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Spatial variation in tree root distribution and growth associated with minirhizotrons

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Abstract

Four minirhizotrons were installed in each of three replicate plots in a deciduous forest dominated by *Acer saccharum* Marsh. The length growth of tree roots along the surface of the minirhizotrons was measured for a period of one year, and the resulting data were analyzed in nested, averaged and pooled arrangements. The analyses of nested data showed that spatial variation in root growth and abundance among minirhizotrons within plots was greater than variation among plots. Averaging data from minirhizotrons within plots prior to analysis reduced variation about plot means, but extensive intraplot variation invalidates this approach on statistical grounds. Both nested and averaged data failed to account for the contribution of individual roots to the mean, and root production rates were consequently overestimated. Pooling the data from the four minirhizotrons reduced variation about the means, and resulted in a more representative estimate of root production rates. The analysis of composited data can be used to incorporate small-scale variation into a single replicate sample in those circumstances where the activity of the root systems of plant communities is the object of study.

Introduction

Recent advances in microvideo technology have made minirhizotrons popular research tools in both agronomic (e.g. Cheng et al., 1990; Hansson and Andren, 1987; Keng, 1988; Upchurch and Ritchie, 1983) and natural plant communities (e.g. Eissenstat and Caldwell, 1988; Hendrick and Pregitzer, 1992). During these and other research efforts, several analytical and statistical problems with minirhizotron data have been identified. High minirhizotron-to-minirhizotron (i.e. spatial) variability in root density and distribution has proven to be especially problematic. Coefficients of variation range to as much as several hundred percent (Merrill et al., 1987; Upchurch and Ritchie, 1983; Upchurch, 1987), often making treatment differences difficult to detect. Quantifying and controlling spatial variation is necessary to properly execute minirhizotron experiments focused on root systems at the level of the plant community or ecosystem, but information on the extent of variation among minirhizotrons at various levels within the hierarchy of an experimental design is generally lacking in the literature.

Individual minirhizotrons are often the sampling units upon which measurements of roots are made, and several minirhizotrons are typically nested within replicate experimental units, usually a field plot or greenhouse pot (e.g. Beyrouty et al., 1987; Box and Johnson, 1987; Cheng et al., 1990). Alternatively, minirhizotrons are sometimes treated as experimental units, with measurements of root numbers or length made along several different transects