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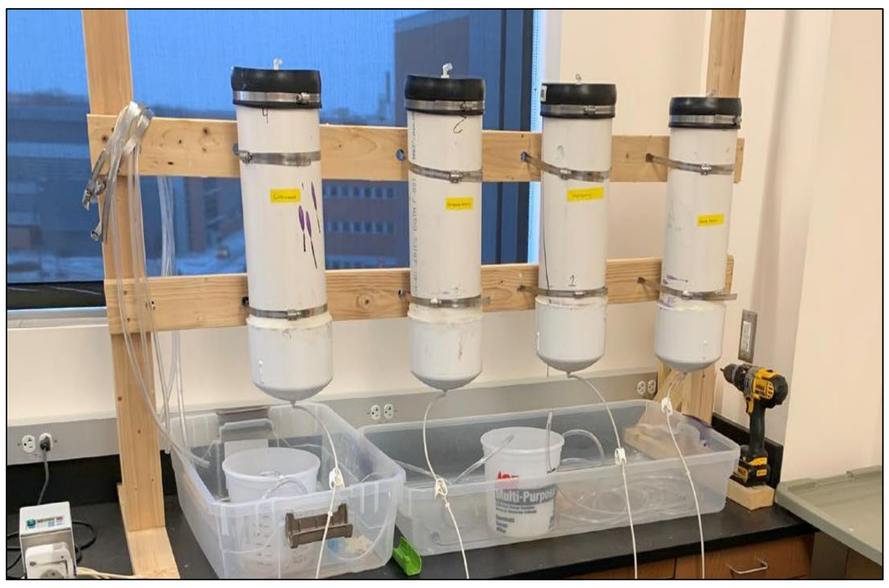
WOOD SPECIES COMPOSITION OF DENITRIFCATION BIOREACTORS INFLUENCES NITRATE REMOVAL AND ADVERSE EFFECTS

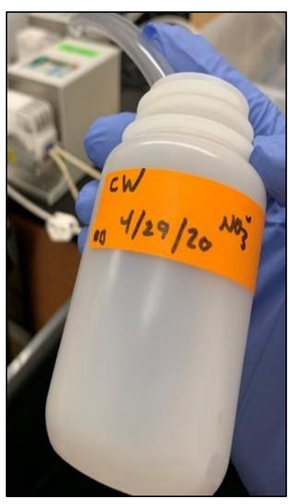
BACKGROUND

Woodchip bioreactors are an effective means to remove excess nitrate from agricultural wastewater. Most bioreactors are composed of a random woodchip mixture consisting of unknown wood species. This paucity of information has contributed to a general underachievement and inconsistency in woodchip bioreactor performances. Bioreactor performance is defined by its ability to remove nitrate and mitigate adverse effects.



OBJECTIVES

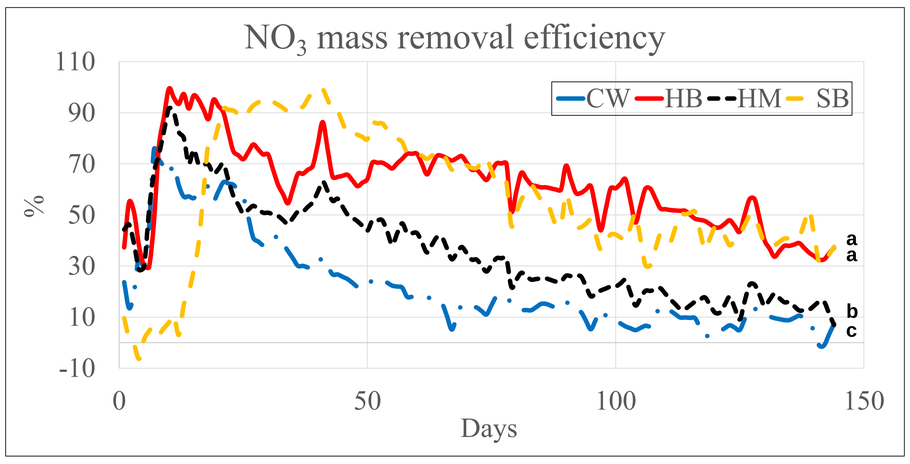
(1) Quantify nitrate (NO_3) removal
(2) Quantify dissolved organic carbon (DOC) leaching
(3) Quantify methane (CH_4-C) and nitrous oxide (N_2O-N) production



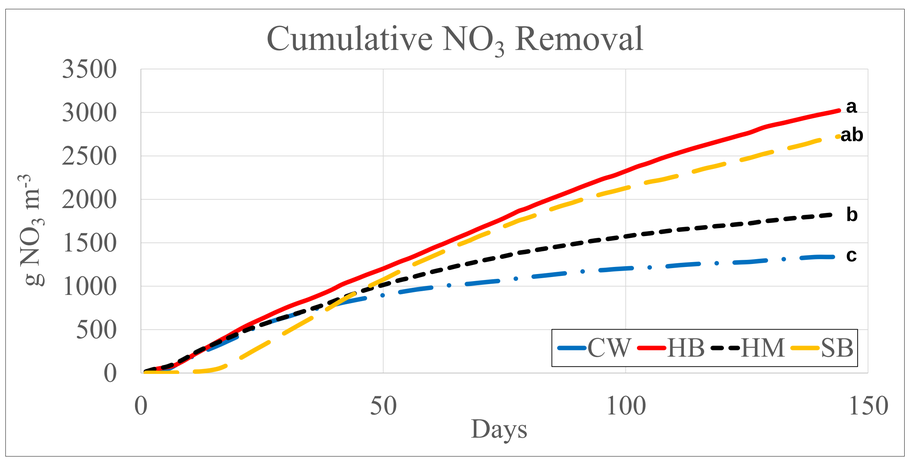
MATERIALS AND METHODS

Cottonwood (CW), hackberry (HB), hard maple (HM), and shagbark hickory (SB) woodchips were isolated into four lab-scale column bioreactors. Flow and inlet NO_3 concentrations were equivalent across all bioreactors. Water and gas samples were collected from the effluent, and analyzed for NO_3, DOC, CH_4-C, and N_2O-N concentrations for 144 days.

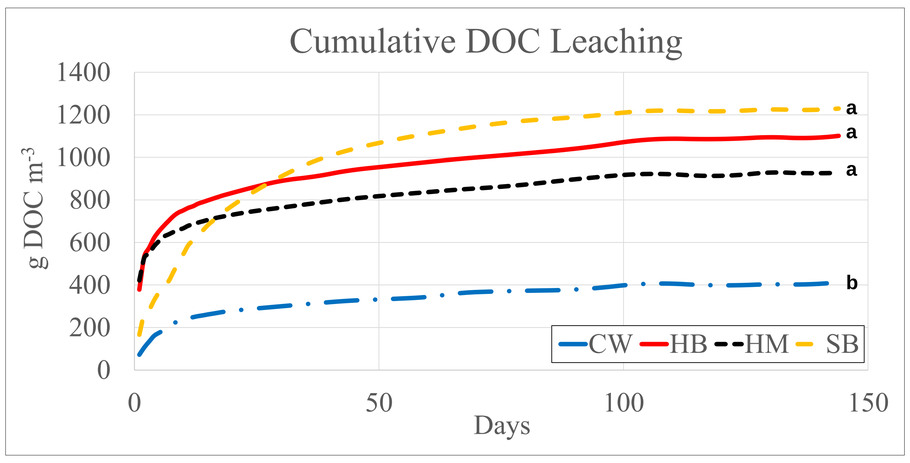
RESULTS



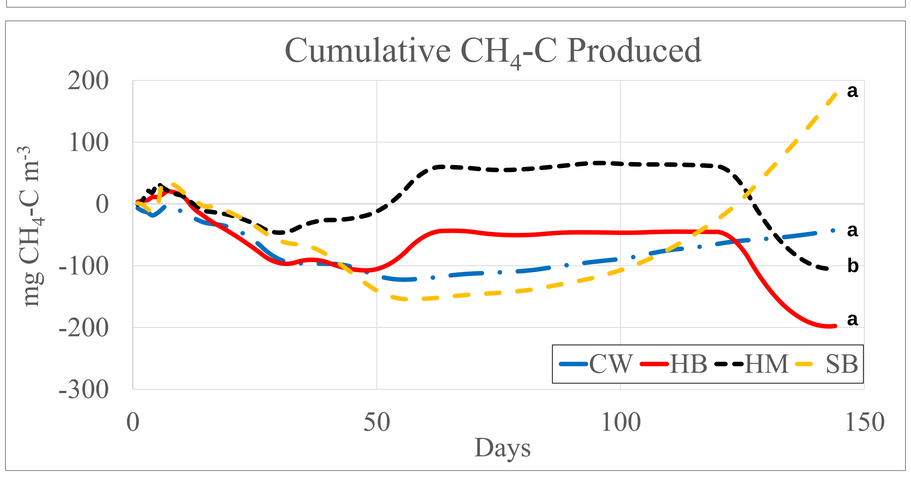
Species	Mean NO_3 mass removal efficiency (%)
Hackberry	61.7
Shagbark hickory	56.6
Hard maple	36.1
Cottonwood	22.5



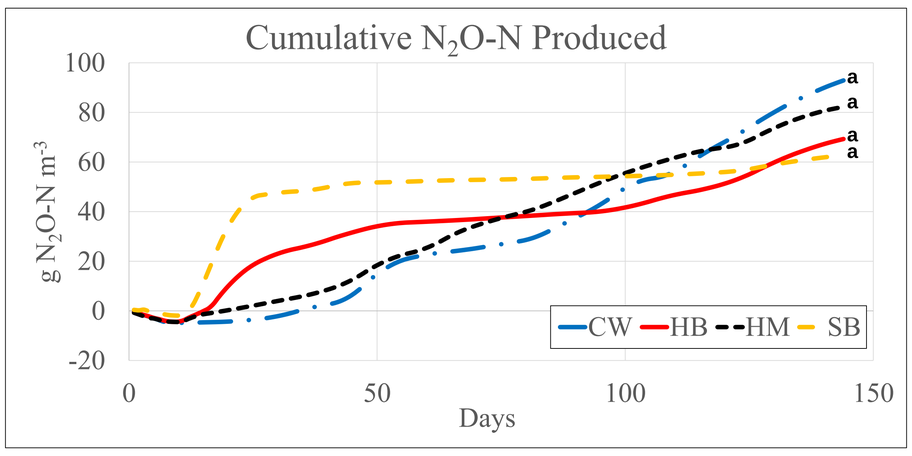
Species	Mean NO_3 removal rate (g NO_3 m^{-3} d^{-1})
Hackberry	20.9
Shagbark hickory	18.9
Hard maple	12.7
Cottonwood	9.3



Species	Mean DOC leaching rate (g DOC m^{-3} d^{-1})
Shagbark hickory	8.54
Hackberry	7.64
Hard maple	6.43
Cottonwood	2.87



Species	Mean CH_4-C production rate (mg CH_4-C m^{-3} d^{-1})
Shagbark hickory	1.2
Cottonwood	-0.3
Hard maple	-0.7
Hackberry	-1.4



Species	Mean N_2O-N production rate (g N_2O-N m^{-3} d^{-1})
Cottonwood	0.64
Hard maple	0.57
Hackberry	0.48
Shagbark hickory	0.43

CONCLUSIONS AND IMPLICATIONS

This experiment suggests that hackberry and shagbark hickory woodchips are capable of removing significantly greater amounts of NO_3 in woodchip bioreactors than hard maple and cottonwood woodchips. Furthermore, adverse effects like CH_4-C production and DOC leaching are observed to be influenced by wood species. This research is currently being replicated to field-scale bioreactors in central Iowa to further investigate the influence wood species selection has on woodchip bioreactor performances.

ACKNOWLEDGEMENTS:
ISU ABE WQRL staff, ISU FYHMP, Dr. Tyler Groh, Troy Heeren, Celaysa Mora-Huber, Rosemary Galdamez, Zach Nie, Emma Kerns