Estimating the depth of the restrictive layer of soil in a cranberry field based on CT scan images

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Cranberry production is a dominant culture in Québec, Canada. In cranberry production, there is a substantial need for water whether for irrigation, harvesting, or frost control. Some farms are implementing subirrigation procedures in order to reduce water use and increase fruit yields. However, this irrigation method may impose hydraulic stresses on soil particles which results in the movement of fine particles. The accumulation of the soil particles in narrow pore throats leads to the formation of restrictive layers in soil. In this respect, we are going to study the changes in soil media and its porosity based on X-ray computed tomography (CT) which is a non-destructive imaging method. Consequently, X-ray CT has become a great asset to analyze soil physical properties. With the analysis of the images captured by the use of X-ray computed tomography, it is possible to visualize and analyze the pore network structure in the soil media.

This study reports the results of subirrigation experiments for four different sandy soils. These column experiments aimed to reproduce the effects of subirrigation in cranberry fields for 40 years. Seven different time steps were taken with a medical CT scanner SOMATOM Definition AS+ 128 (Siemens, Germany). The 2-D horizontal 16-bit gray-scale images were captured by an X-ray energy level of 140 KeV. For each column, we got 1677 images of 512 x 512 pixels with a voxel size of 0.1 x 0.1 x 0.6 mm (x, y, z). Studying our images for further analysis, we used several global and local methods to find the most reliable and efficient one to binarize our images. Results show that the methods and the image analysis neighborhood have a great impact on the accuracy of the image segmentation. We were able to reconstruct a 3-D visualization of the soil pore network for each column. We used this reconstruction to demonstrate that the variation of porosity and soil pore characteristics can be studied over time. We find that the transport of soil particles tends to be highest when there are fine sandy soil particles on top of a layer of coarse soil. These finer particles have sufficient energy to be remobilized within the pore network while coarser particles
remain in place. Our results show that soil particle transport can be assessed using time-lapse imagery and thus makes it possible to approximate the depth and amount of time that will be required for these restrictive layers to form in different soil profiles. Finally, it would be possible to find the best structure of soil in construction of a cranberry field in the future.