# THE EFFECT OF PASTURE TYPE AND MANAGEMENT ON SOIL MATRIC POTENTIAL AND ROOT PROFILE

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## Abstract

Creating a high soil matric potential in autumn is critical for reducing groundwater recharge in the Mediterranean environment of south west Victoria . Under an annual pasture, the soil matric potential was low at depth (120 cm) throughout the year. In contrast, under a set stocked upgraded perennial pasture the soil matric potential was high from mid summer but by July the profile was fully wet. The root length under the annual pasture was less than that under the upgraded perennial pasture. On a similar soil type at two other sites, one with an upgraded perennial pasture and one with a degraded perennial pasture, there was a higher autumn soil matric potential under both rotational grazing and summer spelling, compared with set stocking. The root length under the rotationally grazed pasture was higher under the set stocked pasture. At a fourth site, with a higher rainfall and different soil type, the soil matric potential was higher over summer and autumn under set stocking and summer spell than under rotational grazing.? Reduced groundwater recharge can be expected with some of the systems investigated but none would eliminate it.

*Key words: Pasture type, grazing management, soil matric potential, root profile.*

The results of several recent studies (1, 2) indicate the targets set in several Victorian salinity management plans for reducing groundwater recharge by sowing deep rooted perennial grasses and legumes are unlikely to be achieved. There is a growing awareness that summer activity in any vegetation system is critical for reducing recharge in a Mediterranean climate (3, 4). This paper reports on the impact of pasture type and grazing management on the soil matric potential throughout the year and the root profile in four situations in south west Victoria.

## Materials and methods

Measurements were made at 4 locations. At Vasey, about 40 km north of Hamilton where the productivity of a moderately set stocked annual pasture was compared with a heavily set stocked upgraded perennial pasture (resown in 1988-89 with phalaris, perennial ryegrass and sub clover and then heavily fertilised) (6).? One hectare of the upgraded perennial pasture was grazed rotationally (1 week grazing, 7 weeks spell) for three years. At Cavendish, about 30 km north of Hamilton, an upgraded perennial pasture sown in 1992 was used. The third site was at Balmoral, about 60 km north of Hamilton, where a degraded (low clover content, high annual grass content) phalaris pasture was used. On the fourth site a degraded perennial ryegrass pasture near Hamilton was used.

The first 3 sites were on a similar soil. The top soil was a strongly acid sandy loam, 20-30 cm deep, over a yellowish dense clay sub soil. The Hamilton site was on a moderately acid clay loam top soil, 25-35 cm deep, over a neutral clay sub soil. Sites 2, 3 and 4 were part of the Temperate Pastures Sustainability Key Program.? The set stocking, summer spell (no grazing 1 December - 28 February) and rotational grazing (2 weeks grazing, 6 weeks spell all year) were the only treatments studied at these three sites.

At Vasey the soil matric potential was measured by installing 4 gypsum blocks at each sampling depth (generally 15, 30, 60 and 120 cm) and connecting them so a single average value was measured (5). Two replicate sets of blocks were installed under each pasture. At the other sites blocks were installed in the same way as at Vasey on each of the four replicates of the three selected treatments. All the blocks at Vasey, and one set from each treatment at the other sites, were connected to a data logger which recorded measurements daily. Blocks not connected to a logger were read with a hand held meter at 2-4 week intervals. Data recording commenced in 1993 at Vasey, 1994 at Cavendish and 1995 at Balmoral and Hamilton.

The root profile was measured at Vasey in spring 1994 and 1995 and at Cavendish in spring 1996 . Undisturbed soil cores down to 1 m were collected from 20 positions on each of the two pastures at Vasey and from 5 positions in each of the 4 replicates at Cavendish.? The cores were sectioned (Table 1) and the roots washed out using a modified Rothamstead root washer (8) fitted with a 1 mm mesh nylon plastic sieve. The length of roots was measured using a root length scanner (Comair, Melbourne). The results were analysed using analysis of variance.

## Results

The soil matric potential at 120 cm for the four sites is plotted in Fig. 1-4. They are plotted using a logarithmic scale because it better reflects the changes. Treatment differences at other depths were not as great as at 120 cm and are not shown. Differences between years at a site reflect at least in part differences in seasonal conditions.

At Vasey, soil matric potential below the annual pasture remained low throughout almost the entire sampling period (Fig. 1). In contrast, under the upgraded pasture, the soil matric potential was quite high over the January to June period and became higher with each successive year. Differences between the pastures quickly disappeared after this and by July at the latest, in all years except 1997, both soil profiles were fully wet. Differences in the soil matric potential between the grazing treatments on the upgraded pasture were small, the set stocked pasture having a slightly higher potential.

At Cavendish, the pasture management had a noticeable effect on the soil matric potential (Fig. 2) with the soil at 120 cm being drier under the summer spell and rotational grazing treatments. Differences were most pronounced in 1994-5. The trends observed at Balmoral (Fig. 3) were generally consistent with those at Cavendish. At Hamilton, the rotationally grazed pasture did not produce a soil matric potential as large as that at the other sites (Fig. 4). The potential was higher under set stocking at this site and was similar to that under the summer spell.

The root density under the two pastures at Vasey, and two of the pastures at Cavendish, are shown in Table 1.? The density near the surface was generally less under the annual pasture than under the upgraded pasture but below 40 cm the differences were very small. Under rotational grazing the root density was slightly greater than under set stocking. The density of roots under the rotationally grazed pasture was consistently higher than under the set stocking at Cavendish but the difference was only statistically significant (natural log transformation before analysis) for the 10-20 cm section.

Over the time of the measurements, in mid October phalaris was 5-10% of the available grazed pasture on the set stocked treatment at both Vasey and Cavendish and 25-30% at Balmoral. At Hamilton, perennial ryegrass was 20-25% of the available grazed pasture on the same treatment at the same time.

Table 1. Root density (cm root/cm$^3$ soil) down to 1 metre under an annual and upgraded perennial pasture at Vasey and set stocked and rotationally grazed upgraded perennial pasture at Cavendish.

| | Vasey | | | | | Cavendish | |
|---|---|---|---|---|---|---|---|
| | Annual pasture | | Upgraded perennial | | | Upgraded perennial | |
| | Set stocked | | Set stocked | | Rotational | Set stocked | Rotational |
| Soil section (cm) | 1994 | 1995 | 1994 | 1995 | 1995 | 1996 | 1996 |
| 10-20 | | 4.42$^b$ | | 6.90$^a$ | 6.96$^a$ | 14.6 | 20.3 |
| 20-40 | 2.47$^b$ | 1.40 | 4.70$^a$ | 2.20 | 2.39 | 7.4 | 8.4 |
| 40-60 | 0.24$^b$ | 0.53 | 0.57$^a$ | 0.52 | 0.72 | 4.5 | 4.7 |
| 60-80 | 0.22 | 0.13$^b$ | 0.19 | 0.32 | 0.39$^a$ | 2.4 | 2.9 |
| 80-100 | 0.12 | 0.17 | 0.11 | 0.05 | 0.31 | 1.8 | 2.6 |

For the Vasey data unlike superscripts indicate significant differences ($P<0.05$) between pasture types at a particular depth.

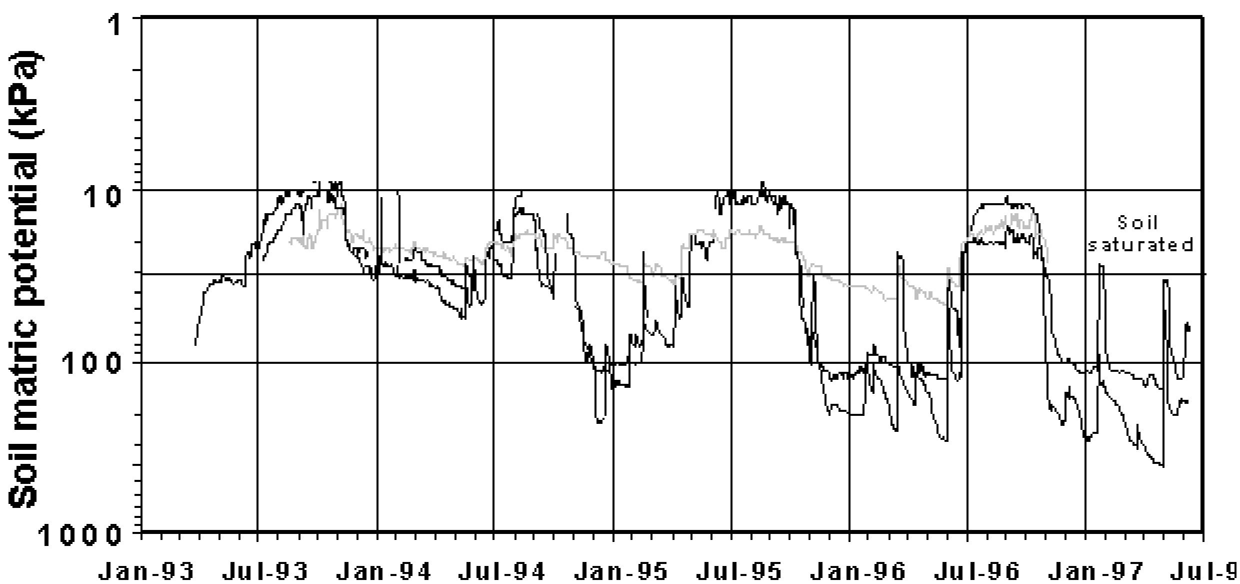


Figure 1

Discussion

In three of the four years at Vasey the soil matric potential was higher under the upgraded perennial pasture than the annual pasture. However, under the upgraded perennial pasture the soil matric potential was less than 30 kPa for 4-6 months in all years except 1994.? The results from Cavendish and Balmoral indicate controlling the grazing of a pasture offers some scope for further manipulating the water balance. Phalaris was present in both pastures and when stock were excluded for any time over summer and autumn a small amount of green plant material grew (up to 260 kg DM/ha was measured), which the soil matric potential results show was sufficient to transpire a significant amount of water at that time of the year. Why rotating the grazing at Vasey did not result in a higher soil matric potential is not clear. At Hamilton, where perennial ryegrass was the perennial grass present, no green plant material developed when stock were excluded over summer and autumn. Thus, the higher rainfall (extra 70 mm/year) and the different soil type may be why the results are different from those at Cavendish and Balmoral.

Overall the results indicate recharge will be lower where a pasture contains a perennial and will be even lower when grazing over summer and autumn is controlled but some recharge will still occur.

The root densities under the pastures are within the range measured by others (7, 9). The root density down to 60 cm at Vasey was substantially higher under the upgraded perennial pasture in both years, which may partly explain the differences in soil drying patterns between mid spring and early summer. Below 60 cm the root densities were substantially lower, probably due to the very high soil bulk density (2.5 g/cm$^3$ at nearby site), and differences between the two pasture were very small. Root density under the rotationally grazed upgraded perennial pasture was consistently higher than under set stocking at both Vasey and Cavendish. Rotational grazing increased the proportion of phalaris in the available pasture at both sites (J. Graham, unpublished data; P. Schroder, unpublished data ) but at no time was it considered to be a major component of the pasture. This may explain why the root density was higher under rotational grazing and why differences were only statistically significant in one section.

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