Techniques for the establishment of kangaroo grass in South Australian conservation reserves

J.L. Stafford, East Torrens Animal and Plant Control Board, Norton Summit, SA 5136, Australia.

Summary

A successful direct seeding technique for kangaroo grass (*Themeda triandra* Forsskal) has been developed after field trials in South Australia. The technique involves cutting *Themeda* culms at the commencement of seed shedding in December and immediately broadcasting them over the seeding site. Germination is triggered nine months later by applying herbicides to weed growth and burning the vegetation as soon as it has cured. *Themeda* seedlings emerging in October usually thrive in the warm moist, undisturbed soil. This simple method is suitable for re-establishment of *Themeda* on both arable and non-arable land and requires only basic equipment.

Introduction

The East Torrens District in South Australia consists of 117.2 km^2 of hilly land abutting and lying due east of suburban Adelaide. Once covered in dry sclerophyll forest, much of this land was cleared for cropping or was grazed early in South Australia's European settlement. A land-use survey conducted by the East Torrens Animal and Plant Control Board in 1987 showed that 50% of the total area of the district was no longer cropped or grazed and having been disturbed to varying degrees, was vulnerable to weed invasion.

Olive (*Olea europaea* L.), boneseed (*Chrysanthemoides monilifera* (L.) Norlindh), montpellier broom (*Genista monspessulana* (L.) L. Johnson) and blackberry (*Rubus fruticosus* spp. agg.) are common woody weed species colonizing both cleared ground and the disturbed understorey of remnant eucalypt forest. With the land no longer utilized for agricultural purposes, attempts to remove weeds resulted in re-infestation by the same or other weed species.

In the 1970s, consideration was given to the re-introduction of indigenous plants to break the cycle of weed removal/weed invasion. The re-establishment of kangaroo grass (*Themeda triandra* Forsskal) was favoured for the following reasons:

- It is found over a range of habitats within the Adelaide Hills, being absent only from steep south-facing slopes.
- Its foliage and litter can be burnt through August-December to control woody weeds when it is either impossible or unsafe to burn other herbaceous plants.
- It is tolerant of herbicides used to control dicotyledonous weeds and responds favourably to cultural control methods such as slashing and burning.

In 1977, the South Australian National Parks and Wildlife Service proposed a program to re-introduce *Themeda* to Cleland Conservation Park. Techniques used to propagate *Themeda* progressed through four identifiable phases over a 13 year period. This paper describes those techniques and outlines the role of *Themeda* re-establishment in the control of herbaceous and woody weeds.

Phase 1. Initial trials at Cleland Conservation Park

Materials and methods

Seed harvesting and cleaning

In 1977, sources of *Themeda* seed were rare and sites within the Southern Mt Lofty Ranges were located and recorded for seed collection purposes. A small quantity (several wheat sacks) of *Themeda* hay was harvested and put through a cone thresher and various seed sieves to extract clean *Themeda* seed.

Field trials

Most areas in Cleland Conservation Park requiring revegetation are non-arable. In late January-early February 1978, *Themeda* culms complete with panicle and seed were cut by hand sickle, tied into sheaves (98 in all) and stored for several days before being taken to a revegetation site at Long Ridge. The culms were separated and laid in parallel to form a close thatch over two 10 m × 10 m plots.

To determine the importance of maintaining whole culms and an attached seed for seedling establishment, another 33 sheaves of harvested culms were passes through a stationary chaff-cutter, bagged and then broadcast over a third 10 m × 10 m plot located near the two previous plots.

In June 1978, a high volume application of paraquat/bromoxynil at 0.04% and 0.07% a.i. respectively, and sodium MCPA at 0.07% a.i. was made to one half of all three plots to control herbaceous weed growth in which salvation jane (*Echium plantagineum* L.) and oats (*Avena* spp.) were prominent. By 19 December 1978, no germination of *Themeda* had occurred and fire was used to burn all ground litter on half the chaffed-culm plot and half an adjacent whole-culm plot transecting both the herbicide-treated and non-herbicide treated strips. In mid-August 1979, *E. plantagineum* and *Avena* spp. were mown to prevent smothering of establishing *Themeda* seedlings. On 16 February 1983, an intensely hot bushfire burnt the site.

Results

Seed harvesting and cleaning

Remnant sources of *Themeda* were generally confined to sites that had a long history of stock exclusion such as cemeteries and Government reserves. The areas were small and harvesting could be done with basic hand tools. The attempt to clean seed from *Themeda* hay proved to be very time consuming. After threshing, extensive sieving failed to reduce the chaff content below 50% of the total volume.

Field trials

The herbicide treatment controlled *E. plantagineum* and *Avena* spp. but failed to encourage germination of *Themeda* seed. The control burn removed all standing herbage and previously laid culms and resulted in immediate germination of seed on the non-chaffed plot. The seedling density, although not recorded at the time, was around 1,000 plants m^{-2}. In contrast, not one seedling emerged from the plot sown with chaffed culms.

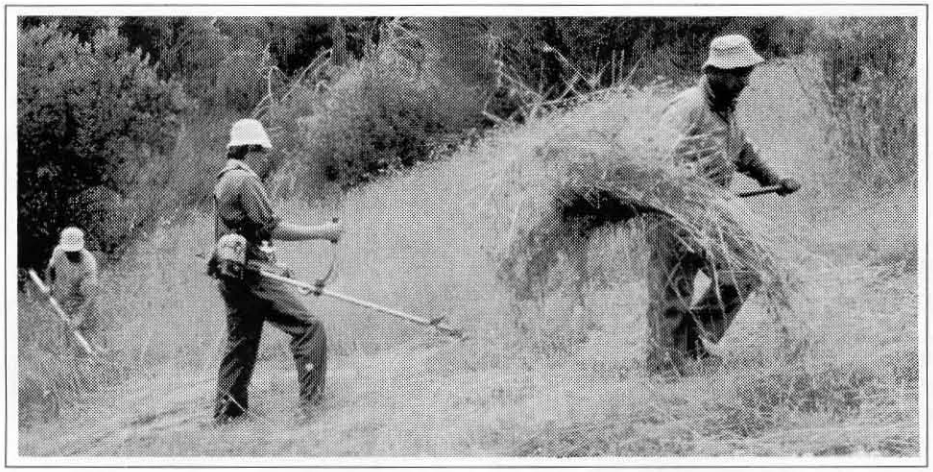
Mowing in mid-August to reduce competition from *E. plantagineum* and *Avena* spp. resulted in the *Themeda* gaining and maintaining dominance over these herbaceous weeds. However, after the hot bushfire of February 1983, very few *Themeda* plants (then four years old) survived burning. Plant survival rate on another plot where plant density was sparse because of poor germination appeared to be 100%.

Phase 2 . Pilot projects on Council reserves and road verges

Materials and methods

Themeda establishment trials at Cleland Conservation Park were followed by pilot projects to demonstrate the potential of *Themeda* in the management of Council reserves and roadverges.

During the first half of December 1985, *Themeda* seed was harvested from early-maturing, naturally-regenerated areas in the foot-hills adjacent to Adelaide. Sites were harvested as the first maturing seeds were about to be shed from the panicles. Four workers, two with brush-cutters and two with pitch-forks, were engaged in cutting, loading and spreading 8.5 m^3 of culms per day. In all, 42.5 m^3 were harvested and spread in Black Hill Conservation Park over 7,000 m^2 of roadverge averaging 10 m in width. Culms were broad-



Harvesting *Themeda* with brushcutters - arduous on steep slopes

cast to form a light lattice over the ground with the intent of establishing no more than 10 plants m^{-2}.

On 30 September 1976, a pre-germination spray of glyphosate at 3 kg ha^{-1} a.i. and atrazine at 4.3 kg ha^{-1} a.i. was applied to kill *E. plantagineum* and *Avena* spp. This area was subsequently burnt to promote germination of *Themeda*. In late February 1987, 1080-treated oats were laid on trails adjacent the site to control browsing rabbits. On 4 March 1987, a post-emergent application of bromoxynil at 1.1 kg ha^{-1} a.i. and sodium MCPA at 1.1 kg ha^{-1} a.i. was made to control *E. plantagineum*. This was followed almost three months later by a second herbicide treatment of chlorsulfuron at 19 gm ha^{-1}.

Results

Harvesting *Themeda* with a brush-cutter and loading directly into a high-sided trailer proved to be arduous on steep slopes. Spraying with glyphosate and atrazine effectively killed all herbaceous weeds. Three weeks after spraying, plants were sufficiently dry to be burnt and the fire promoted germination of *Themeda* by the end of October. Good seedling establishment ensued and plants growing in the deepest soil were producing seed by February 1987. Baiting rabbits with 1080-treated oats reduced grazing on the conspicuously lush growth of *Themeda*. The post-emergent application of bromoxynil and MCPA to control *E. plantagineum* only suppressed its growth temporarily. The subsequent treatment with chlorsulfuron was most effective for control of *E. plantagineum* and no suppression of *Themeda* was observed.

Phase 3. Mechanical harvesting techniques

Materials and methods

In 1987, efforts were made to reduce the high labour input associated with hand-harvesting *Themeda* seed.

An hydraulically-powered reel-stripper was custom built and mounted on the front of a Fendt 380 GTA four-wheel drive tool carrier. It featured a forward rotating reel with six fixed wooden paddles to gather in *Themeda* culms and knock mature seed into a trough directly under and to the rear of the reel. The design of this machine was similar to the unit described by Wotzko (1981). Several passes over the *Themeda* stand were needed to gather seed as it matured.

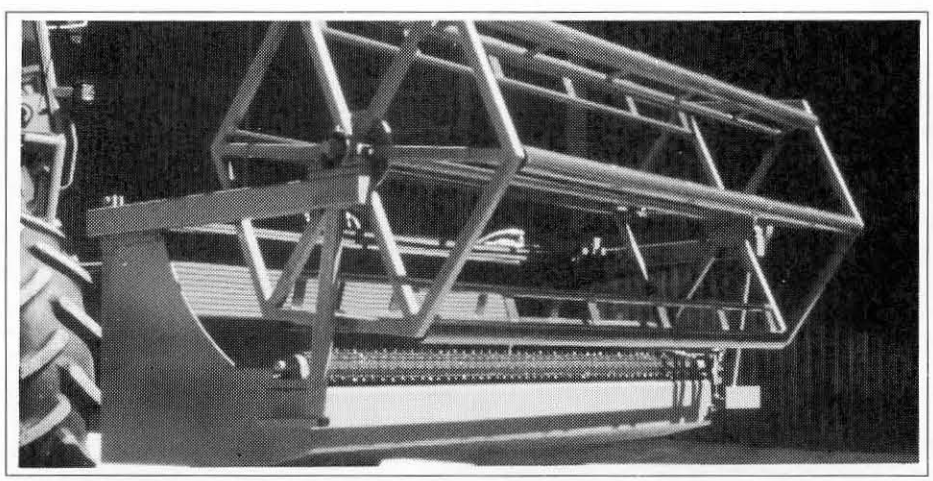
The reel-stripper was later modified by replacing the fixed wooden paddles with pivoted swing-back paddles of tubular steel. A contra-rotating roller of 50 mm diameter steel tubing along which eight lengths of 3 mm diameter steel rod had been welded was located immediately below the reel and in close tolerance to it. It was intended that as the reel gathered in culms, the panicles would be wedged between the roller and the paddles and would be dislodged from the culms. The pivoting paddles would swing back to avoid damage from any intruding obstacles. This unit was further modified by slightly raising the reel and adding flails to the rotor by threading 400 short lengths of fencing wire through holes drilled in the 3 mm rod and twisting to form a "V" shape flail. Rotating at 1,600 rpm, the flails were designed to intercept and dislodge the panicle which would then be collected in the trough.

Themeda panicles harvested in 1988-89 were transported to seeding sites in wheat sacks and broadcast at the rate of one bag per 150 m^2.

Results

The tractor-mounted reel-stripper was effective in obtaining a relatively clean sample of *Themeda* seed with no apparent damage to the seed awn. A comparison of the volume of seed collected by the reel-stripper and hand-harvested panicles suggested that mechanical harvesting was not very efficient. Much of the apparently mature seed had not been dislodged from the panicles. Also, several passes by the tractor over stands of *Themeda* severely damaged at least one third of the grass sward. Sites sown with seed harvested by the reel-stripper resulted in very poor germination of *Themeda*.

The first version of the modified reel-stripper failed to dislodge the panicles from the culms. However, the addition of wire flails to the lower rotor proved to be effective with close to 100% of the panicles being removed when the tractor was driven at speeds under 1 km hr^{-1}. Although plant establishment on some sites sown with this seed was acceptable, other sites produced poor results which, at the time, were attributed to causes other than the seed germinability. The next season a comparison was made between seed sown with mechanically harvested panicles, and seed sown with whole culms. The germination rate of the former was only 10% of the latter.



A custom built hydraulically-powered reel-stripper

Phase 4. Establishing seed nurseries

Materials and methods

During the 1988-89 harvest it became apparent that yields of seed from naturally regenerating sites of *Themeda* were declining. To maintain the revegetation programs in the East Torrens District more reliable sources of seed were required.

Attempts to establish a *Themeda* seed

nursery were made at the East Torrens Council depot, Ashton, which had good access and a reliable supply of water. Some seed was sown in 1987; further seeding was made over the next three years on a 1.5 ha plot of arable land (previously a vegetable garden). An irrigation system was installed to ensure rapid early development of the grass and to gain a second crop of seed by irrigating after the first harvest in December.

Results

Much of the nursery site had been sown with seed harvested in 1988 by the modified reel-stripper and as a result the density of *Themeda* in some areas was below the intended 5 plants m^{-2}. Poor germination was further aggravated by slow plant growth in areas where the market garden soil was prone to baking in warm weather. Seedlings germinating in late October and sustained by irrigation made rapid crown growth and were producing inflorescences in the following January.

Grass weeds, particularly perennial ryegrass (*Lolium perenne* L.), took advantage of the low cover of *Themeda* and, sustained by irrigation, provided constant competition to the *Themeda*. Stopping mid-summer irrigation in 1990-91 substantially reduced the vigour of grass weeds and allowed *Themeda* to dominate. Strong weed competition thwarted attempts to produce a second *Themeda* seed crop by summer irrigation.

Discussion

Establishment of Themeda

Collecting *Themeda* seed with the whole culm and broadcasting it immediately over unprepared ground has proved to be an effective and reliable method of harvesting and seeding (McDougal 1989) and is suitable for use on non-arable land with basic equipment.

Since 1986, the spray-burn technique for triggering *Themeda* germination in late October has been regularly used with consistent results. The pre-germination herbicide treatment of deliberately retained herbaceous weeds facilitates burning one to two months prior to the normal seasonal-curing of these plants. Removing competition from weeds by the use of herbicides and fire gives *Themeda* seedlings exclusive access to moisture retained in the soil throughout the vital establishment period of November-December.

At times atrazine failed to prevent the recurrence of *E. plantagineum*, a main weed on revegetation sites. However, chlorsulfuron applied as a post-emergent treatment was effective in controlling this weed. On two occasions the use of metsulfuron methyl (10 g/100 L), in lieu of chlorsulfuron, stunted mature *Themeda* plants and killed many seedlings. The post-germination application of herbicides has been useful in temporarily removing the competition of broadleaved weeds but it is the sustained growth of *Themeda* into the summer months and its subsequent persistence under dry conditions that enables it to dominate herbaceous competitors.

The reason why mechanically-stripped seed should fail to produce as many seedlings as seed harvested with the whole culm is currently being investigated.

Woody weed control

Much of the weed invasion in the East Torrens District has resulted from disturbance of the understorey in natural bushland. Restoring the understorey flora with indigenous plants has been the principal objective of the East Torrens Animal and Plant Control Board. Although *Themeda* would have been just one component of the original understorey community, its re-establishment has been beneficial for weed control. Physical removal of woody weeds and control by broadleaf-selective herbicide treatments do not adversely affect *Themeda* in the long-term. When dry foliage has accumulated in *Themeda* crowns it can be used to fuel a control burn in spring which is useful in eliminating seedlings and woody weeds, such as boneseed, olive and montpellier broom while encouraging further regeneration of *Themeda*. The combination of chemical and cultural methods for controlling weeds with a native plant that responds favourably to the controls methods constitutes a well balanced integrated control program. Such methods have been termed 'ecological weed control' (Groves 1991) and have an important role in the management of natural ecosystems.

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