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# Interactions Between Roots and Soil Microorganisms in Promoting Streambank Fluvial Erosion Resistance

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How do plant roots protect streambanks from fluvial erosion? Multiple root mechanisms are considered important in reducing fluvial erosion rates, including increasing soil resistance to erosion or roots extending out of the streambank face and altering the applied hydrodynamic force. Limited work has been done to determine the relative importance of these mechanisms; thus, the purpose of this research was to quantify the physical and biological effects of roots on streambank fluvial erosion.

This research addressed the following hypotheses: 1) The fiber matrix created by densely packed synthetic (inert) roots will reduce fluvial erosion rates due to their impact on the boundary layer; 2) Soil amended with organic matter will enhance soil resistance to fluvial erosion through higher aggregate stability and the production of extracellular polymeric substances (EPS); and 3) The fiber matrix of live roots will provide the most reduction in erosion rates due to their impact on both soil resistance and stream hydrodynamics. Ultimately, this research seeks to identify whether the physical presence of fibers or the biological root-microbe interactions play a dominate role in reducing fluvial erosion rates.

Laboratory-scale testing was conducted using a recirculating flume. A randomized complete block design was used for the experimental setup with six replicates of eight soil treatments: 1) no roots (NR, control); 2) no roots, amended soil (NR-A); 3) flexible synthetic roots (FSR); 4) flexible synthetic roots, amended soil (FSR-A); 5) rigid synthetic roots (RSR); 6) flexible rigid synthetic roots, amended soil (RSR-A); 7) live roots (LR; switchgrass [Panicum virgatum]); and 8) live roots, amended soil (LR-A). Amended soil treatments were included to enhance microbial activity by adding 1 g dried and pulverized grass clippings per 100 g soil. SR treatments were “planted” at root length densities (RLD) between 0.67 to 2.8 $cm/cm^3$. All treatments were established in 10.2-cm diameter and 24.8-cm long PVC pipes in a greenhouse prior to flume erosion testing.

Regression analysis of unamended and rooted soil treatments (FSR, RSR, and LR) revealed a significant and negative trend between RLD and erosion rate. However, the erosion rates of FSR and RSR treatments were statistically equivalent to the NR control treatment. While the RLD of synthetic roots does appear to decrease erosion rates, the results were not statistically different from the control. On the other hand, amended (NR-A, FSR-A, RSR-A, and LR-A) and LR soil treatments significantly reduced erosion rates compared to the control. These results highlight the dominant role that soil microorganisms, and their interaction with living roots, play in protecting

soil from fluvial erosion, particularly for streambanks with low root length density (< 1.0 cm/cm$^3$). From a riparian vegetation management standpoint, the results of this study underscore the importance of focusing on soil-root biological mechanisms when undertaking stream restoration projects with the goal of reducing bank erosion.