Root sampling and analysis in lucerne (*Medicago sativa L.*) field trial

Amir Raza[*1], Gabriele Pietsch[1], Ali Moghaddam[1], Willibald Loiskandl[2], Margaritta Himmelbauer[2], M.R.Ardakani[3] and Jürgen K. Friedel[1]*

[*1] Division of Organic Farming (IFÖL), Department of Sustainable Agricultural Systems, University of Natural Resources and Applied Life Sciences (BOKU), Vienna, Austria.
[2] Institute of Hydraulics and Rural Water Management, BOKU, Vienna, Austria
[3] Islamic Azad University, Karaj Branch, IRAN.
Author: IFÖL, BOKU, Gregor Mendel Str. 33, A- 1180, Vienna, Austria.
Phone (Fax): +43 1 47654 3775 (3792), E-mail: amir.raza@boku.ac.at

ABSTRACT

Use of reliable method for estimation of root biomass is crucial in organic farming system. The main objective of this study was to compare two common root sampling methods using soil corer (9 cm diameter) and soil monolith (12.5 cm wide) in order to determine their suitability for estimation of root biomass. A randomized block experiment with four replicates was carried out on organically managed fields at Raasdorf, Eastern Austria, for two consecutive years (2007 & 2008). Root biomass of Lucerne cultivar Sitel was determined in the top 30 cm soil layer. With the soil corer, two samples were taken per plot, one sample on the row and one between the rows. Calculations of root biomass were based on the percentage of "on" and "between"-row area. Monolith samples were taken from each of the harvest areas per plot integrating over the whole "on" and "between"-row area. Results revealed that the root biomass differ significantly ($P \leq 0.05$) due to the sampling method, and it also differed significantly ($P \leq 0.05$) between the two years. The soil monolith method yielded slightly more root biomass than the soil corer method in both years, suggesting its better suitability for estimation of root biomass in large field experiments.
KEYWORDS: Lucerne, Root biomass, Soil Corer, Soil Monolith, Sampling methods

INTRODUCTION

Roots play a major role in water and nutrient uptake by plants besides the useful effects of root exudates on microbial activities in soil. Organic farming systems usually produce larger root biomass as compared to conventional farming systems because of the basic role of forage legumes for nitrogen delivery and soil fertility enhancement. The use of reliable methods of root biomass estimation is crucial due to the relative importance of roots in organic farming systems. Root samples from field are usually collected using soil corer or soil monolith and roots are then washed out of the soil. In the samples, surface area, biomass, necromass, diameter, length and other root morphological parameters can be determined besides chemical and isotopic analysis (Smucker et al., 1982, 1987; Srivastava et al., 1982; Vogt and Persson, 1991).

The soil corer (9 cm diameter in our stydy) usually is smaller than the row distance of forage legumes (i.e. 12 cm). Therefore, separate samples need to be taken to determine the amount (and biomass) of roots present on the crop row and between the crop rows. Total root biomass is then calculated regarding the percentage of "on" and "between"-row area. This method requires extra time and labor. The shortcoming can be partly overcome by using the soil monolith (12.5 cm wide) method that regards roots present on the row as well as between the rows. Thus, a reasonable amount of time can be saved by reducing the number of samples to half. Owing to the importance of roots in organic farming systems, it is imperative to use a root sampling method that provides reliable estimates of root residues left in soil with minimum input of efforts. Keeping in view the same objective, soil corer and soil monolith methods were compared to estimate root biomass of lucerne in a field trial.

MATERIALS AND METHODS

A field experiment with lucerne cultivar Sitel was laid out on organically managed fields at Raasdorf, Eastern Austria for two consecutive years (2007 & 2008). The randomized complete block experiment with four replicates, having a plot size of 3 m x 3 m and row spacing of 12.5 cm, received usual management from sowing to harvest. Every year at the time of final harvest, root sampling was done using soil corer (9 cm diameter) and soil monolith (12.5 cm wide) in the top 30 cm soil layer. Using soil corer, one sample was taken on the row and one between the rows from each harvest area of a single Lucerne plot having two distinct harvest areas each of 0.5 m^{-2} sizes. Monolith samples were taken from sides of each of the harvest areas of each lucerne plot integrating over the whole "on" and "between"-row area.

Soil samples were washed using a root washing machine (Gillison´s Variety Fabrication Inc., USA) to separate roots from soil. Separated roots were passed through sieves having a mesh size of 0.75 mm. Collected roots were dried in an oven at 60 ^{0}C for 48 hours for determination of root biomass. For soil corer samples, root biomass was calculated separately for both positions, on the row and between the rows using a correction factor for the percentage of area present on and between the rows. Total biomass was the sum of root biomass found on and between the rows. For calculation of root biomass from the monolith samples, an area percentage factor is not used as the monolith area already regards roots present on both row and between row positions. Data were analyzed using GLM procedure in statistical software SPSS 15 where year and treatment were used as fixed factors and replicate as random factors.

RESULTS

Root biomass varied from 4738 kg DM ha^{-1} in 2007 to 13103 kg DM ha^{-1} in 2008 (Fig. 1) and differed significantly between the years ($P \leq 0.05$). This may be attributed to relatively higher rainfall during vegetation period in 2008. Root biomass also differed significantly ($P \leq 0.05$) because of the sampling method. These findings are not in agreement with those of Sochacki et al. (2007) and Levillain et al. (2008). Soil monolith yielded more root biomass than soil corer samples in both years.

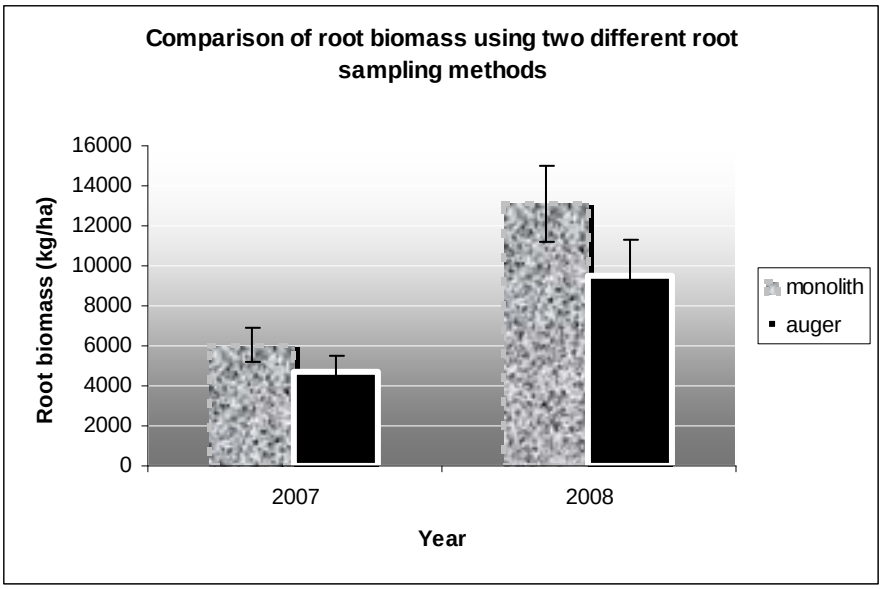

Fig. 1 Lucerne dried root biomass (*kg DM ha*$^{-1}$) as affected by the method of sampling. Bars indicate standard deviation.

CONCLUSION

Soil monolith can be preferred over soil corer for reliable estimation of root biomass in larger field experiments.

REFERENCES

Lavellain J., Jourdan C., Saint-Andre L. (2008) Estimations of fine root biomass in eucalyptus plantations. A comparison of four sampling methods . CARBOAFRICA Newsletter No. 5 pp.13-15. http://www.carboafrica.net/downs/newsletters/05-Carboafrica_Newsletter_05-2008.pdf.

Smucker A. J. M., McBurney S. L. Srivastava A. K. (1982) Quantitative separation of roots from compacted soil profiles by the hydropneumatic elutriation system. Agron. J. 74, 500-503.

Smucker A. J. M., Ferguson J. C., Debruyn W. P., Belford R. L. Ritchie J. T. (1987) Image analysis of video recorded plant root systems. *In* Minirhizotron Observation tubes: Methods and Applications for Measuring Rhizosphere Dynamics. Ed. H M Taylor. pp 67-80. ASA Spec. Publ. no. 50. ASA, CSSA, SSSA, Madison, WI.

Sochacki S., Ritson P., Brand B. (2007) A specialised soil corer for sampling tree roots. *Australian Journal of Soil Research*, 2007, 45, 111–117.

Srivastava A. K., Smucker A. J. M. McBurney S. L. (1982) An improved mechanical soil-root sampler. Transactions of ASAE 25, 868-871.

Vogt C., Persson H. (1991) Measuring growth and development of roots. *In* Techniques and Approaches in Forest Tree Ecophysiology. Eds. J P Lassoie and T M Hincley. Pp 477-501. CRS Press, Boca Raton, FL.