Limited ability of native pastures to control deep drainage

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Abstract

There have been few measurements published on the effect of different land uses on deep drainage in the Wimmera region of Victoria. The aim of this study was to compare estimates of drainage in relation to land use. Deep soil cores to 6 m were taken on a Sodosol in the Wimmera region of Victoria. Cores were sampled from a relatively uniform landscape that supported three distinct land uses in adjacent paddocks: native pasture (established 20 years); annual crops (40 years); and native bushland (>40 years, *Allocasuarina luehmannii*). Cores were taken in November 2005 and soil moisture content and chloride concentration measured down the profiles. Results indicate that there is “leakage” of plant available water below 1 m from under the native pasture and the annual cropping paddock. In contrast, chloride was concentrated at shallow depths in the native bushland indicating that this landuse has the least deep drainage.

Key Words

Native grasses, deep drainage, salinity, chloride profiles

Introduction

Prior to European agriculture, much of the landscape of the Wimmera region in Victoria was dominated by open woodlands interspersed with perennial grasses such as *Austrostipa spp., Austrodanthonia spp.* and *Themeda triandra* (Connor 1966). It is assumed that these native pastures maintained a hydrological balance in the Wimmera before agriculture based on annual cropping began. It is generally thought that the clearing of the “deep-rooted perennial native pasture” and replacement with shallow-rooted annual crops created an imbalance in the hydrology of the land system which led to deep drainage and the movement of salts to the surface. Much of the focus of the estimates for deep drainage has been in higher rainfall areas (*eg* White *et al*, 1999) but there are few measurements from the Wimmera which is relatively dry (420 mm average annual rainfall) and has soils with relatively high clay contents (>45%) and many subsoils contain chemo-physical constraints to root growth (Nuttall *et al* 2003).

In 2004 a field experiment was established to compare the water use of native pastures with annual cropping in the Wimmera catchment of Victoria. This site was returned to native pasture after a long history of annual cropping more than 20 years ago and now has well established stands of *Austrodanthonia spp.*, *Austrostipa spp.* and *Enteropogon acicularis*. Preliminary observations on this site showed that the soil below 1 m was near the estimated drained upper limit suggesting that the native pasture had not extracted deep soil water. To further investigate these findings a study was undertaken in 2005 to compare the pattern of deep drainage between three adjacent paddocks with long-term histories of native pasture, annual cropping or native bushland.

Methods

Six soil cores of 45 mm diameter were taken in November 2005, to 6 m depth in each of three landuse zones (native pasture (*Danthonia spp, Austostipa spp* and *Enteropogon acicularis*, established 20 years), annual crops (40 years) and native scrub (>40 years, *Allocasuarina luehmannii*) at a site near Boolite, Victoria (34?47'S 137?34'E). The areas selected were adjacent to each other, each based on a Sodosol soil (Isbell 2002) with equivalent rainfall and similar positions in the landscape. Two cores were taken 50 cm apart and bulked to increase volume of sample size. Each core was divided into 0.2 m layers to a depth of 2 m, and cores of length 80 mm were taken at 0.5 m intervals for soil depths between 2 m and 6 m. Gravimetric water content (%) and total chloride (mg/kg) were measured for each layer (O'Leary and O'Connell 2004).

Results and Discussion

In the root zone (0-2 m), the highest levels of chloride occurred in the bushland (Figure 1b), indicating very little movement of water. The gravimetric moisture contents indicate the tree belt has dried the soil to wilting point (-1500 KPa) (Figure 1a). Under the annual cropping system, where the land was in fallow since the previous crop in 2004, soil moisture content remained relatively high throughout the potential root zone. This land use has the highest soil water content at 2 m.

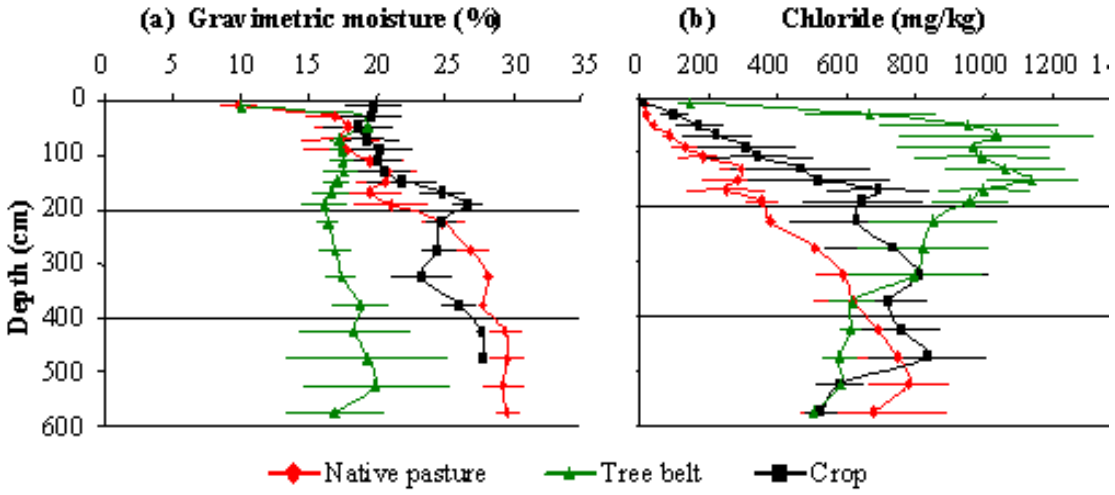

Figure 1. Gravimetric soil moisture content and chloride concentrations within three soil profiles to a depth of 6m under native pasture, annual cropping and bushland in November 2005 at Boolite, Victoria. Standard errors are indicated for each measure.

Water content under native pasture was similar to the bushland in the top 1 m, but was markedly wetter at soil depths greater than 2 m. Chloride levels were lowest in the top 3 m under native pasture, indicating that this land use had the highest drainage of the three different land systems studied. The native pasture may use enough water to survive during active growth in the spring, but then may become dormant during times of water stress, rather than grow prolifically when water is made available. The water use pattern observed also raises questions over the ability of the root systems of native grasses to extract water from depth in these soils.

Future work will parameterise soil water dynamic models, such as PERFECT, to evaluate long term trends in deep drainage, by utilising data collected in the field. These simulations will provide risk assessments for particular land uses on particular soil types and the associated risk of deep drainage. In particular, with the high conservation value now placed on these relatively rare native grasslands in the Wimmera catchment, there is a need to understand their contribution to deep drainage relative to other land use options.

Conclusion

Our results indicate leakage of plant available water from the native pasture and the annual cropping paddock below 1 m whereas the bushland contained the most chloride at the shallow depths, indicating least deep drainage.

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