

Separating Roots from the Soil by Hand Sieving

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Introduction

Root biomass in the upper 4 inches of the soil is an input value for the Revised Universal Soil Loss Equation (RUSLE) (Renard, et al., 1997). The mass, size, and distribution of roots in the near surface are among the most important factors in determining the resistance of the topsoil to water and wind erosion. Root biomass is also one of the major carbon pools found in soil. Commonly, root mass and plant residue in the soil form between 3,000 (annual crop) and 15,000 (perennial grasses) pounds/acre/year soil biomass (Harwood, et al., 1998).

The development of new roots and ultimately the decomposition of roots within the soil are major contributors to the Soil Organic Carbon (SOC) pool. Plant roots contribute to the fertility of soils by slowly releasing macronutrients and micronutrients into the soils.

Root biomass and SOC help bind the soil together by forming aggregates and granular structure. This process improves the tilth as well as the erosion resistance of the soil. Depending on the root turnover rate (known for some species), climate, and residue decomposition rate (known for some areas, based on climate and soil moisture status), the amount of carbon stored in the soil can be determined from the root biomass, plant residue, and SOC.

Root biomass is frequently used in calculations of root/shoot ratios, which are used to evaluate the health and vigor of plants and to determine the likely success of establishing seeded plants at the four-leaf stage.

Dried roots can be ground, and standard analyses for C, N, P, and S can be determined. (Contact your local university extension agent regarding standard analyses for soil fertility.) The C/N ratio can also be determined. This is typically different from the C/N ratio of the above-ground plant material. Low levels of N in the soil will promote root growth over top growth (Bedunah and Sosebee, 1995). The C/N ratio of roots, plant residue in the soil, and SOC each contribute to the residue decomposition rate in soils. Low C/N values lead to more rapid decomposition, while high C/N levels slow decomposition. The C/N ratio required for decomposition of plant residue, without a net tie-up of N, is approximately 25:1. Plant residue from young legumes commonly has a C/N ratio of 15:1. Plant residue from woody materials commonly has a ratio of 400:1 (Harwood, et al., 1998). The C/N ratio of soil microbes is quite variable but commonly falls between 15:1 and 3:1 (Paul and Clark, 1989).

Root biomass/horizon can be paired with the description of roots in each soil horizon (i.e., few fine, many very fine, etc.) in the pedon description, and thus a qualitative estimate can be made of the mass in each size fraction of roots.

Method Summary

Roots are removed from the soil by hand rinsing soil from the roots through a sieve followed by drying.

Interferences

The soil must be dispersed for successful separation of the roots and plant residue from the soil sample. Frequently, soils containing carbonates are difficult to disperse and Calgon (P formulation) or Sodium Hexametaphosphate can be added to disperse the soil. Tap water, rather than distilled water, should be used to help avoid puddling and dispersion problems.

Equipment

- ✓ Oven safe tray (example: baking pan)
- ✓ Drying oven (if desired)
- ✓ #30 (ASTM standard) mesh stainless steel or brass sieve
- ✓ Analytical balance

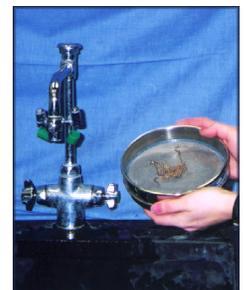
Reagent

Calgon (P formulation, marked with an R) or Sodium Hexametaphosphate

Procedure

Field Sampling Procedure

Field sampling procedures include: selecting representative sites, sampling by horizon, and designating and sampling a subhorizon if root mass and morphology change. The sampling area is approximately 1 m². Typically, paired sites are sampled for comparison and data evaluation purposes.



Laboratory Analysis

1. Weigh and tare oven safe tray and record weight.
2. Weigh 100-200 grams of field moist soil. Dry and reweigh soil. Place dried sample into tray.
3. Add enough water to cover sample, but leave enough room to stir or shake the sample. Gently shake the sample for a few minutes.
4. Pour the floating roots onto the #30 stainless steel sieve.
5. Continue steps 3 and 4 until all roots are on the sieve.
6. Let the roots dry -- either air dry overnight or in a 68°C drying oven. Root systems can be spread out in the tray and dried for later examination of the rooting pattern for different types of plants (taproots, dendritic patterns, etc.).
7. Tap the roots out of the sieve into the dry tray and weigh.
8. Spread out the roots on a clear sheet and photocopy or take a picture for later use in comparing different soils/plants.
9. Grind the roots to < 80 mesh if total carbon and nitrogen content is desired.

Calculations

1. Calculate the gravimetric moisture content of the soil just prior to root washing.
$$\text{Moist Soil (g) - Oven Dry Soil (g) = Moisture Content (g)}$$
$$[\text{Moisture Content (g) / Oven Dry Soil (g)}] \times 100 = \% \text{ Moisture Content}$$
2. Calculate the soil bulk density from undisturbed soil (dry weight of soil / volume). Alternatively, calculate the pore space.
$$(100\% - [(\text{Bulk Density} / \text{Particle Density (usually 2.65 g/g)}) \times 100\%])$$
3. Convert the weight of roots to mass.
$$[\text{Oven Dry Roots (g)} \times \text{Moisture Content Air Dry (g)}] + \text{Oven Dry Roots (g)} = \text{Air Dry Roots (g)}$$
$$\text{Air Dry Roots, including woody material (g) / Air Dry Soil (g) = Air Dry Mass (used for aerial determinations, i.e., kg/ha)}$$
$$\text{Oven Dry Roots, including woody material (g) / Oven Dry Soil (g) = Oven Dry Mass}$$
4. Convert the mass of roots / g soil to volume.
$$\text{Oven Dry Mass (g)} \times \text{Soil Bulk Density (g/cc)} = \text{Root Content g/cc}$$
5. Convert the root mass of soil to a depth interval and multiply by the Soil Bulk Density. Convert to area and report as kg/ha or lbs/ac for a given depth.
$$\text{Air Dry Roots (g)} \times \text{Depth (cm)} \times \text{Soil Bulk Density (g/cc)} \times 100,000 \text{ (cm}^2\text{/ha)} = \text{Air Dry Roots kg/ha depth interval}$$

Report

Report root biomass in lbs/ac or kg/ha, over a given depth, and as a “root bulk density” g/cc of oven dry root biomass in the soil of a particular horizon.

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