Rate of root growth in lucerne varies with soil type in Western Australia

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Abstract

The rate of lucerne root growth in soil will influence how quickly soils are dried and therefore influence the amount of drainage from the root zone of lucerne. The rate and depth of lucerne root growth was determined by measuring soil water contents at four sites on contrasting soil types in Western Australia. To determine if roots were actively removing water from the soil at a given depth a minimum 0.02 m^3/m^3 decrease in soil water content had to occur, compared with the previous measurement. Changes in soil water contents of less than 0.02 m^3/m^3 were considered to be within the experimental error. The rate of root growth was variable; over a 2-3 year period, roots grew fastest (10 mm/d) in a deep sand while on a sodic alkaline soil, roots grew at only 1.7 mm/d. This analysis will assist in determining where in the Western Australian landscape lucerne will have the greatest benefit in reducing drainage.

Key Words

clay subsoils, acidity

Introduction

The potential rate of lucerne root growth varies with cultivar and has been measured in the range of 11-14 mm/d (1). Root growth of lucerne may be less than potential because it is sensitive to soil acidity (2), high bulk density (3) and waterlogging (4). In Western Australia most surface soils are acidic (5) and many soils have poorly structured clay B horizons with low permeability (6,7). If lucerne is not adapted to these soils then not only will the rate of root growth be reduced but the ability of lucerne to reduce drainage will also be reduced. The relationship between soil type and lucerne root growth in Western Australian soils has not been examined in detail.

Methods

The downward rates of root growth by lucerne from sowing were measured at four experimental sites in the south west of Western Australia. The sites were located near Cascades (33? S, 122? E), Katanning (34? S, 117? E), Moora (31? S, 116? E) and Wellstead (34? S, 118? E). The Cascades site was an alkaline brown shallow sandy duplex with a poorly structured and sodic clay subsoil. The Katanning site was a yellow deep sandy duplex with an acidic subsoil (pH in calcium chloride of 4.2 at a depth of 120 cm). The Moora site was a yellow deep sand, which was moderately acidic in the surface 50 cm but with no impeding factors below 50 cm. The Wellstead site was a grey deep sandy duplex with a neutral, non-sodic and permeable subsoil. Two cultivars were sown (Trifecta or Sceptre) and were grazed approximately 1 week in 7, except at Cascades, which was mown every 6 weeks. Root growth was determined by measuring the maximum depth of water extraction at sequential samplings. To determine if roots were actively removing water from the soil, a minimum 0.02 m^3/m^3 decrease in soil water had to occur compared with the previous measurement. Changes in soil water contents of less than 0.02 m^3/m^3 were considered to be within the experimental error. The technique was used to indicate the periods when root activity was drying the soil profile.

Results

The most rapid rate of root growth occurred in the deep sand soil at Moora (Figure 1), with an average rate of 10 mm/d. All other sites had clay subsoils and the root growth was only 17 to 38% (1.7-3.8 mm/d) of that at Moora (Figure 1). The lowest rate of root growth occurred at the site with the poorly structured subsoil (Cascades). A possible contributing factor to the slow root growth at this site was the heavier than average rainfall at the start of the third year (January-March), which may have slowed water extraction at depth in favour of that from surface layers, or alternatively it may have caused temporary waterlogging. The results also indicated that the rate of root growth was generally higher in the first year than in the second or third years (Figure 1), which coincided with the arrival of the roots at the top of the subsoil. This decline in root growth was particularly noticeable at the Katanning site when the roots encountered the acidic subsoil. The exception was at Wellstead and additional characterisation of this soil will be required to determine the reason for this increase.

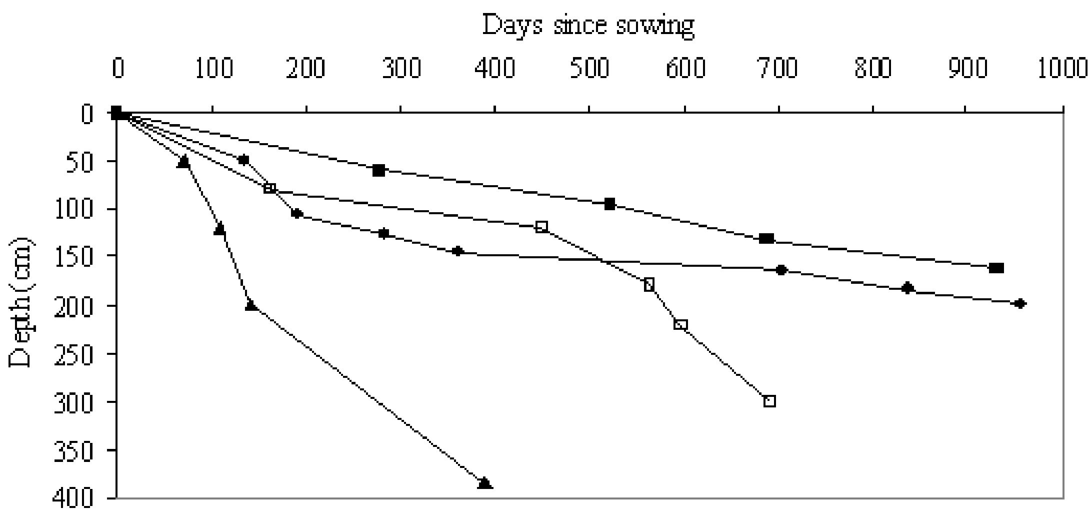

Figure 1. The depth at which the deepest active lucerne root was detected over time at Cascades (■), Katanning (●), Wellstead (□) and Moora (▲).

Conclusion

Soil type had a major impact on the rate of lucerne root growth; soils with high clay contents reduce the potential rate of lucerne root growth relative to that in the deep sands of Western Australia. In addition soils that are poorly structured or acidic also reduced the rate of root growth. The implication of this analysis is that for soils to which lucerne is not well adapted, it will be less effective in drying soil profiles and this will reduce the effectiveness of deep drainage control using lucerne. This analysis will assist in determining where in the Western Australian landscape lucerne will have the greatest benefit in reducing drainage.

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