Responses of Dissimilatory Nitrate Reduction to Ammonium and Denitrification to Plant Presence, Plant Species and Species Richness in Simulated Vertical Flow Constructed Wetlands

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Abstract T ... *Cyperus alternifolius* ... *Canna glauca* ... *Iris pseudacorus* ...

Keywords

Introduction

... *Clostridium welchii*, ...

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(. 2011). ,
,
. T , -
,
A .
A ,
, O_3^-
(/ O_2^-) ,
(- $_4^+$), -
A O_3^-
(/ O_2^-) (. 2013).
, , -
O_3^-
, A
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-
, ,
,
, -
(. 2003). A ,
, , , -
(Z . 2011). O
, -
(. .) -
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-
(
2001 ,Z . 2010, 2011). T , -
,
A ,
A
, O_2 (
200 ,Z . 2015).
, -
-
(. 2011). ,
/
A ,
. ,
,
(.
200). , ,
A
,
.
T ,
T , Z

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30
, 4-
. T -
(1) -
, , O O -
,
,(2)
A -
, (3)
A ,
, O O -
.

Materials and Methods

Experimental System Design

O 2012,
(V) T
(11 2, 21 ′, 28 34′) Z
. ,
0.24 3,
50 (1−
2), 30 (
4–), 30 (
50–85) (. 2015). 2015,
Iris pseudacorus ( ),
Canna glauca (G), *Scirpus validus* (V) *Cyperus alternifolius* (A) T -
Z ,
, . A
,
V
( ), (O O) 4-
( ). T
, O O
-
. A V
(
A 1 50),
O 132.5 −1,
O 5 .5 1 −1,
34.52 −1, $_4^+$– 38.05 −1
O_3^- – 3 3 −1, . A
(0.2 3 −1), -
1 0
0.5 (. 2015).
T
2015 A 2015.

pH, Dissolved Oxygen (DO) and Oxidization-Reduction Potential (ORP) Determination in Simulated Wastewater

A A 20 1 5, (4.5
30)
30
O /O
(8 1 1 , A A,). T
, 0.5
. A O (550A,
, A) O -
. T
, .

Sample Collection

A , O O,
. T - -
. ,
5
,
−2.
A , - -
30-
, . (200)
30
. - V
,
(2) Z T .
, -
,
4
A ,
−20
A .

Potential DNF and DNRA Rates

A
1 5 . , 1 0
1 20 ,
, 2

C. alternifolius O
, , O O ,
. *C. glauca* *S. validus*

Results

Plant Biomass Production

T - -

-
, -
A OVA (*P* 0.05, T 1). - -
-
C. glauca (1 0
1 0 3.4 −2),
C. alternifolius (4. 245 −2).
A (T 1), -
- -
V 4
V (*P* 0.05).

pH, DO and ORP Patterns

T .5 .0
(T 2),
(
4-),

(*P* 0.05). T O
2.4 .54 - -
(T 2), -

(*P* 0.05). A , O
(*P* 0.05),

Table 2 , (O) -
(O)

			O (¯1)		O (–)	
	[illegible].8	0.2	0.23	0.08	38 0	25.[illegible]
V	[illegible]. 3	0.2	0.30	0.0	8 .23	1 4.2
	[illegible]8	0.1	0.23	0.0 1	5. 2 1	8 . 1 1
G	[illegible]8 5	0.3	0.24	0.05	8 4.42	2 .
V	[illegible]88	0.2	0.2	0. 1	. 0	33.5
A	.0 1	0.3	0.5	0. 11	[illegible]2.4[illegible]	1 .
	[illegible].8	0.2	0.23	0.08	38 0	25.3
O O	[illegible]. 0	0.2	0.33	0. 1	. 3	34.4
	[illegible]. 5	0.2	0.2	0.0	88 .54	33.5

A T 1

-
(P 0.05, . 1). O ,
A , T -
-
, (P 0.05, . 1).
A , T
- A -
(P 0.05, . 2),
T
(P 0.05, . 2),
I. pseudacorus
T , -
C. glauca *S. validus*, -
C. alternifolius
. , T -
A -
(P 0.05, . 2).
C. alternifolius, T A -
I. pseudacorus,
C. glauca *S. validus*
(P 0.05, . 2).
, T
I. pseudacorus *C. glauca* A -
(P 0.05, . 2).
A
, T -
(P 0.05,
. 3). , T
4-
(P 0.05, . 3).
, A
T , T -

(P 0.05, . 3 ,). -
A
T -
(P 0.05),
T

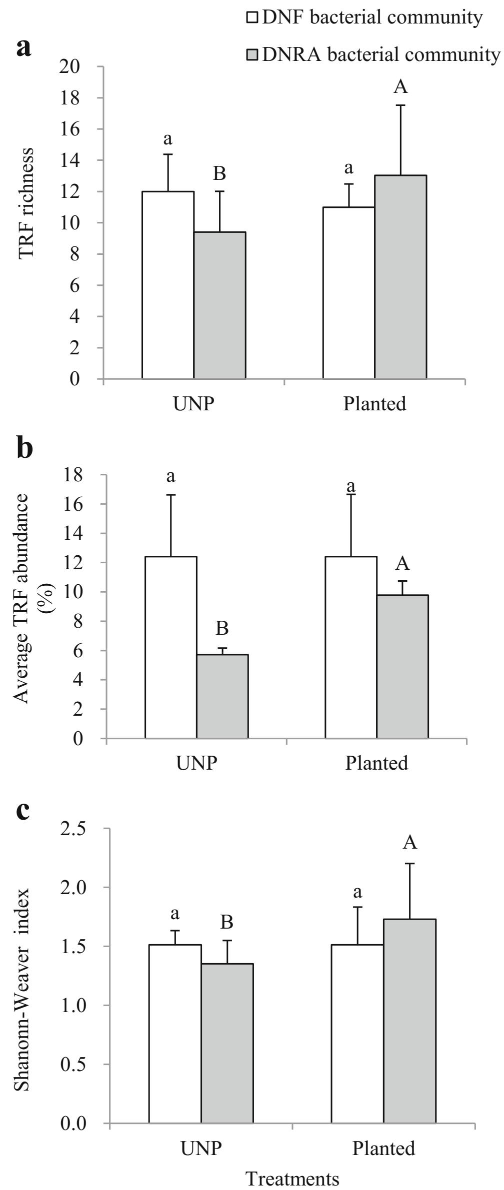


Fig. 1 A
T (T
, **a**), T (
T , **b**) - **(c)**
( ) (V). T T
A .
(n 5
n 25 20
4-). T 1 2 1 .2 4. 1 5 [illegible] 2 1

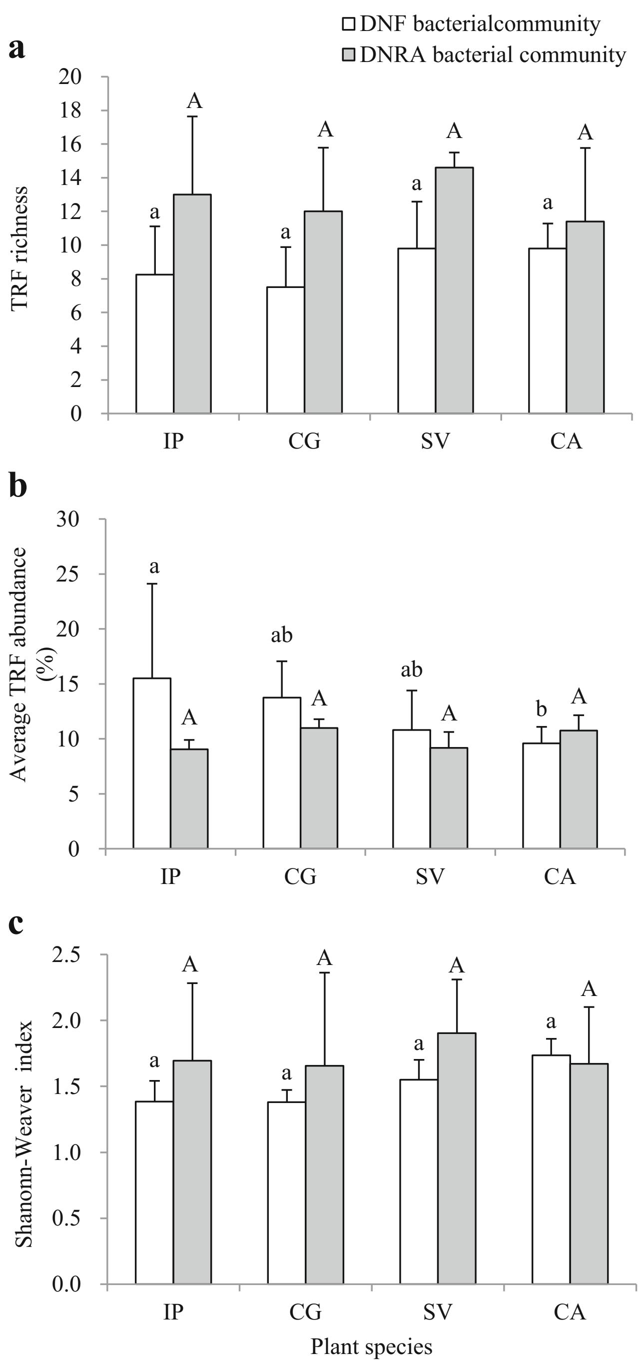


Fig. 2 A
(**a**, **b** **c**) .
, .1 T 1

A (P 0.05).

Potential DNF and DNRA Rates

T 5.5
8.30 μ ‾1 ‾1 ,

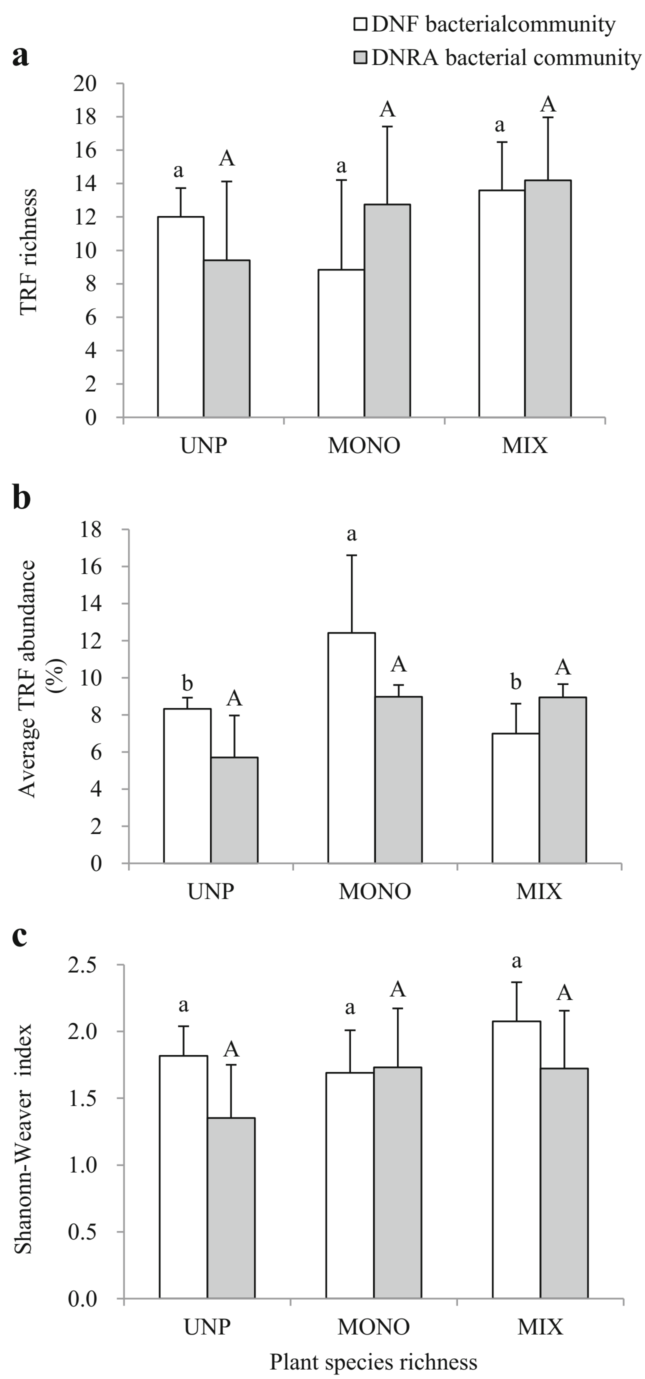
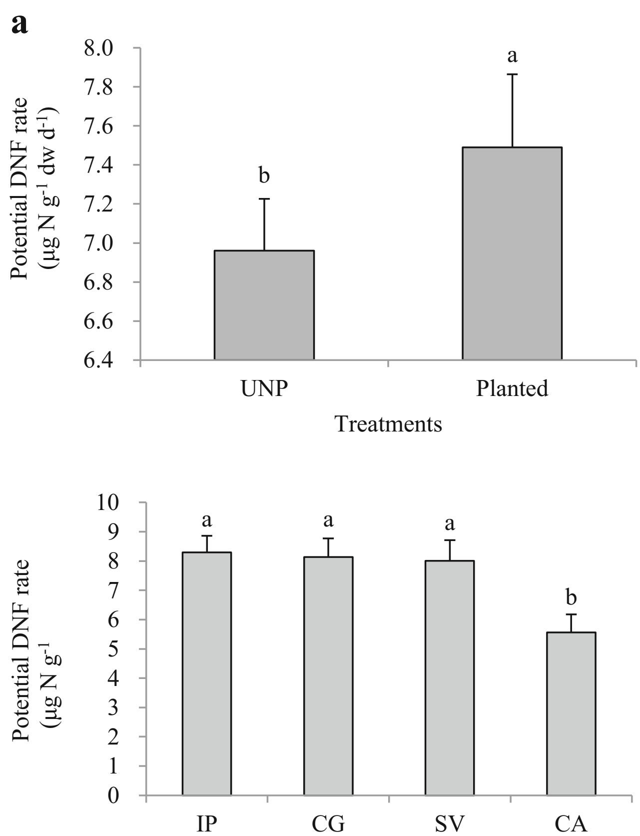


Fig. 3 A
(**a**, **b** **c**) .
O O 4-
, . , .1

(P 0.05, . 4). A
, *C. alternifolius*
(5.5 μ ‾1
‾1, P 0.05)
I. pseudacorus, *C. glauca* *S. validus*
(. 4). A ,
4-



(P 0.05, . 4),

.

T A 4.3

3 . 2 µ ¯1 ¯1 , 1 -

(P 0.05, . 5). A - ¯1)

, *I. pseudacorus* A (. 5). ,

A (32.42 µ ¯1 A 4-

(*P* 0.05, . 5),
. T
A 2, 3 5
, 4- -
(*P* 0.05).

Correlation Analysis of Microbial Parameters to Plant Biomass Production, pH, DO and ORP

A T 3,
, - -
(*P* 0.05),
A (*P* 0.05). A , -
O (*P* 0.05).
, A
A
T , T -
(*P* 0.05).
A
(T 4), - -
A (*P* 0.05),
A (*P* 0.05).
, O
(*P* 0.05, T 4).

Discussion

Plant Biomass Production

,
(. 20 1 4 , .
20 1 5),
(. 2003). , -
-
.
T *C. glauca*
, *C. glauca* -
(. 200). , -
-
,
-
(200 ,
Z . 20 1 0).

pH, DO and ORP

,
( ) + O −
1 −
− ,(2)
, (3)

O_2

(. 2002 , . 200).

T , / , -

. , ,

30- -

,

.

, -

(. 2003). **G** ,

(.

2003). T , -

- .

T

,

, (

A 1 50).

,

O O

,

,

, ,

,

-

(. 2014). A , -

-

, , *nirS*

(Č . 2010). , - . (200) -

nirS

.

. (2005) *nirK*

Vicia faba, Lupinus albus and Pisum sativum. .

(200) *nirK*-

.

, - . (200) *nosZ* -

Typha latifolia *Phragmites australis*.

T -

-

,

, -

(- . 200). G ,

,

, ,

(. 200). , ,

T

- . T

-

. , -

-

. , -

T -

C. alternifolius

. T

O O

C. alternifolius, O O

.

,

-

. T

(. 2005 ,Z . 200).

, . (2015)

2- 5.0 4(3 -.) 4(( )2)200 03- 2 ( ) 3- .0 (4(3 - 2( )-25)-) T T 0T 3 (( )-42

. T ,

A

0-30

. , ( )

1

(*Glyceria*

maxima), A (53 %) O_3^-

,

(1 %).

Potential DNF and DNRA Rate

/ -

(. 20 1 4). ,

,

(. 2004). ,

O O -

,

, -

O . ,

,

. T

. T

(O .5 1 −1, .

20 1 5),

. Z

. (20 1 3)

-

O 5.

, . .,

C. alternifolius -

,

- . T

O O -

, O

O

C. alternifolius -

. A , - -

C. alternifolius,

, -

. , .

(200)

- *G. maxima*

. T -

. - . (200)

-

P. australis

T. latifolia. T

. -

, -

-

C. alternifolius.

A , 4-

- . T

- - -

3 5( )20( ) 1 5( )-25 ( ) 1 30 O T 0

, -2 4( )2 1 ( )

(. 200)20 1 4

A

,

. T , -

, A

, ,

O O .

A ,

I. pseudacorus A

. T

-

I. pseudacorus (. 200),

. , 4-

A ,

. ,

O_2 , /O_2

.

, A 4-

-

, **G** V, , , , ,
AK, O (200) -
.
35 **8** – 004
, 1 , **G** (**8**)
1 -
. 34 4 –52
…

, , , (2002)

Z A . & 34 3 – 34
Z , , A , T, (2013) 1113 11 11

Z , , , Z , G , , G 1 555–5 3
(2010) -
- .

Z , , , G 3 2–3
, , (2011)

T 1 02 02 0– 02 5
Z , T, , Z 1 (2015)
(A)
.

Z , , K A, O 1 5 523–531 (200) ,
,
.

A 3 1 – 2