Impact of a history of lucerne (*Medicago sativa* L.) on the root dynamics of a subsequent canola (*Brassica napus* L.) and wheat (*Triticum aestivum* L.) crop

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Abstract

Lucerne has been advanced as a tool for combating dryland salinity. After the removal of lucerne, the soil contains a substantial network of root-formed biopores which may benefit the root development of succeeding crops. The root dynamics of canola and wheat were quantified in 2.5 m deep intact lysimeter cores containing a Kandosol soil (Exp. 1) or canola in a sodic Vertisol soil (Exp. 2) with or without a history of lucerne. Root growth was monitored by minirhizotron tubes installed horizontally at 6 depths. In the Kandosol soil, the main residual effect of lucerne was in facilitating the development of a deeper and a smaller root system in canola. While wheat, following lucerne, developed a larger root system but without affecting the maximum rooting depth. In the sodic Vertisol soil canola benefited by the development of a larger and deeper root system. (Funded by GRDC: UCS00003)

Key Words

rooting depth, primer crops, biopores, root channels

Introduction

Lucerne is a deep-rooted, summer active, perennial species which may help to alleviate dryland salinity (Irwin *et al.* 2001). Prior research has shown that after removal of lucerne, the soil is dryer with increased nitrogen, and contains a substantial network of root-formed biopores which may benefit the root development of succeeding crops (McCallum *et al.* 2004). The objective of this study was to quantify the root dynamics of canola and wheat in intact soil monoliths of contrasting soil types following a lucerne crop.

Methods

Wheat cv. Diamondbird and canola cv. Rivette were grown in intact soil monoliths (2.5 m deep, 0.74 m diameter) with or without a history of lucerne. The soils were a light clay Kandosol with 0-20 cm A, 20-55 cm B and 55+ cm C horizons (Exp. 1), and a medium clay, high bulk density sodic (SAR >15 %) Vertisol with 0-25 cm A and 25+ cm B horizons (Exp. 2). Experiment 1 consisted of 3 lucerne treatments (SR: summer lucerne removal, AR: autumn lucerne removal and NC: no previous lucerne crop), the 2 crops (wheat and canola) and 3 replications which were arranged in a split-plot design where the annual crops were the main plots and lucerne removal were the split-plots. Experiment 2 consisted of 2 lucerne removals (SR and NC), canola and 3 replications which were arranged in a randomized complete block design. Nitrogen and water was supplemented to remove the confounding residual effects following lucerne. Root growth was monitored by minirhizotron tubes (3 cm ID) installed horizontally at 6 depths (20, 40, 65, 90, 120, 145, 205 cm) and each tube was scribed with lines at the 10 o'clock and 2 o'clock positions. The projected soil area of the tubes represented ~6 % of the cross-sectional area of the soil cores. Roots per minirhizotron were quantified by counting the number of roots that crossed either the left or right horizontal line markings at a given time and the approach was based on the theory proposed by Lang and Melhuish (1970). Root counts were done every 5 to 8 days throughout the growing season. Root counts per core were combined across depth for analysis purposes. The data was analysed as described in the statistical software GenStat (VSN International) using the repeated measurements procedure in the mixed model (REML) approach and curves were fitted using the splines function procedure.

Results

In the Kandosol soil both wheat and canola roots benefited when grown in a soil with a history of lucerne, although in different ways. Regardless of lucerne history more prolific root growth, as expressed by total root counts, was exhibited by the 'tap' rooted canola than the 'fibrous' rooted wheat (Figure 1a,b). Timing of lucerne removal (AR vs. SR) did not significantly affect the total root counts or the rooting depth of canola and wheat (Figure 1a, b). Canola had fewer total root counts after lucerne (AR and SR) than after no crop (NC) (Figure 1a). However, canola roots in AR and SR reached a greater depth by harvest (145 cm) when compared to NC (90 cm; Figure 2a). Wheat roots, when following lucerne, initially developed a deeper root system but, by harvest, lucerne history did not influence the maximum rooting depth (90 cm; Figure 2a). In the Vertisol, the total canola root counts were twice as large in soils with a history of lucerne (Figure 1c). In addition, the rate and depth of root development was greater in cores with a history of lucerne (ie. 145 cm versus 90 cm) than those without (Figure 2b).

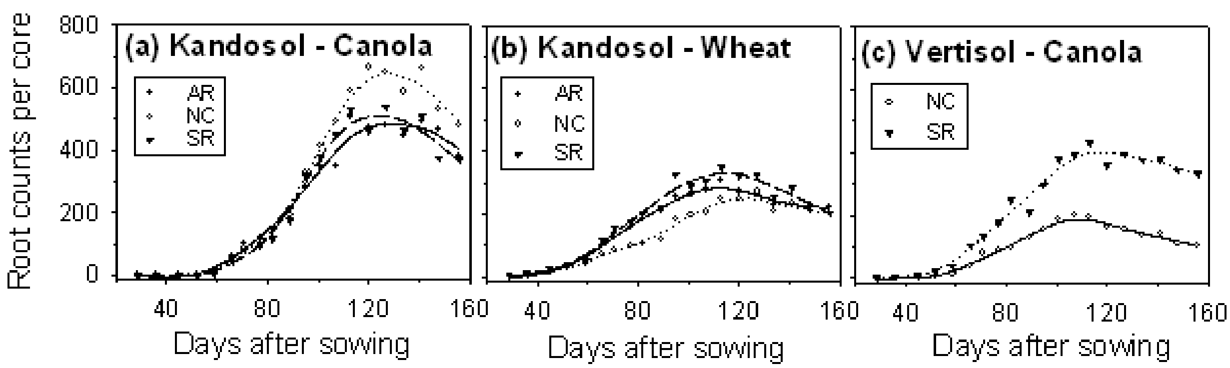

Figure 1. Total root counts of (a) canola and (b) wheat grown in lysimeter cores containing a Kandosol soil or (c) canola in a Vertisol soil with or without a history of lucerne. AR: autumn lucerne removal, SR: spring lucerne removal, NC: no lucerne crop.

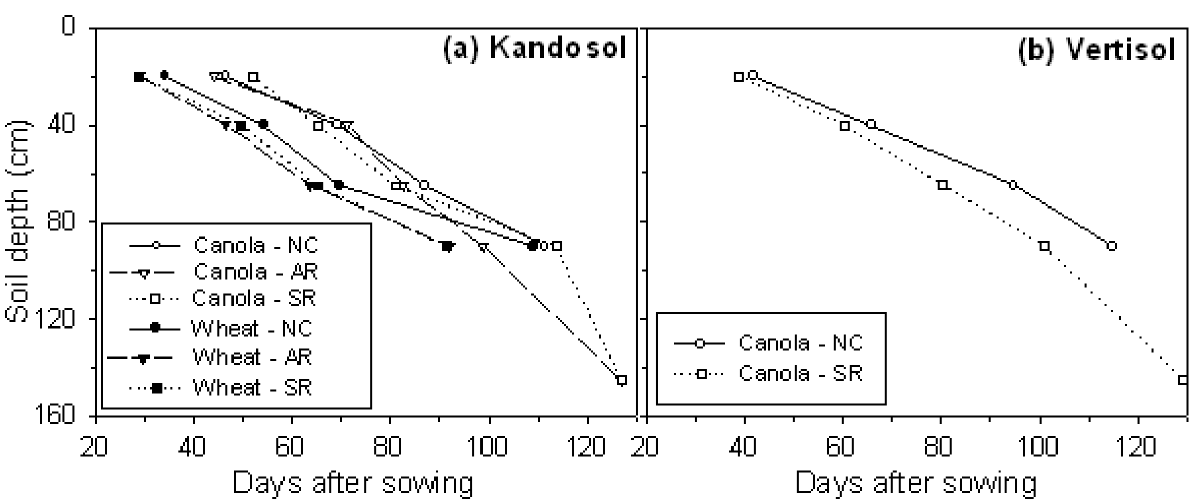

Figure 2. Rooting depth of (a) canola and wheat grown in lysimeter cores containing a Kandosol soil or (b) canola in a Vertisol soil with or without a history of lucerne. AR: autumn lucerne removal, SR: spring lucerne removal, NC: no lucerne crop.

Conclusion

In the Kandosol soil, the main residual effect of lucerne was in facilitating the development of deeper roots in canola and a larger root system in wheat, while in the sodic Vertisol soil canola benefited by the development of both a much larger and deeper root system.

References

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