Effect of lucerne density on soil moisture content during summer in southern NSW

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Abstract

Plots (4 m x 4 m) were established with 0, 4, 9, 16 and 30 lucerne plants/m^2 in October 1996. These were left to develop until early 1998 at which time they had thinned to 0, 3.0, 7.3, 11.6 and 18.2 plants/m^2, respectively. All plots were watered in mid-January 1998 and subsequently monitored for soil moisture (neutron moisture meter) from 24 January to 10 March. Due to the variability between plots a regression approach was taken and shows that there was a sigmoidal relationship between changes in soil moisture in the upper profile (0-90 cm) and lucerne density. A similar relationship existed in the lower profile (90-180 cm) but over a more restricted soil moisture range. By inspection, it appears that lucerne plots with greater than 12 plants/m^2 are able to provide maximum water extraction capacity in summer and plots with less than 5 plants/m^2 were not noticeably different from fallow plots. The results are discussed with respect to the condition of lucerne pastures and the importance of maintaining adequate plant populations to achieve the "de-watering" function.

Introduction

The incorporation of lucerne in phase farming systems has attracted a great deal of research over the last decade. A range of studies has found that compared with annual pastures, lucerne has the potential to reduce deep drainage (eg. 1,2). Together with its capacity to support high rates of animal production (3), results from such studies support the promotion of lucerne as an important component of sustainable and productive phase farming systems. The survival of individual lucerne plants may be threatened by any combination of competitive interactions, pests, diseases, and grazing management (4). Hence, as a lucerne population declines over time (there being no or little seedling recruitment), it is important to investigate density effects on soil moisture. This paper reports the effects of lucerne density on changes in soil moisture over 6 weeks in summer-autumn 1998.

Methods

The experiment was located at the Wagga Wagga Research Institute, (35?5’S, 148?6’E; elevation, 219 m; average annual rainfall, 572 mm) in southern New South Wales on a yellow lithosol (5). Lucerne (*Medicago sativa* L. cv. Aquarius) plants were raised in a glasshouse over winter and planted at densities of 0, 4, 9, 16 and 30 plants/m^2 in 4 x 4 m plots on 16 October 1996. The prepared seed bed that had been sprayed with Trifluralin[?] (1.8 l/ha) to control weeds. During 1997, plots and buffers (1 m wide) were regularly sprayed (for volunteer grasses) and cut, to control weeds. In October 1997, one (2 m deep) neutron moisture meter (NMM) access tube was placed near the middle of each plot, equidistant from the two nearest plants. On 13 January 1998 all plants were cut to 5 cm height and subsequently watered with 105 ? 10 mm over the next 5 days to simulate a summer rainfall event and reduce differences between plots due to previous water use. Soil moisture was measured on 24 January 1998 and again on 10 March using a calibrated NMM probe. In the intervening period, the plants were cut to 5 cm on 19 February and there was only one rainfall event of 20 mm on 7 February.

Results

At the commencement of the measurement period the plots had thinned significantly leaving an average of 0, 2.4, 5.9, 10.1 and 18.2 plants/m^2 for the treatments that were originally sown at 0, 4, 9, 16 and 30 plants/m^2, respectively. With respect to analysis, two approaches have been used. The first, analysis of variance based on the original populations density, showed that if the profile was divided into upper (0-90 cm) and lower (90-180 cm) layers then treatment had a significant impact on change in soil moisture over the period. In the upper layer, decline in soil moisture was greater at densities of 16 and 30 plants/m^2 than 0 and 4 plants/m^2, with 9 plants/m^2 being intermediate. In the lower layer change in soil water was only significantly different between densities of 0 and 30 plants/m^2. However, the degree to which populations had thinned was not even across plots or within treatments. For instance, the three plots planted with 16 plants/m^2 had declined to 12, 11.75 and 6.75 plants/m^2, demonstrating the limitations of the classical ANOVA approach. In the second approach, the change in soil moisture content versus actual density for the upper and lower profiles were simply plotted (Figure 1). This shows a sigmoidal relationship for both upper and lower profiles (r^2 = 0.88, P<0.001 and r^2=0.82 P<0.001, respectively). Over the range of densities measured, the predicted minima and maxima for changes in soil water content were 45 to 84 mm for the upper profile and 0 to 24.3 mm for the lower profile, respectively.

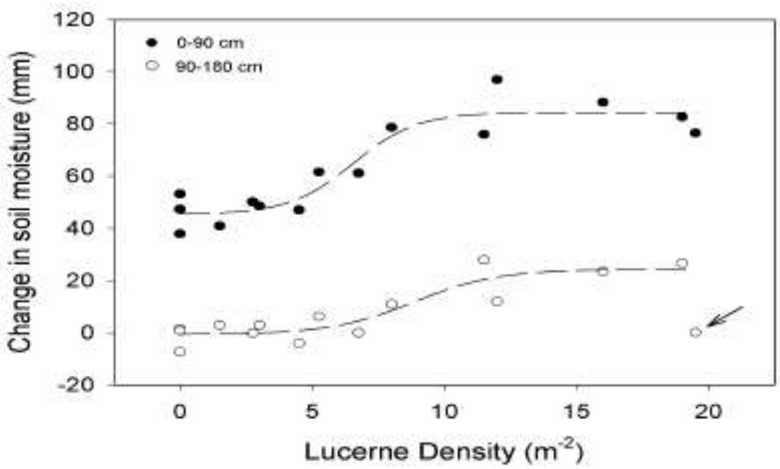

Figure 1. Relationship between the change in soil moisture content between 24/1-10/3/98 and lucerne density. Lines represent regressions (see text). The arrow point to one plot omitted from the regression analysis, as it was much drier than all other plots at the commencement of the drying cycle.

Conclusion

Given that only one site was investigated for only one season, it is not prudent to generalise too broadly on these results. However, some approximate benchmarks can be set and then adapted for seasonal and regional variation with further experimentation. By inspection, it appears that lucerne plots with >12 plants/m^2 are able to provide maximum water extraction capacity in summer and plots with <5 plant/m^2 were not noticeably different from fallow plots (Figure 1). These figures are both conservative estimates and take into account the relationship for both parts of the profile. For the upper section, representing the part of the profile most likely to be accessed by a crop, it is evident that soil moisture loss did not increase above 8-10 plants/m^2. However, in this experiment herbicide and/or hand weeding controlled other species. Hence, with respect to on-farm lucerne management, soil moisture levels would probably be lower over summer than those reported here, particularly where lucerne densities were low. Much emphasis has been placed on the role of lucerne as a solution to the hydrological imbalance in phase farming systems (6). While there is considerable potential for increased utilisation of lucerne pastures in phase farming systems, modellers, agronomists and farmers need to appreciate that the inevitable decline in lucerne density will have an impact on soil water extraction.

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References

(1) Angus, J.F., Gault, R.R., Peoples, M.B., Stapper, M., and van Herwaaden, A.F. 2001. Aust. J. Agric. Res., 52: 183-192.

(2) Ridley, A.M. Christy, B., Dunin, F.X., Haines, P.J., Wilson, K.F., and Ellington, A. 2001. Aust. J. Agric. Res., 52: 263-277.

(3) Wolfe, E.C., Fitzgerald, R.D., Hall, D.G., and Southwood, O.R. 1980. Aust. J. Exp. Agric. Anim. Husb., 20: 678-687

(4) Lodge, G.M. 1991. Aust. J. Exp. Agric., 31: 713-724.

(5) Isbell, R. F. 1996. The Australian Soil Classification. CSIRO, Australia.

(6) Passioura, J.B. and Ridley, A.M. 1998. Proc 9th Aust. Agron Conf., Wagga Wagga. p99-106.