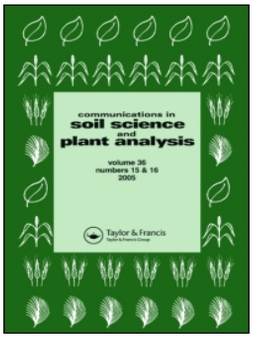

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USING ACETIC ACID TO WASH ROOTS FROM CALCAREOUS SOIL

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ABSTRACT: Washing clay soil from roots is difficult, time consuming, and potentially destructive to roots. The objective of this study was to test a procedure using acetic acid to wash roots from calcareous clay soil. Three concentrations of acetic acid and water were tested on cores in the laboratory with the highest concentration (2.5M) found to be the most effective. The most concentrated acetic acid solution was used with favorable results in the trench-profile method of root counting in the field. There was no damage to roots by the acid in any treatment.

INTRODUCTION

Clay soils present special problems for root studies. Methods of washing sandy and loamy soils with a water stream or fine mist simply are not effective, because the soil clay adheres so strongly to the roots. Heavy, compacted clay soil is difficult to remove from roots without damage and loss of root parts (2). The profile-wall or trench-profile method (6) for root-distribution mapping and counting is problematic for clay soils because it requires unbroken, intact roots. The method consists of smoothing the side of a trench and washing a soil layer 3- to 5-mm thick, while leaving the roots intact for counting and mapping their distribution. Soil is loosened with wire picks and washed off with water or a

stream of pressurized air. Unfortunately, applying water to clay soil profiles will not loosen the aggregates. Furthermore, intense washing will result in root damage and displacement as the aggregates break off the profile wall.

Dispersion, or the breakdown of soil aggregates into their primary particle sizes, is the process that removes soil from roots. Bohm (1) discussed chemicals that facilitate root washing, including pyrophosphates, sodium chloride, and hydrochloric acid. Dispersion is enhanced by monovalent cations, such as sodium, which replace the divalent cations on soil colloids, thus weakening the chemical bonding of the clay and causing it to disperse.

Heringa et al. (2) and Vos and Groenwold (5) used oxalic acid to wash roots out of cores of clay soil. This was done by placing the soil sample on a screen in a container of oxalic acid solution and shaking occasionally. The production of carbon dioxide (CO_2) disperses the aggregate by mechanically pushing the particles apart.

We propose using a dilute acid solution to facilitate root washing for calcareous clay soils. Our objective was to test this method by screening different concentrations of acetic acid in the laboratory followed by field testing. We measured the time needed to disperse soil cores in the laboratory, then applied the most effective solution concentration to profile-wall method.

MATERIAL AND METHODS

The soil used was a Holtville silty clay (classified as a clayey over loamy, montmorillonitic, vertic Torrifluvent) from the USDA-ARS Irrigated Desert Research Station, Brawley, CA. This soil had a pH of 7.6 and a calcium carbonate equivalent of 11.8% (4). The texture was 10% sand, 38% silt, and 52% clay. Soil samples were taken from the root zone of alfalfa (*Medicago sativa* L.).

We measured the time require for complete root washing by water and three concentrations of acetic acid (2.5, 1.0, and 0.25M). These molar concentrations correspond to 10%, 4%, and 1% solutions. We selected acetic acid because it is less odorous than other common acids, and because we were concerned about damage to roots at extremely low pH. Acetic acid has a relatively high pH of 2.4 at 1.0M concentration in comparison with other acids. We did not test higher concentrations than 2.5M because of the potential damage to roots, and because we wanted to minimize the safety risk for handing the solution.

TABLE 1. Time Required for Complete Soil Dispersion.

Treatment	Dispersion Time minutes	Relative Time %
Water	77	100
Acetic acid, 0.25M	57	74
Acetic acid, 1.0M	41	53
Acetic acid, 2.5M	23	30

Moist soil (50 g) containing mature alfalfa roots was wrapped in nylon mesh and doused in 0.4 L of treatment solution with a 14-mm displacement stroke at the rate of 2.0 cycles/s using a modified aggregate stability apparatus (3). The time for the soil to completely disperse was noted. Afterwards, the roots and soil were separated and the final condition of the roots was visually observed. Typical root length densities of the cores were 50 km/m^3.

The best results from the laboratory tests were then applied to a profile wall in the field. Washing 3 to 5 mm of soil from the trench wall was accomplished by applying 0.4 L/m^2 of 2.5M acetic acid generously with a wash bottle. After approximately 30 seconds, the acid and soil carbonate ceased fizzing, and the dispersed soil was washed from the wall with water from a garden sprayer.

RESULTS

The data in Table 1 indicate the superiority of the acetic acid solutions. The 2.5M solution required only 30% of the time needed to wash the soil from roots with water.

The final condition of the roots was the same for all treatments. Large roots were white and small roots light to dark brown. The brown color of the fine roots was independent of treatment, which led us to conclude that the color was due to senescence and not acid damage.

Using acetic acid in the profile wall method was a vast improvement over water alone. Washing time for a 1/m^2 profile was less than five minutes. No loss

of roots was observed, and it was not necessary to loosen the soil with wire picks. Only small amounts of water were required to expose the face, thus leaving minimal amounts of waste water at the bottom of the trench.

In conclusion, using a 2.5M acetic acid solution followed by light spraying with water was very effective in exposing roots from the profile wall of a calcareous clay soil.

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