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Seasonal, Operational, and Plant Effects on Water Treatment Processes in Constructed Wetlands

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Abstract Text:

Constructed wetlands (CWs) can provide cost-effective treatment of water originating from agriculture, stormwater runoff, and domestic and municipal sources. However, gaps in understanding of the factors and processes that control contaminant removal limit effective design and operation, particularly in cold regions. Objectives of this USDA-NRI funded project were to (1) evaluate the effects of 19 plant species on root oxygen loss (ROL) and seasonal CW performance, (2) test the effects of carbon load, plant species, season, and batch versus continuous flow operation on seasonal CW performance, and (3) determine rootzone microbial community structure and activity and its relation to carbon load, season, and plant species. All of our studies used greenhouse CW microcosms (0.15-0.50 m3) operated year-round at 4-24C and loaded with synthetic wastewater. Differences in wastewater treatment and ROL among plant species were significant in the cold, dormant season but not during the growing season. Plant traits associated with better winter performance were ROL, flooding tolerance, and obligate wetland indicator status. While these traits cannot fully predict CW performance, they can help guide plant selection for cold-region CWs. Effects of COD loading rate, season, and plant species interacted strongly. In unplanted CWs, winter performance was poor regardless of loading rate. In planted CWs, performance remained good at low COD loading but was reduced at high loading; performance reduction varied by species. Selecting appropriate species and maintaining low COD loading rates may enhance cold-region CW performance. We have developed a PCR-DGGE strategy that uses both universal bacterial and functional-group-specific primers to analyze microbial diversity in rootzone samples. Preliminary tests indicated differences in CW microbial communities between plant species. Goals for application of results are to improve design, plant selection, and operation of cold-region CWs and to overcome regulator's resistance to CW use in cold regions.

Impact Statement:

Constructed wetlands can be a cost-effective treatment option for on-site and water treatment and for small, rural communities. Study results will contribute to improved design, plant selection, and operation of constructed water treatment wetlands in cold-regions. Additionally, science-based evidence can build confidence in use of constructed wetlands in cold regions and pave the way for acceptance by regulators.