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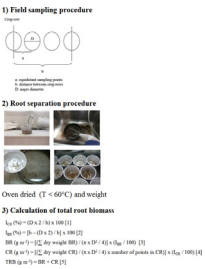
Direct field method for root biomass quantification in agroecosystems

Ileana Frasier[a,b], Elke Noellemeyer[c,*], Romina Fernández[a], Alberto Quiroga[a,c]

[a] Instituto Nacional de Tecnología Agropecuaria, EEA Anguil, La Pampa, Argentina
[b] Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina
[c] Facultad de Agronomía Universidad Nacional de La Pampa, Santa Rosa, La Pampa, Argentina

GRAPHICAL ABSTRACT



ABSTRACT

The present article describes a field auger sampling method for row-crop root measurements. In agroecosystems where crops are planted in a specific design (row crops), sampling procedures for root biomass quantification need to consider the spatial variability of the root system. This article explains in detail how to sample and calculate root biomass considering the sampling position in the field and the differential weight of the root biomass in the inter-row compared to the crop row when expressing data per area unit. This method is highly reproducible in the field and requires no expensive equipment and/or special skills. It proposes to use a narrow auger thus reducing field labor with less destructive sampling, and decreases laboratory time because samples are smaller. The small sample size also facilitates the washing and root separation with tweezers. This method is suitable for either winter- or summer crop roots.

- Description of a direct field method for row-crop root measurements.
- Description of data calculation for total root-biomass estimation per unit area.
- The proposed method is simple, less labor- and less time consuming.

* Corresponding author at: Facultad de Agronomía, Universidad Nacional de La Pampa, CC 300, RA 6300, Santa Rosa, La Pampa, Argentina.
E-mail addresses: noellemeyer@agro.unlpam.edu.ar, enoellemeyer@gmail.com (E. Noellemeyer).

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Method details

Field sampling procedure

In the field, take four samples at equidistant points in between two crop rows with a narrow tubular soil auger (0.032 m diameter). The first and last sampling points have to coincide with two neighboring crop rows (Fig. 1). For determination of the equidistant points, it is convenient to use a ruler or metric tape. In very sandy soils, first take the samples on the crop-rows and then those in-between rows. In order to avoid soil crumbling and drift when introducing the auger the soil can be moistened, or sampling should be carried out when soil has good moisture conditions.

The objectives of each study and the length of the available auger will define the overall sampling depth. However, this method is especially recommendable for rooting depth and root stratification studies. It is highly recommendable to take at least four full replicates for each experimental unit (e.g. plot), thus reducing the inherent spatial variability and accounting for increased variability with depth (Table 1). When there are few roots present in the between-row samples, these can be pooled into one sample per depth interval for further study, or they will have to be processed individually if there are abundant roots. For field plots without vegetation, e.g. fallow, random sampling or the same procedure as described above can be used. Immediately after taking the soil samples place these into plastic bags and keep in a freezer at − 20 °C until washing.

The proposed method is valid and useful for studying both winter and summer crops (Fig. 2). Time-series of root determinations within the same plot are useful to analyze the effect of crop rotations on root dynamics [2].

Root separation procedure

In order to separate roots from soil wash the samples through a submerged 250 μm sieve with running tap water [3] and then collect the roots retained by- and floating on the sieve with tweezers (Fig. 3). The recuperation of roots depends on sieve mesh size [4], therefore it is necessary to unify criteria in order to obtain comparable results. Processing small-sized samples facilitates root recollection by flotation since this allows for using smaller mesh sizes independent of soil texture.

Root samples are then oven-dried to constant weight at temperatures below 60 °C and weighed using a precision scale. The dry root material should be stored in well-closed bags or plastic vials in a dry place. These samples can be used to determine root length by image analysis [5], or can be milled for chemical analysis of the root biomass.

Calculation of total root biomass

Considering the differential weight of the root biomass in the inter-row per area unit compared to the root biomass in the row is crucial for obtaining representative results. This is done by calculating the influence-percentage (I%) using the data for the distance between crop-rows (b) and the diameter of the auger (D). The following equations use the parameters of the diagram shown in Fig. 1.

$$I_{CR}\,(\%) = (D \times 2/b) \times 100 \quad (1)$$