementing management practices that strengthen and maintain native grasses in a competitive state rather than focus exclusive on eradication of serrated tussock.

The Weeds CRC is taking up the challenge to facilitate the development of IWM systems for serrated tussock, especially in non-arable landscapes, by supporting projects that fill the substantial gaps in our knowledge of the biology and ecology of native grassy woodlands and their response to management. For some land classes this may require a change in land use ranging from complete retirement from agriculture to conservation use (e.g. nature reserves, windbreaks, and corridors for wildlife movement) that may attract future revenue from carbon credits after being

re-afforested with appropriate trees and shrubs. In investigating the role of re-afforestation in serrated tussock control, Campbell and Nicol (1996) concluded that *Pinus radiata* and native eucalypts warrant further research for use in non-arable situations. When applied to selected parts of a property, such alternative land uses may help to achieve sustainability and biodiversity goals on a landscape scale.

For parts of the landscape where livestock enterprises are considered to be viable, more appropriate grazing practices can be strategically implemented once they are developed for our native grasses. For example, there is no technical reason why strategic rests which have proved to be an important tool to manipulate pasture composition in other pasture types cannot be used to manage plant community dynamics to disadvantage serrated tussock and strengthen desirable perennial grasses. Identification and assessment of the value of strategic rest periods in conjunction with other tactics such as herbicide application, fertiliser inputs and fire are central to programs being implemented by Weeds CRC partners in central NSW and Victoria.

In addition to developing IWM systems for specific situations, research is also needed to define important interactions between different control options. For example, Hussaini *et al.* (1998) infer that the activity of *Z. argentinensis*, a fungus that attacks the flowering culms and inflorescences of serrated tussock, was only found in areas that had not been sprayed with herbicides for some time (Hussaini *et al.* 1998). Due to the effectiveness of Frenock® the positive and negative impacts of such interactions on the overall efficacy of IWM systems have not been fully explored for serrated tussock.

#### CONCLUSIONS

The answers to these and many more questions are prerequisites for developing a low-cost IWM system for serrated tussock. Emphasis should be given to systems for use in non-arable, marginal grazing lands where site potential and finances precludes the successful introduction of existing IWM packages. These marginal lands account for the largest proportion of the present tussock infestation (308,000 ha in NSW alone) and cannot be ignored any longer. The Weeds CRC is committed to initiate new research and value add to existing programs to improve our understanding of the ecology of grassy woodlands to facilitate the development of low-cost IWM systems for non-arable landscapes.

Hopefully, the recent classification of serrated tussock as a “Weed of National Significance” by the Federal government may provide funding for the implementation of the above serrated tussock control program. From a producer’s viewpoint IWM will need to be shown to be profitable, relatively simple, biologically feasible and environmentally safe before they will adopt such programs.

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