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Constructed Wetlands with Subsurface Flow for Nitrogen and Metazachlor Removal from Tile Drainage: First Year Results

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Abstract : Pollution from agricultural drainage is a severe issue for water quality, and it is a major reason for the failure in accomplishment of 'good chemical status' according to Water Framework Directive, especially due to high nitrogen and pesticide burden of receiving waters. Constructed wetlands were proposed as a suitable measure for removal of nitrogen from agricultural drainage in the early 1990s. Until now, the vast majority of constructed wetlands designed to treat tile drainage were free-surface constructed wetlands. In 2018, three small experimental constructed wetlands with horizontal subsurface flow were built in Czech Highlands to treat tile drainage from 15.73 ha watershed. The wetlands have a surface area of 79, 90 and 98 m^2 and were planted with Phalaris arundinacea and Glyceria maxima in parallel bands. The substrate in the first two wetlands is gravel (4-8 mm) mixed with birch woodchips (10:1 volume ratio). In one of those wetlands, the water level is kept 10 cm above the surface; in the second one, the water is kept below the surface. The third wetland has 20 cm layer of birch woodchips on top of gravel. The drainage outlet, as well as wetland outlets, are equipped with automatic discharge-gauging devices, temperature probes, as well as automatic water samplers (Teledyne ISCO). During the monitored period (2018-2019), the flows were unexpectedly low due to a drop of the shallow ground water level, being the main source of water for the monitored drainage system, as experienced at many areas of the Czech Republic. The mean water residence time was analyzed in the wetlands (KBr), which was 16, 9 and 27 days, respectively. The mean total nitrogen concentration eliminations during one-year period were 61.2%, 62.6%, and 70.9% for wetlands 1, 2, and 3, respectively. The average load removals amounted to 0.516, 0.323, and 0.399 g N m-2 d-1 or 1885, 1180 and 1457 kg ha-1 yr-1 in wetlands 1, 2 and 3, respectively. The plant uptake and nitrogen sequestration in aboveground biomass contributed only marginally to the overall nitrogen removal. Among the three variants, the one with shallow water on the surface was revealed to be the most effective for removal of nitrogen from drainage water. In August 2019, herbicide Metazachlor was experimentally poured in time of 2 hours at drainage outlet in a concentration of 250 ug/l to find out the removal rates of the aforementioned wetlands. Water samples were taken the first day every six hours, and for the next nine days, every day one water sample was taken. The removal rates were as follows 94, 69 and 99%; when the most effective wetland was the one with the longest water residence time and the birch woodchip-layer on top of gravel.

Keywords : constructed wetlands, metazachlor, nitrogen, tile drainage
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