It is important to maintain good vegetation cover to compete with *C. ciliaris* in extensive areas subject to a high risk of invasion. This approach has implications for the management of total grazing pressure, fire management and the rehabilitation of disturbed areas. It is possible to treat small areas of established *C. ciliaris* with herbicide applications or to grub it out, but follow-up control is essential. These techniques are labour intensive, costly and inappropriate for extensive areas but may be applicable in priority areas.

Conclusion

Cenchrus ciliaris presents a long-term threat to the biodiversity of some rangeland areas. With the inevitable continued introduction and spread of this species, native flora and fauna may be displaced and some species possibly threatened in the long term. In the short-term it is important to promote the disadvantages of *C. ciliaris* within the wider community and to actively address its management in priority areas. The challenge for rangeland managers in SA is to survey its current distribution and to develop a coordinated and prioritized management approach based on benefit and risk analysis. It will also require ongoing commitment into the future to maintain priority areas free of *C. ciliaris*.

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Salt tolerant grasses in the Upper South East of South Australia: a perspective on production, saltland management and weed potential

Tracey Strugnell, Combined South East Soil Conservation Boards, Keith, South Australia 5267, Australia.

Introduction

In recent years questions have been raised about the weed potential of puccinellia (*Puccinellia ciliata* Bor) and tall wheatgrass (*Thinopyrum ponticum* (Podp.) Z.-W. Liu & R.R.-C. Wang). Both of these grasses are very useful introduced pasture species in the Upper South East region of South Australia (SA) on land affected by salinity and waterlogging. This paper includes a discussion of three different aspects of these grasses: on farm production; salinity management in the Upper South East, and; weed potential and management. This background is needed for an informed discussion of the best way to utilize and manage the weed risks of these grasses. Firstly a brief description of both grasses and their advantages and disadvantages is given.

Description of *T. ponticum*

Tall wheatgrass has at least seven scientific synonyms (Virtue and Melland 2003), but *Thinopyrum ponticum* is used most commonly amongst pasture agronomists in Australia. However, *Lophopyrum ponticum* (Podp.) Á.Löve is the preferred synonym given in Shepherd *et al*. (2001). *T. ponticum* is a summer-growing, tussock-forming, perennial grass with a C3 photosynthetic pathway. It is native to the Balkans, Asia Minor and Southern Russia. *T. ponticum* occurs naturally in marshy situations, seashores and areas subject to inundation by seawater. It grows best in areas receiving more than 450 mm annual rainfall and has moderate salt and waterlogging tolerance. The plant has long bluish leaves and can grow up to 2 m high (Dohle 2000).

The two available varieties of *T. ponticum* are 'Tyrrell' and a newer cultivar called 'Dundas'. Tyrell was a CSIRO selection from the USA variety 'Largo', which in turn originates from seed collected in north-west Turkey (Virtue and Melland 2003). Dundas was developed (from Tyrell) by the Department of Primary Industries (DPI) at Hamilton, Victoria, to enhance the plant's leafiness, productivity and digestibility.

Description of *P. ciliata*

Puccinellia ciliata is a perennial grass that is very salt and waterlogging tolerant (more so than *T. ponticum*). *P. ciliata* was selected in Turkey by the CSIRO and was introduced to Australia in 1951. *P. ciliata* is a winter growing, summer dormant, C3 plant that grows from mid autumn to spring and matures in early summer. It is an excellent stock feed, best suited to saline areas with a shallow water table and where annual rainfall is more than 350 mm. It will grow in areas covered by sea barley grass (*Hordeum marinum* Huds.) and where the soil has become bare.

Puccinellia ciliata is able to colonize by seed in both summer-wet and summer-dry conditions, but seedlings of the plant grow very slowly in the first year and need to be protected both from grazing and competition from other species (Dohle 2000). *P. ciliata* either dies out or loses competitive ability when soil salinity and waterlogging decreases, whether that be through drainage or a series of dry years. There is also a native species of puccinellia, *Puccinellia stricta* (Hook.f.) C.H.Blom, and investigations of it are being made in Victoria (Kelm personal communication).

Advantages and disadvantages of *T. ponticum* and *P. ciliata*

Thinopyrum ponticum and *P. ciliata* provide the following environmental advantages:

- They can contribute to lowering local water tables in discharge sites and reducing recharge.
- They can form a perennial surface cover on bare saline soils (or sites becoming bare).
- The formation of this surface cover helps prevent soil erosion.
- The formation of this surface cover reduces evaporation from the soil surface and the concentration of salt.
- *P. ciliata* can be established on sites where nothing else will persist.

In addition both plants provide the following agronomic advantages:

- Provision of additional grazing later in summer, extending the growing season up to three months compared with other annual and perennial pasture species.
- Provision of valuable grazing on land that would otherwise be non-productive.

- Can be used in conjunction with salt tolerant legumes e.g. balansa clover (*Trifolium balansae* Boiss.) and strawberry clover (*Trifolium fragiferum* L.).
- When effectively managed, *T. ponticum* pastures sown with a companion legume are capable of increasing stocking rates from 0.5 dry sheep equivalents (dse) per hectare to 12 dse per hectare (Nichols 2002), and provide high quality green feed over summer.
- Landholders applying optimum levels of nitrogen and phosphorus fertilizers on *P. ciliata* pastures have increased stocking rates from 0.5 to 10 dse per hectare.

Thinopyrum ponticum and *P. ciliata* have the potential disadvantage:

- These exotic perennial pasture species are selected due to their ability to cope with drought, salt, waterlogging and their perennial habit. These attributes can make these species invasive in certain conditions and therefore prone to becoming weeds.

Salinity in the Upper South East – the big picture

Extensive agricultural developments occurred in the Upper South East after the discovery that trace elements were essential for both pasture and animal growth. The native bushland was cleared and Hunter River lucerne (*Medicago sativa* L.) was widely planted, its high productivity and water use helping to maintain the balance in the groundwater system in the absence of the native vegetation. By the mid 1970s there was approximately 300 000 ha of dryland lucerne. However, in 1978 a combination of lucerne aphids, drought and wingless grasshoppers decimated the lucerne stands to such an extent that only around 20 000 ha remained.

In 1981 a severe flood event inundated a large portion of the region. This raised the saline groundwater table to the surface and left bare soil over summer. A severe drought followed in 1982 and the saline water table concentrated through evaporation. Dryland salinity then became a cause for concern. The farming community struggled to come to terms with the problem as the area of salinized land increased. The salinization impacted on wetlands, remnant vegetation and farmland. Following more floods in 1988 and a succession of wet winters, concerns were raised as to the extent of the problem. Approximately 326 000 ha are presently affected by dryland salinity in South Australia. Of this, 251 000 ha (77%) is located in the Upper South East and another 175 000 ha is at risk of salinization in the region (National Land and Water Resources Audit 2001). Agricultural production losses caused by dryland salinity in SA are currently estimated at $26.1 m per annum (2000 data), with over 400 producers directly affected in the Upper South East region (National Land and Water Resources Audit 2001).

Although plenty of dryland lucerne is now being established in the region it is still a long way short of the peak of 300 000 ha. Non-wetting sand, disease, weeds, insects and unfavourable spring rains have all provided considerable, but not insurmountable, challenges to lucerne establishment.

Pasture production with salt-tolerant grasses

The rapid onset of salinization in the 1980s had a considerable impact on farm production in the Upper South East. Some farms suddenly had up to two thirds of productive land area affected by salinity. The choices were stark: either find a way to gain some production off these areas, or give up and face a permanent reduction in income. Innovative landholders trialed a number of options including *P. ciliata*, *T. ponticum* and saltbush (*Atriplex* spp.). Saltbush did not tolerate the waterlogging in the region well.

In many regions the recharge areas that are targeted are often the hills. In the Upper South East the whole landscape is a recharge area, in fact areas of the flats (often saline) have been found to have a recharge rate four times greater than the dunes. As a result establishment of high water use perennial vegetation is important everywhere, especially on the saline flats. Establishment of groundcover is also of great importance on the salt scalds so that the salt load at the soil surface does not have the opportunity to concentrate to extreme levels through evaporation. This reduces the likelihood for off-site export of this salt and reduces soil erosion risk. It is for these reasons that *P. ciliata* and *T. ponticum* are such important tools in saltland management in the Upper South East. These plants will establish on bare soils where little else will grow and they will maintain water use.

In the Keith area the main salt tolerant pasture adopted has been *P. ciliata*. In addition to its high salt and waterlogging tolerance, it also copes with other inhospitable soil characteristics such as high pH, and otherwise toxic levels of boron and chloride. *T. ponticum* has been used more extensively south of Keith and to the south-west around Kingston, on moderately saline areas.

Many areas of poorly managed *T. ponticum* can now be seen throughout the Upper South East, due to insufficient grazing pressure during the active growing period of spring to autumn. Landholders found that they had insufficient livestock to keep pace with the vigorous growth of *T. ponticum*. The result is rank and tussocky paddocks that have low feed quality and are difficult to traverse. Recent work carried out by Department of Primary Industries in Hamilton has provided more information about the optimum management of this pasture to obtain high quality feed (Smith 1996, Borg and Fairbairn 2003). This work shows that regularly grazed *T. ponticum* provides superior quality feed to that which is allowed to become rank. Therefore it is to the land manager's advantage to ensure that *T. ponticum* is not allowed to set seed.

The weed potential of *T. ponticum*

Thinopyrum ponticum was recorded in 13 out of 40 wetland sites recently surveyed in the Upper South East (McInerney 2003). *T. ponticum* occurred in areas of degraded vegetation and there were not many plants present. It would be beneficial if this survey could be repeated to gain an idea of whether these plants are spreading. *T. ponticum* is commonly seen on ungrazed roadsides, where it has spread from paddocks in saline and periodically inundated areas. It is present in some reserves, including the Coorong National Park (Virtue and Melland 2003).

A study was initiated by the Department of Primary Industries at Hamilton for the Glenelg Hopkins Catchment region, following concerns about weediness of *T. ponticum* in Victoria. Little and Kearney (2003) surveyed 60 sites where *T. ponticum* had been planted, representing a range of soil and land management types. Minimal or no spread was detected for most of the 60 sites. Spread was only detected at sites where plants had been allowed to set seed at some stage, with the distance of spread mostly being less than 20 metres from the sown site. Minimal or no spread was recorded where grazing pressure was present. However, where a road was adjacent to a sown site there was a greater likelihood that spread had occurred. There were instances where spread occurred at significantly greater levels than the average for that area. These sites were characterized by being poorly maintained with large amounts of seed shed onto the ground and/or being subject to inundation with water that then flowed into roadside drains and nearby creek systems (Little and Kearney 2003).

Managing *T. ponticum*

There is no conceivable reason for *T. ponticum* to set seed in a grazing enterprise. The pasture quality declines, becomes rank and unpalatable, is difficult to manage and can become invasive. Borg and Fairbairn (2003) studied *T. ponticum* feed quality around Hamilton, Victoria. Their results strongly indicated that effectively managed *T. ponticum* (kept <20 cm in height) is a high quality pasture, more than capable of filling the summer/autumn feed gap (when most other pastures are dormant or dead). This clearly indicates that *T. ponticum* pastures must be kept short and vegetative. The study also showed that old, rank *T. ponticum* pastures could easily be returned to productive pastures just by slashing, burning or mulching old growth.

Hence, to restrict the spread of *T. ponticum* and gain the most out of the pasture, graze it from spring through to autumn, maintaining it to a height of approximately 10 cm over summer. If grazing is not an option due to a lack of stock numbers then *T. ponticum* can be cut for hay or silage. Good quality hay or silage comparable to other perennial pasture hay should be expected, provided it is cut early enough before it becomes too stalky (<50 cm) (Borg and Fairbairn 2003). *T. ponticum* should only be sown where the aim is to establish and manage it as a viable grazing pasture (with an adequate stocking rate), not just as groundcover. It should not be sown adjacent to native vegetation, wetlands or creeks. Sites should be fenced, of an appropriate size for controlled grazing and should always contain a watering point.

The weed potential of *P. ciliata*

Puccinellia ciliata has a low competitive ability at the seedling establishment stage. Mature plants are not good competitors in non-waterlogged and/or non-saline situations. Virtue and Melland (2003) concluded that *P. ciliata* is likely to only reach a low overall density in native vegetation, being restricted to saline areas. *P. ciliata* does appear to establish readily on bare ground in saline watercourses, and has been observed spreading into samphire (*Halosarcia* spp.) and salinized *Melaleuca* vegetation where there are high levels of bare soil. Overall, *P. ciliata* has a very low weed risk threat and is not seen by other Australian states to be a plant of concern (Dohle 2000).

Managing *P. ciliata*

Livestock should be rotationally grazed on the higher ground away from areas prone to inundation during wet periods in winter. Stock can then be put on *P. ciliata* pasture flats for the late summer/autumn period. Whilst *P. ciliata* is at its best through winter to late spring, saltland pastures in the region can be inundated in an average to wet year. As a consequence it is important that *P. ciliata* is carefully grazed in early winter to maintain some height to survive the effects of waterlogging. It is also important to maintain cover through late spring and summer to reduce the salinity level, which peaks in this period. Groundcover minimizes evaporation from the soil surface and consequent 'crusting' of salts. It is for this reason that most landholders will carryover feed into the autumn (Morris 2001). Leaving *P. ciliata* to stand for use as an autumn 'haystack' does mean that it is able to set seed. If future weed surveys show that *P. ciliata* is becoming invasive then this type of management recommendation may need to be reviewed.

Putting weed risk into a wider perspective

Thinopyrum ponticum has been identified as an environmental weed risk in the Upper South East (Virtue and Melland 2003). Yet there is the competing and probably more imminent environmental threat of salinity in the region. Are recharge control and the maintenance of an economically viable farming community more important than the potential for spread of *T. ponticum*? For example, the risks to a local wetland are a rising saline groundwater and *T. ponticum* spread. Which is the greater risk and which is easier to manage? Do you stop *T. ponticum* pasture establishment and hence decrease water use and increase salt concentration on saline areas, to avoid the weed risk? Or do you manage these *T. ponticum* pastures more effectively? There are few viable alternative pastures on the horizon for these cleared, saline, waterlogged agricultural lands of the Upper South East, and *T. ponticum* is already widely planted in the region. Ensuring better landholder management of *T. ponticum* would appear to be the best course of action.

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