Using raised beds to reduce waterlogging of pastures - pasture productivity effects

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Abstract

Research and industry experience indicates that growing field crops on raised beds can lead to substantial grain yield increases on waterlogging prone soils. In a 2 year south west Victorian trial, the effect of growing grazed pastures on raised beds was investigated to determine if similar DM yield advantages occurred with pastures. One third of a 14 ha poorly drained paddock had raised beds (1.7 m beds, 0.3 m furrows) installed, a third had hump and hollows (25 m wide) installed and a third was left undrained. The trial area was sown to Italian ryegrass (*Lolium multiflorum* Lam.) each autumn and grazed from mid winter until early summer with Coopworth ewes and lambs. In the drought year of 2006 the raised beds grew 37% less and the hump & hollows 7% less than the undrained (7.61 t DM/ha). In the higher rainfall 2007 the raised beds produced 15% less pasture DM than the undrained, whilst the hump & hollows grew 10% more than the undrained (10.65 t DM/ha). In 2006, the better drainage of the raised beds may have caused more severe and prolonged moisture stress reducing herbage DM accumulation. In 2007, the reduced herbage accumulation was in part due to wet conditions favouring the growth of winter grass (*Poa annua* L.) which in turn substantially reduced the herbage production in the furrows. It is concluded that growing pasture for grazing on raised beds is not an effective method of increasing pasture DM production in areas prone to winter waterlogging.

Key Words

Raised beds, waterlogging, drainage, pasture productivity,

Introduction

Poor soil drainage leading to periodic waterlogging limits the production of crops and pastures on many soil types in south eastern Australia (MacEwan *et al.* 1992). In south west Victoria there has been the widespread adoption of raised beds for field cropping to reduce the severity and duration of waterlogging (Peries *et al.* 2004). In a review of the results of research trials, demonstrations and surveys comparing grain yields from raised beds and flat land over a diverse range of environments and soil types in southern Australia, Wightman *et al*. (2005) reported a positive grain yield response for beds in 40 out of 56 comparisons with an average yield response of +35%. In light of such crop responses, livestock producers have asked if similar improvements in herbage DM production from grazed pastures grown on raised beds could be obtained. A study was undertaken to determine the effect of raised beds on DM production from grazed pastures.

Methods

Study site and trial establishment

The trial was conducted on a commercial sheep farm (38^{o} 03'S, 143^{o} 10'E) near Derrinallum in south west Victoria. The soil is a poorly drained light clay described as a Grey Vertosol (Isbell 1996) derived from Quaternary basalt. Initial soil tests (0-10 cm) indicated a soil pH_{H2O} of 5.0, electrical conductivity of 0.33 dS/m, Olsen P of 26 mg/kg, available K of 208 mg/kg and CPC S of 114 mg/kg. During the autumn of 2005 a 14 ha pasture paddock was cultivated and divided into three equal areas. Raised beds (1.7 m beds, 0.3 m furrows) and "hump and hollow" (25 m wide beds) drainage were installed using commercial cropping equipment on a third each of the area, with the remaining one third of the paddock being left as an undrained control. The paddock was fenced along the boundaries between treatment areas to form three paddocks. In April of both 2006 and 2007 the existing pasture was sprayed out with a knockdown

herbicide, Roundup Max (540 g/L glyphosate) at 2.0 L/ha. The trial area was direct drilled to Italian ryegrass (*Lolium multiflorum* Lam.) cv. Crusader at 25 kg/ha on 26 April 2006 and a mixture of Crusader at 10 kg/ha and Abundant at 15 kg/ha on 12 May 2007. In the raised beds, seed was drilled into both the top of the beds and the furrows. In both years, the seed was drilled with 80 kg/ha of DAP (14.4 kg N/ha, 16 kg P/ha). The establishing pasture was topdressed with urea at 100 kg/ha (46 kg N/ha) and 120 kg/ha (55.2 kg N/ha) on 16 July 2006 and 3 July 2007 respectively. Triple superphosphate was broadcast at 100 kg/ha (20 kg P/ha) in April 2006. All three treatments were stocked with mature, in-lamb Coopworth ewes on 14 July 2006 initially at 7.5 ewes/ha, increasing to 12 ewes/ha on 10 August. The ewes lambed down on the trial, grazing it through the winter-spring period until the lambs were weaned and removed from the trial on 8 November 2006. In 2007, maiden, in lamb Coopworth ewes were used, being introduced to the trial at 9 ewes/ha on 19 July 2007, increasing to 13.6 ewes/ha on 22 August. Lambs were weaned and the trial destocked on 3 December 2007.

Pasture Measurements

Pasture DM accumulation was measured using pasture exclusion cages and a calibrated weighted disc, falling plate pasture meter (Cayley and Bird 1991). Eighteen pasture cages, in 3 strata of 6 cages each were randomly placed on typical areas of pasture in the undrained and the Hump & Hollow treatment areas. In the raised bed area, 18 cages were used on the top of the beds (1.7 m wide) and 18 cages used on the furrows (0.3 m wide). At the start of each measurement interval, the pasture cage was moved to a new spot and a plate meter reading taken. Pasture under the cage was allowed to regrow until the appearance of 2-3 leaves on the ryegrass plant (3–6 weeks) and then a further plate meter reading taken. At each assessment time, 10 calibration cuts (0.10 m^2 cut to ground level) from the regrowth under the cages and 10 from the surrounding grazed pasture equivalent to the new cage positions were taken and dried at 100^oC for 72 hours. A linear regression equation of pasture meter reading and herbage DM mass for each treatment at each assessment time was developed. Regressions were then pooled to develop a winter, early spring and late spring regression for each treatment. Pasture DM accumulation was calculated as the change in the estimated pasture mass (t DM/ha) at the end of the growth interval less that at the start. Pasture DM accumulation in the furrows of the raised bed treatment was estimated by trimming the pasture within a 0.3 m x 0.7 m quadrat to 15 mm height using electric clippers with a height guide at the start of the growth interval, placing the cage over the spot and harvesting the pasture to 15 mm at the end of the growth interval and measuring DM accumulated. As herbage DM accumulation from the raised bed treatment was made up of pasture growing on the top of the beds together with that growing in the furrows, a weighted figure was estimated

Results and Discussion

Total annual herbage accumulation of systems

The total growing season herbage DM accumulation for the raised beds was the lowest of all the treatments in both years (Figure 1). In the drought year of 2006, total DM accumulation of the raised beds was only 4.81 t DM/ha while the undrained and hump & hollow production were similar with 7.61 and 7.05 t DM/ha accumulated respectively. Pasture DM accumulation rates (data not presented) declined for the raised beds relative to the other two treatments from mid September onward**.** In the much wetter 2007 season, the raised beds were still the lowest yielding at 9.07 t DM/ha compared to the undrained at 10.65 and the hump & hollow at 11.71 t DM/ha. This is despite the undrained and to a lesser extent the hump & hollow experiencing periods of waterlogging during the year. These results suggest that the pasture growing on raised beds was more drought affected in the dry year whilst in the wet year the better drainage of the beds was not translated into greater herbage DM accumulation compared with the other treatments.

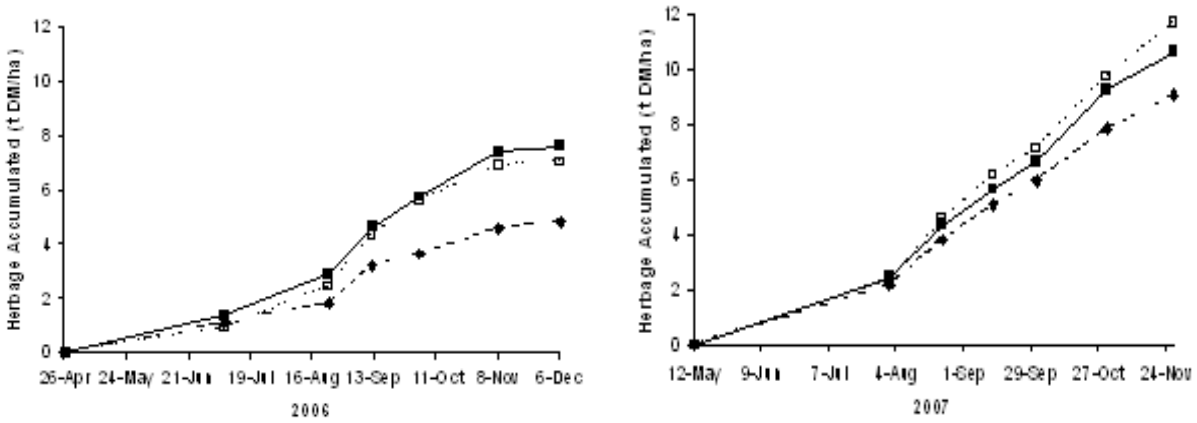

Figure 1. The cumulative herbage accumulated (t DM/ha) during the 2006 and 2007 growing seasons from pasture growing on the undrained (■), hump & hollow (□) and raised bed (♦) treatments.

Throughout the dry 2006 growing season, herbage DM accumulation rates in the furrows and on the tops of the raised beds were similar (Figure 2). However, in the wetter 2007 growing season herbage DM accumulation rates in the furrows were considerably lower than the top of the beds from early August onwards. By the end of November herbage DM accumulation for the furrows (4.61 t DM/ha) was only half that of the top of the beds (9.68 t DM/ha). Although the furrows made up only 15% of the land area of the raised bed treatment it is clear that this lower DM accumulation in the furrows contributed to the overall lower DM yields of this treatment. This finding is consistent with that in cereal crops where Riffkin and Evans (2003) found that cereal crop grain yields with raised beds were sometimes reduced in excess of 25-30% because of poor production in the furrows.

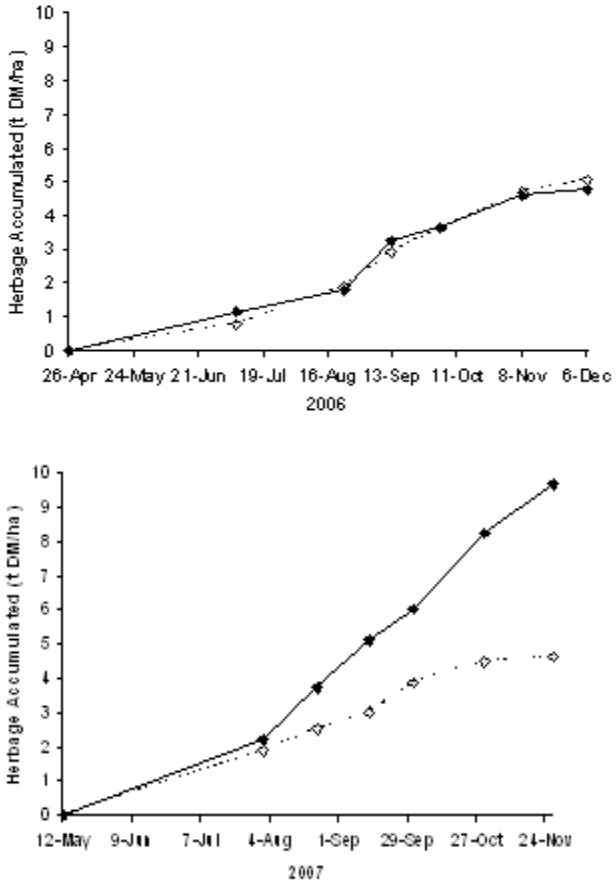

Figure 2. The cumulative herbage accumulated (t DM/ha) during the 2006 and 2007 growing seasons of pasture growing on the top of the raised beds (♦) and in the furrows between the beds (◊).

Botanical composition

The botanical composition (data not presented) of the pasture growing on the undrained was similar to the hump & hollow in both years. In mid spring of 2006 both had ryegrass contents of around 75% and 20% clover, while in 2007 they were composed of 60% ryegrass, 10% clover and 20% annual grass. There were however marked differences between the years in the botanical composition of the pasture on the top of the raised beds and that in the furrows. In the dry 2006, the pasture composition was similar (Figure 3) both being ryegrass dominant and the bed tops having a higher proportion of clover. The furrows had a higher proportion of annual grass (predominantly *Poa annua* L.), but this never exceeded 15%. During 2007 the pasture growing in the furrows was dominated by the annual grass *Poa annua* L. (Figure 4). The ryegrass content of the furrow pasture was only 10% in early August, rising to a high of 45% by late October.

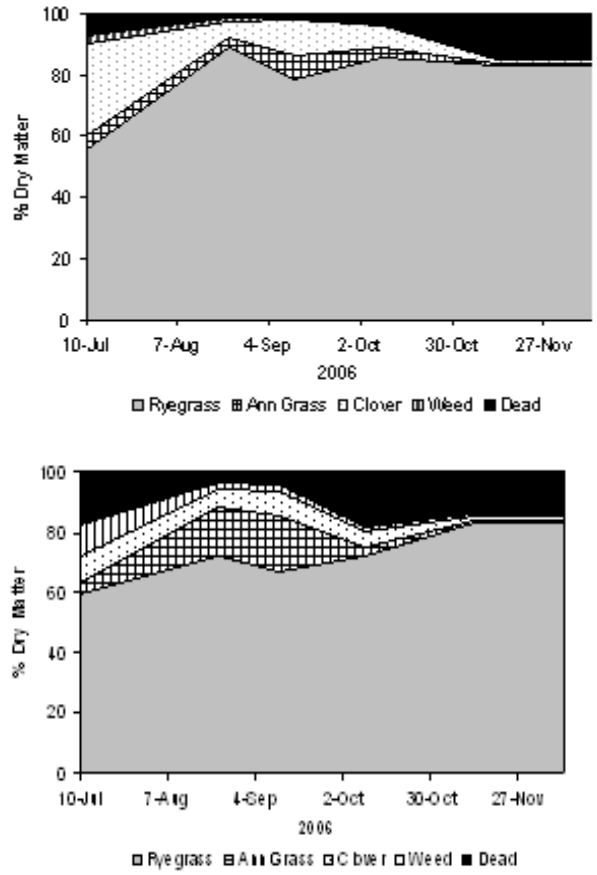

Figure 3. The botanical composition of the pasture growing on a) the top of the beds, and b) in the furrows of the raised beds during the 2006 growing season.

In contrast the ryegrass content of the bed tops was 60% and 79% for these same months. This suggests that periodic waterlogging during 2007 encouraged the growth of the *Poa annua* L. at the expense of the ryegrass causing markedly lower herbage DM accumulation in the furrows.

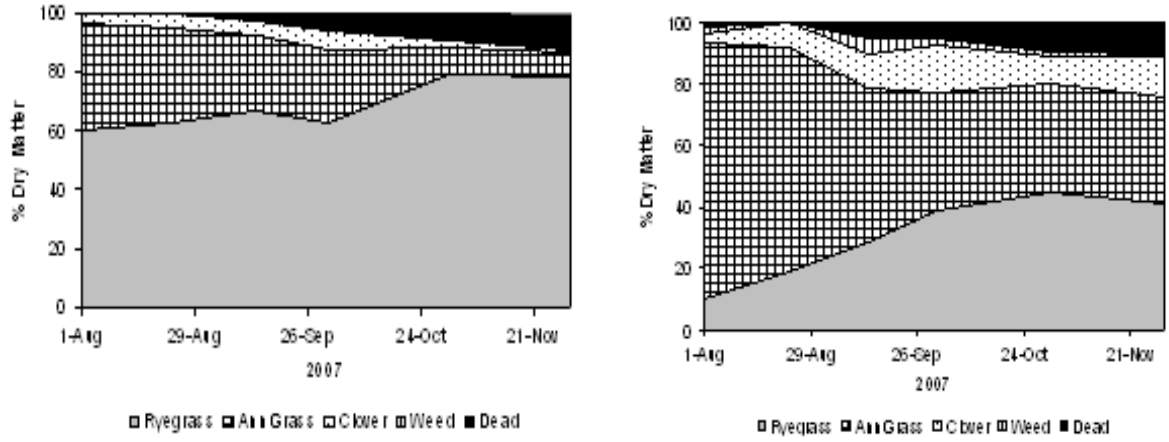

Figure 4. The botanical composition of the pasture growing on a) the top of the beds, and b) in the furrows of the raised beds during the 2007 growing season.

Conclusion

The growing of ryegrass pasture on raised beds resulted in a reduction in total herbage DM accumulation for the growing season in both dry and wet years. In the dry year the better drainage of the raised beds may have caused more severe and prolonged moisture stress reducing herbage DM accumulation. In the wet year, the reduced herbage DM accumulation was in part due to wet conditions favouring the growth of winter grass (*Poa annua* L.) which in turn substantially reduced the herbage accumulation in the furrows. It is concluded that the growing of pasture on raised beds is not an effective method of increasing pasture DM production on wet soils.

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