# USE OF HYDROCHAR AND BIOCHAR AS PEAT REPLACEMENT: CHARACTERIZATION AND COMPARATIVE PLANT GROWTH TESTS

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# Introduction

Reduction in peat usage is desirable due to

•Rising concern of the destruction of peat bogs

•Emission of GHG due to peat mining

•Destruction of Biodiversity due to peat mining

Biochar and Hydrochar could be good candidates for partial or total peat replacement due to their ability to sequester GHG and are energy neutral or positive during their production

•Although great deal of work has been done in these two materials they are almost all related to soil application of these materials

•Any research in relation to growing media has been patchy and on *ad hoc* basis using a plethora of tests

# Introduction

Consequently we:

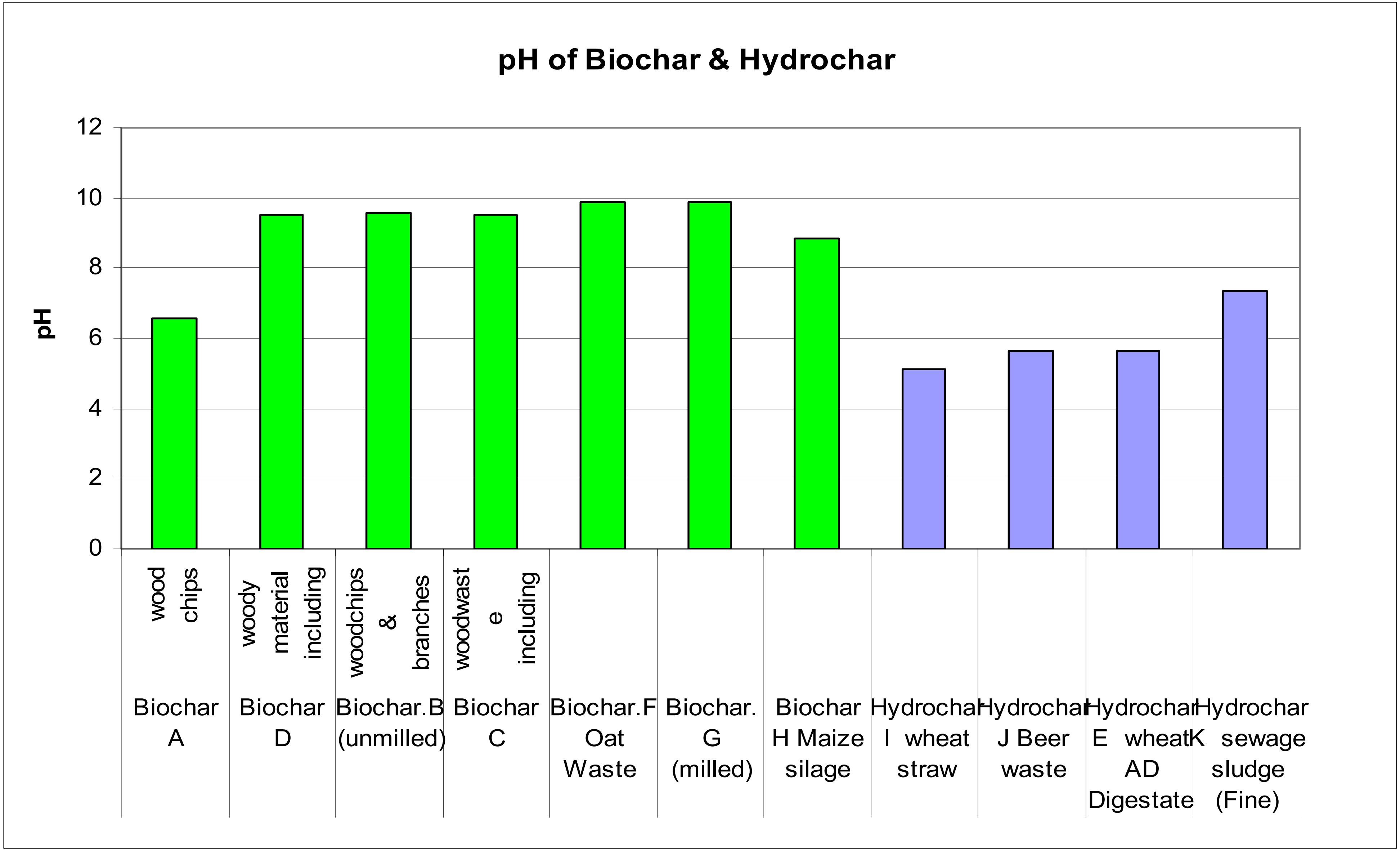
- Characterized Biochar and Hydrochar from the point of view of growing media using *CEN* methods which are designed  for use in growing media (as a peat replacement)
- We carried out germination trials and initial plant growth tests and related to very recent work done in this area

# Materials and Methods

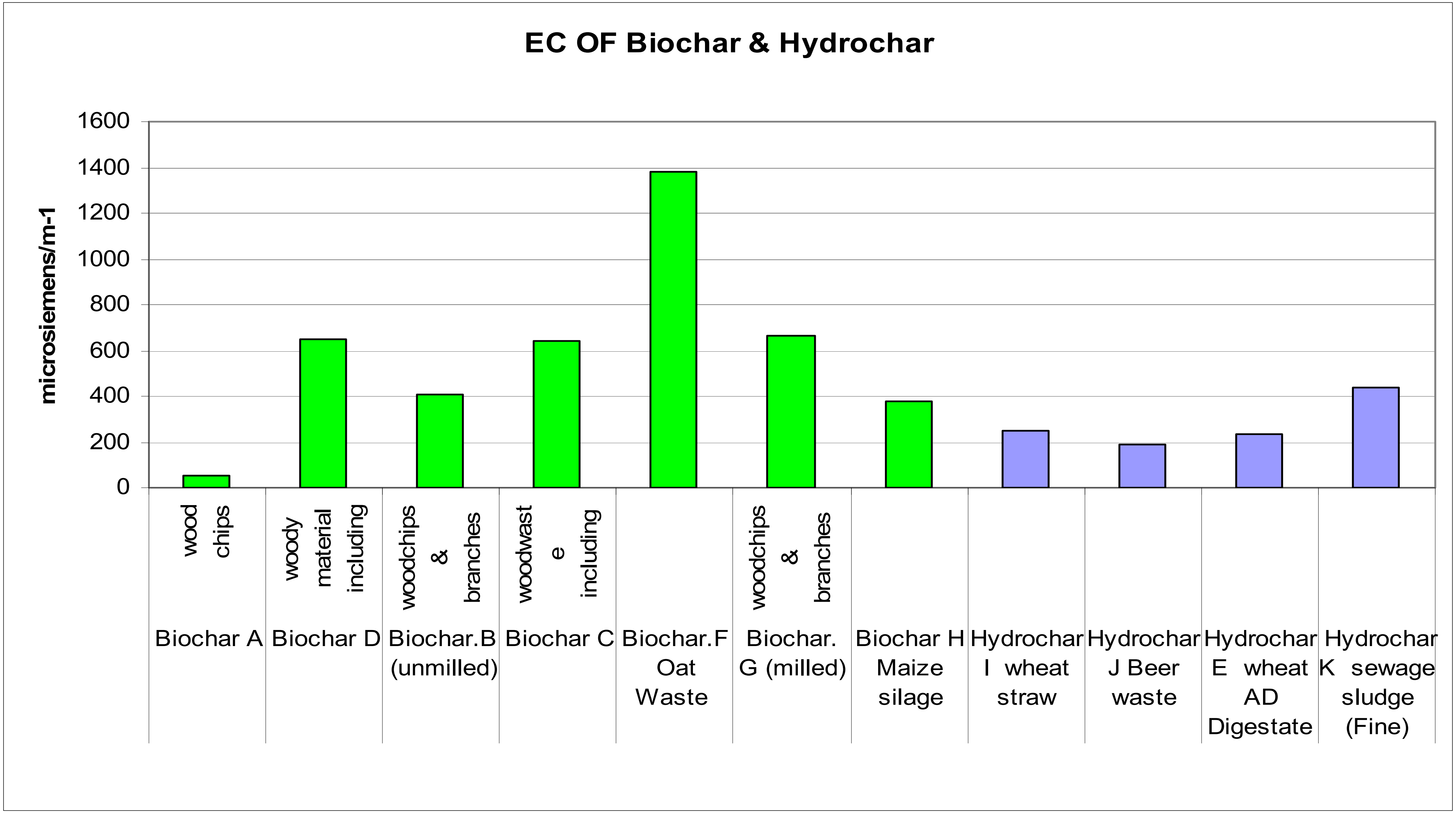
- We obtained 7 samples of experimental and commercial biochar samples
- Similarly we obtained 4 samples of experimental and commercial hydrochar samples.
- We characterized these materials using *CEN* methods designed for use in growing media. These tests were  all chemical and biological tests.
- Germination tests were carried out(after one week) as well as initial growth trials ( after 2 weeks)using some of these materials at rates up to 50%.With one hydrochar from wheat straw we went up to 100%
- Since it has been shown that hydrochar can be phytotoxic due presence volatile fatty acids, we carried out pre-treatment  to overcome the phytotoxicity

## IMPORTANT *CEN* Methods FOR GROWING MEDIA AND SOIL IMPROVERS

•pH **EN 13037:2011**
•Electrical Conductivity **EN 13038:2011**
•Available Nutrients,NO3-N, NH4-N, P, Mg and K + micronutrients **EN 13651:2001**
•Phytotoxicity test **EN 16086-2: 2011**
•Plant Growth test **EN 16086-1: 2011**
•Organic Matter **EN 13039:2011**
•Bulk Density **EN 12580:2008**
•Particle size **EN 15428: 2009**
•Physical Properties Air volume, water volume, shrinkage and total pore space. **EN 1344-2**

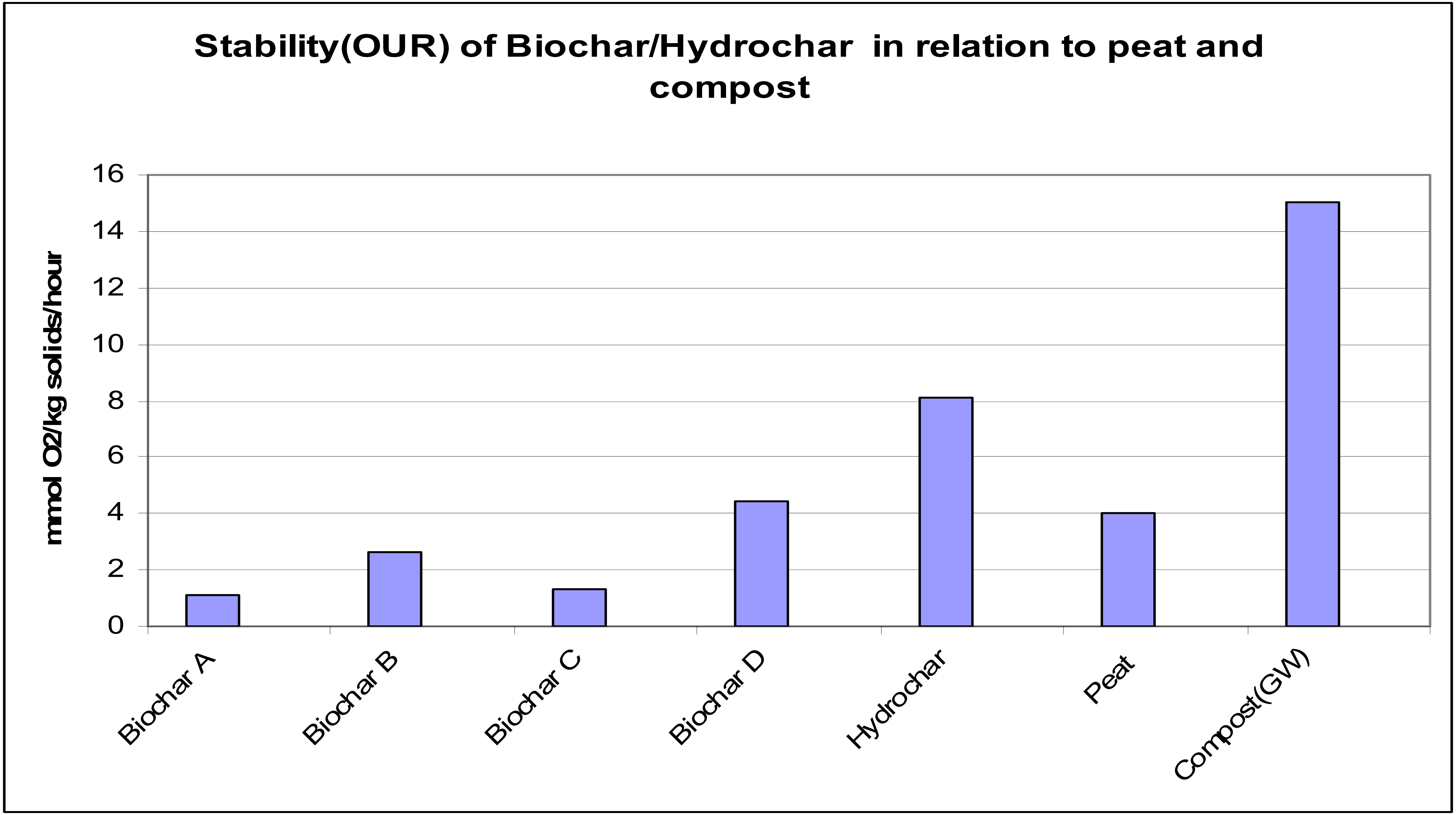


pH of Biochar & Hydrochar
pH
0
2
4
6
8
10
12
wood chips
woody material including
woodchips & branches
woodwast e including
Biochar A
Biochar D
Biochar.B (unmilled)
Biochar C
Biochar.F Oat Waste
Biochar. G (milled)
Biochar H Maize silage
Hydrochar I wheat straw
Hydrochar J Beer waste
Hydrochar E wheat AD Digestate
Hydrochar K sewage sludge (Fine)

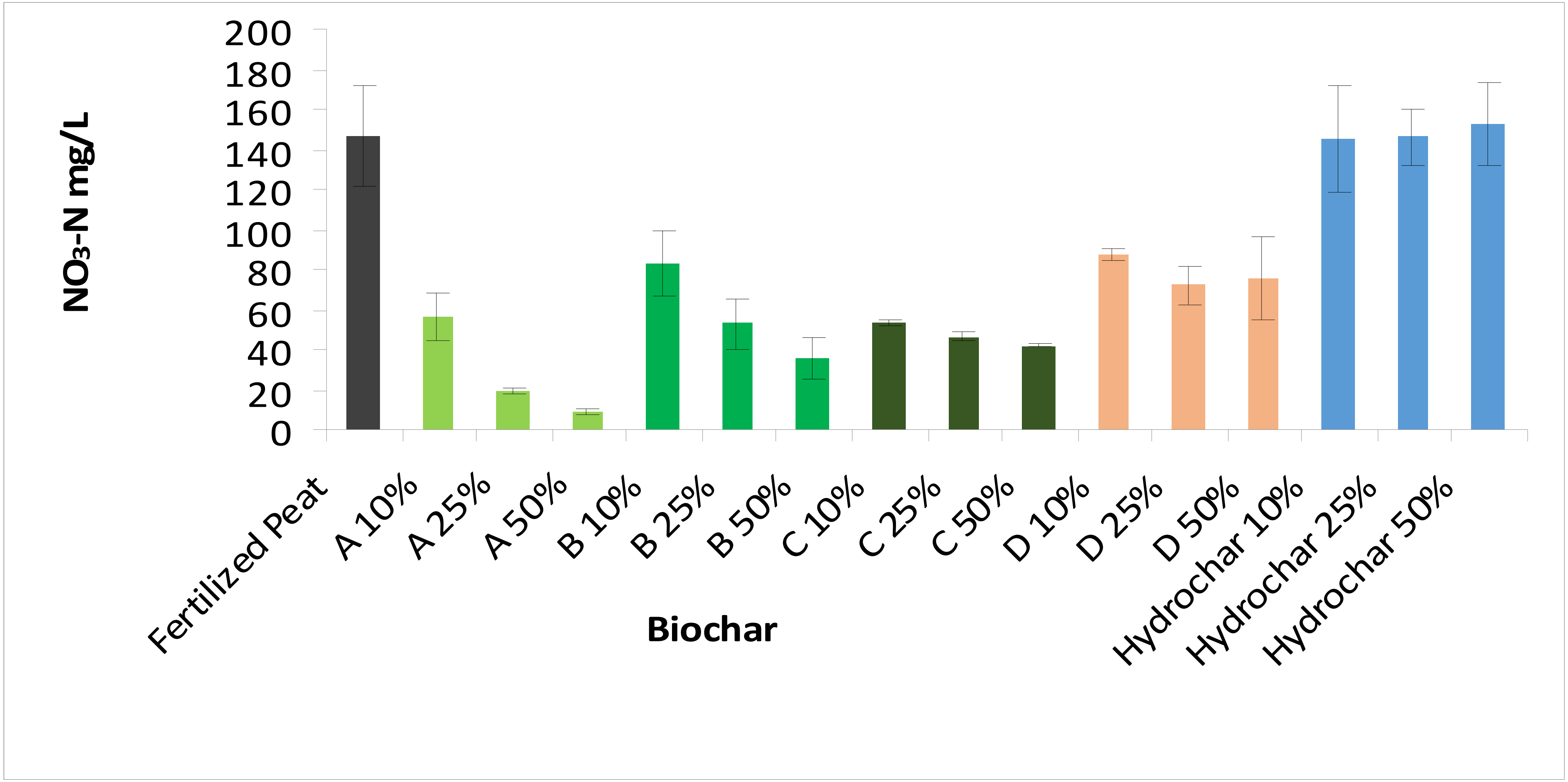

EC OF Biochar & Hydrochar
microsiemens/m-1
1600
1400
1200
1000
800
600
400
200
0
wood chips
woody material including
woodchips & branches
woodwast e including
woodchips & branches
Biochar A
Biochar D
Biochar.B (unmilled)
Biochar C
Biochar.F Oat Waste
Biochar. G (milled)
Biochar H Maize silage
Hydrochar I wheat straw
Hydrochar J Beer waste
Hydrochar E wheat AD Digestate
Hydrochar K sewage sludge (Fine)

# Some chemical Properties using CAT extract(*EN*)

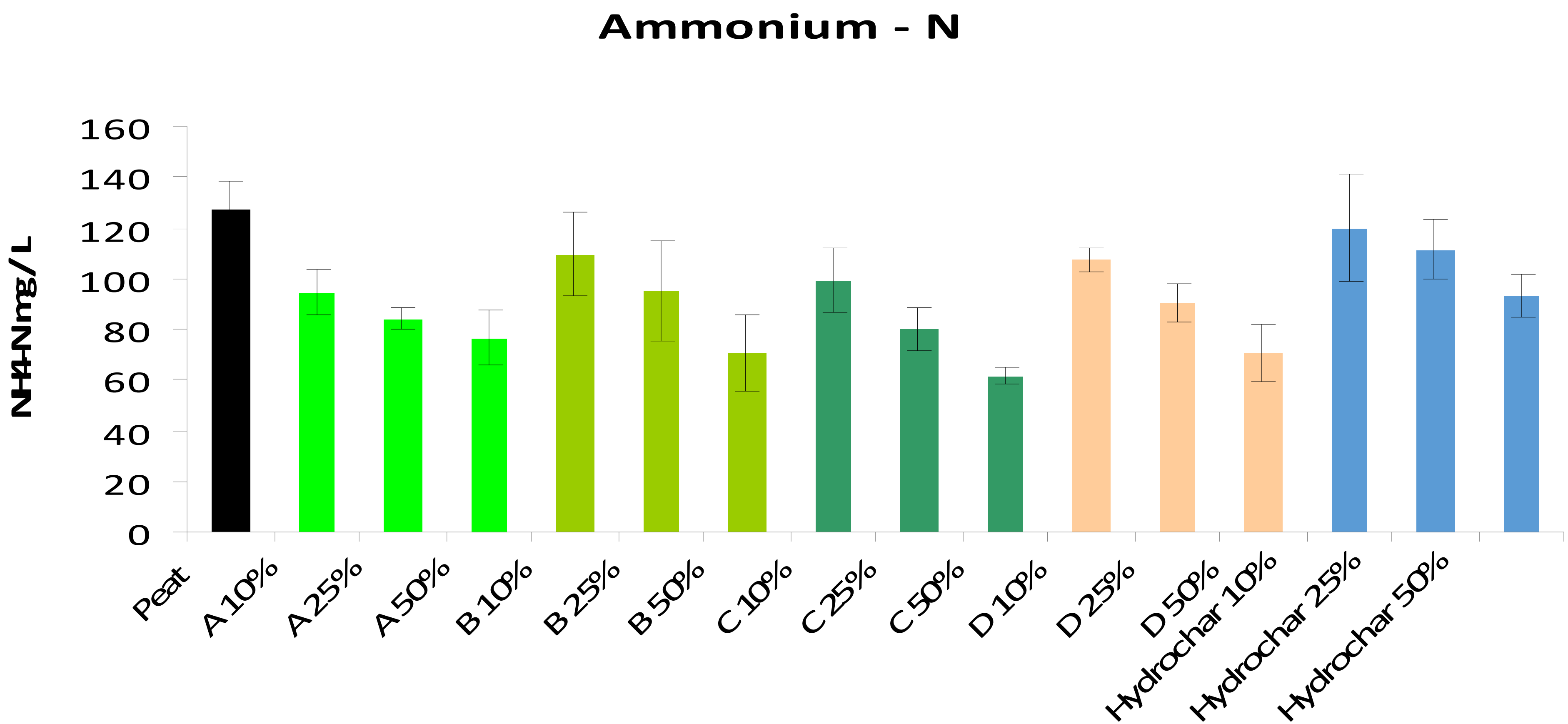
| | NH4-N | NO3-N | P | K |
|---|---|---|---|---|
| | mg/L | mg/L | mg/L | mg/L |
| **Biochar A wood chips** | 0 | 1 | 3 | 25 |
| **Biochar D woody material including fiber** | 1 | 1 | 11 | 891 |
| **Biochar.B (unmilled) woodchips & branches** | 1 | 1 | 8 | 671 |
| **Biochar C woodwaste including food waste** | 1 | 1 | 3 | 990 |
| **Biochar.F Oat Waste** | 0 | 1 | 9 | 1710 |
| **Biochar. G (milled) woodchips & branches** | 1 | 1 | 4 | 1130 |
| **Biochar H Maize silage** | 96 | 1 | 5 | 631 |
| **Hydrochar I wheat straw** | 5 | 1 | 30 | 283 |
| **Hydrochar J Beer waste** | 2 | 1 | 204 | 33 |
| **Hydrochar E wheat AD Digestate** | 46 | 1 | 336 | 500 |
| **Hydrochar K sewage sludge (Fine)** | 1 | 107 | 11 | 191 |


Stability(OUR) of Biochar/Hydrochar in relation to peat and compost
mmol O2/kg solids/hour
16
14
12
10
8
6
4
2
0
Biochar A
Biochar B
Biochar C
Biochar D
Hydrochar
Peat
Compost(GW)

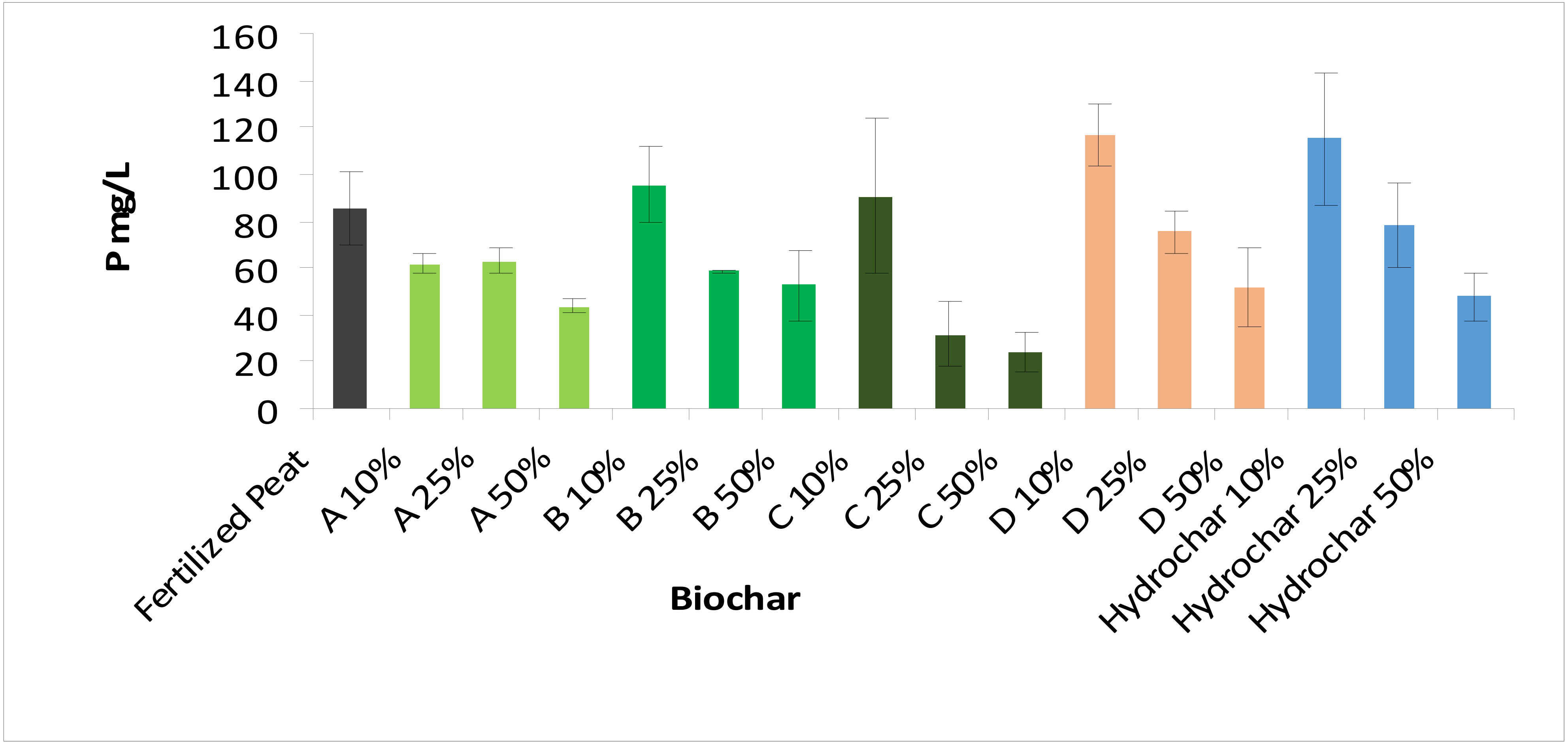
## Recovery of NO3-N from Biochar and Hydrochar in relation to Peat(H4-H5)

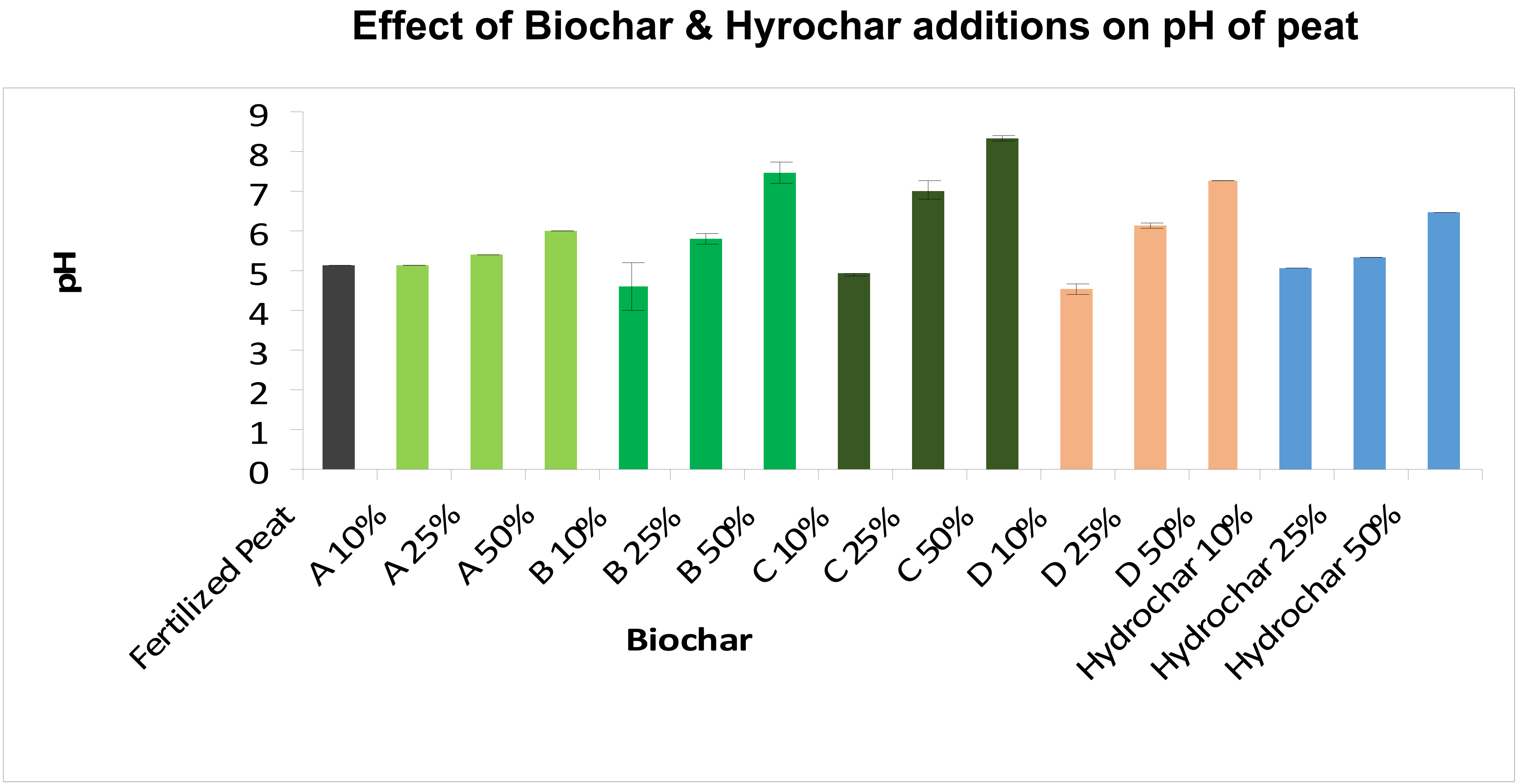


# Recovery of NH4-N from Biochar and Hydrochar in relation to Peat(H4-H5)

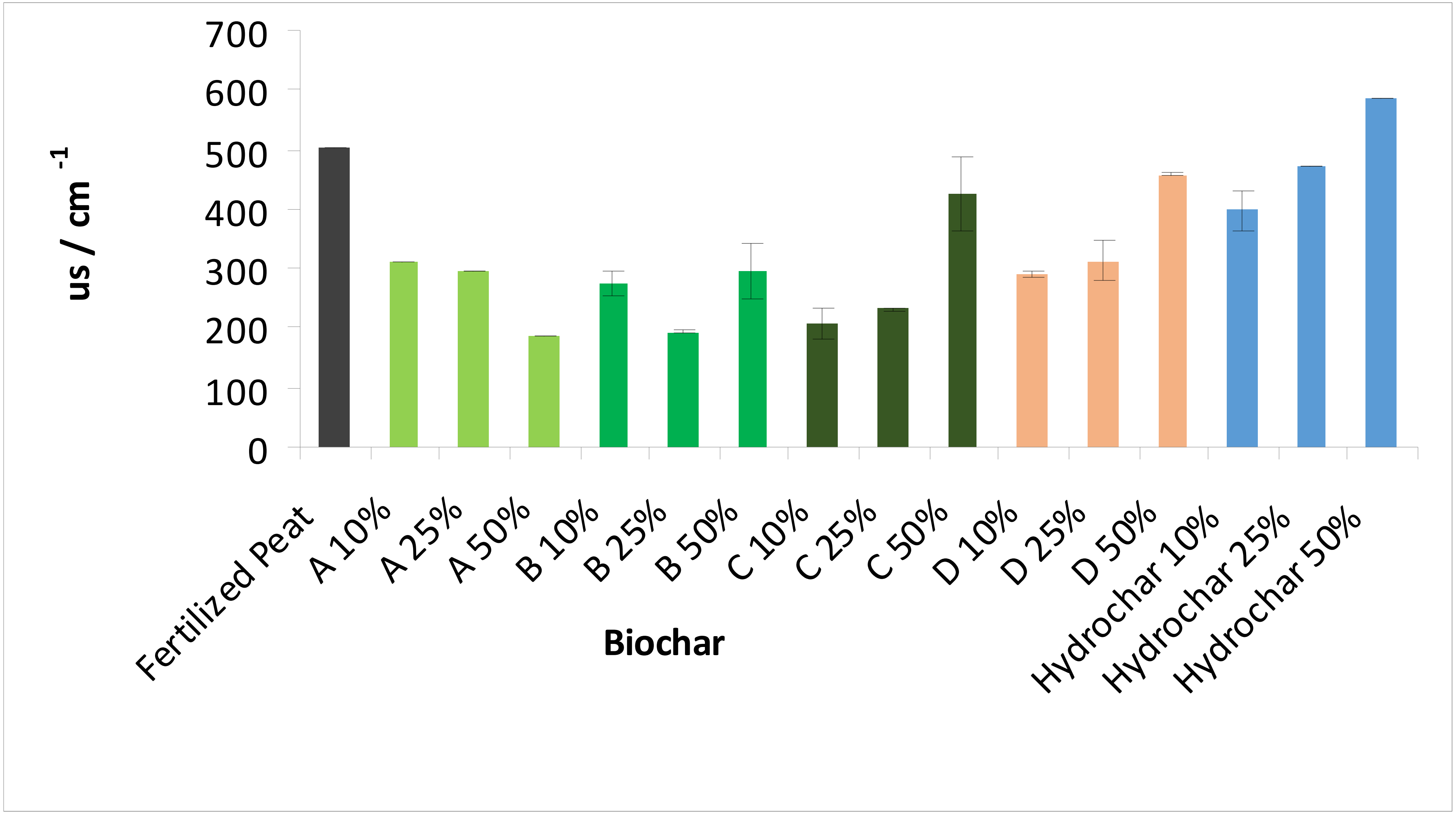


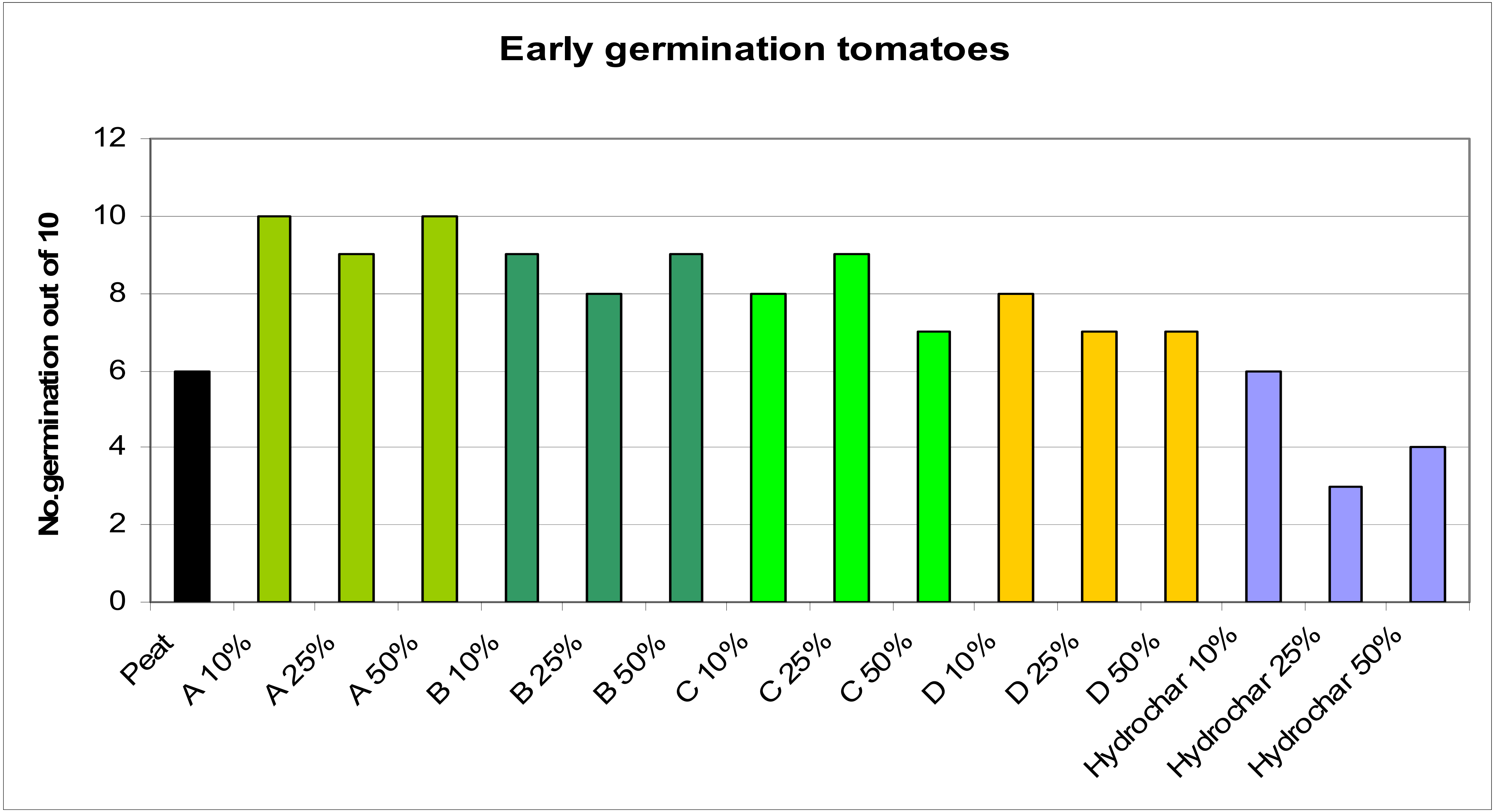
## Recovery of P from Biochar and Hydrochar in relation to Peat(H4-H5)



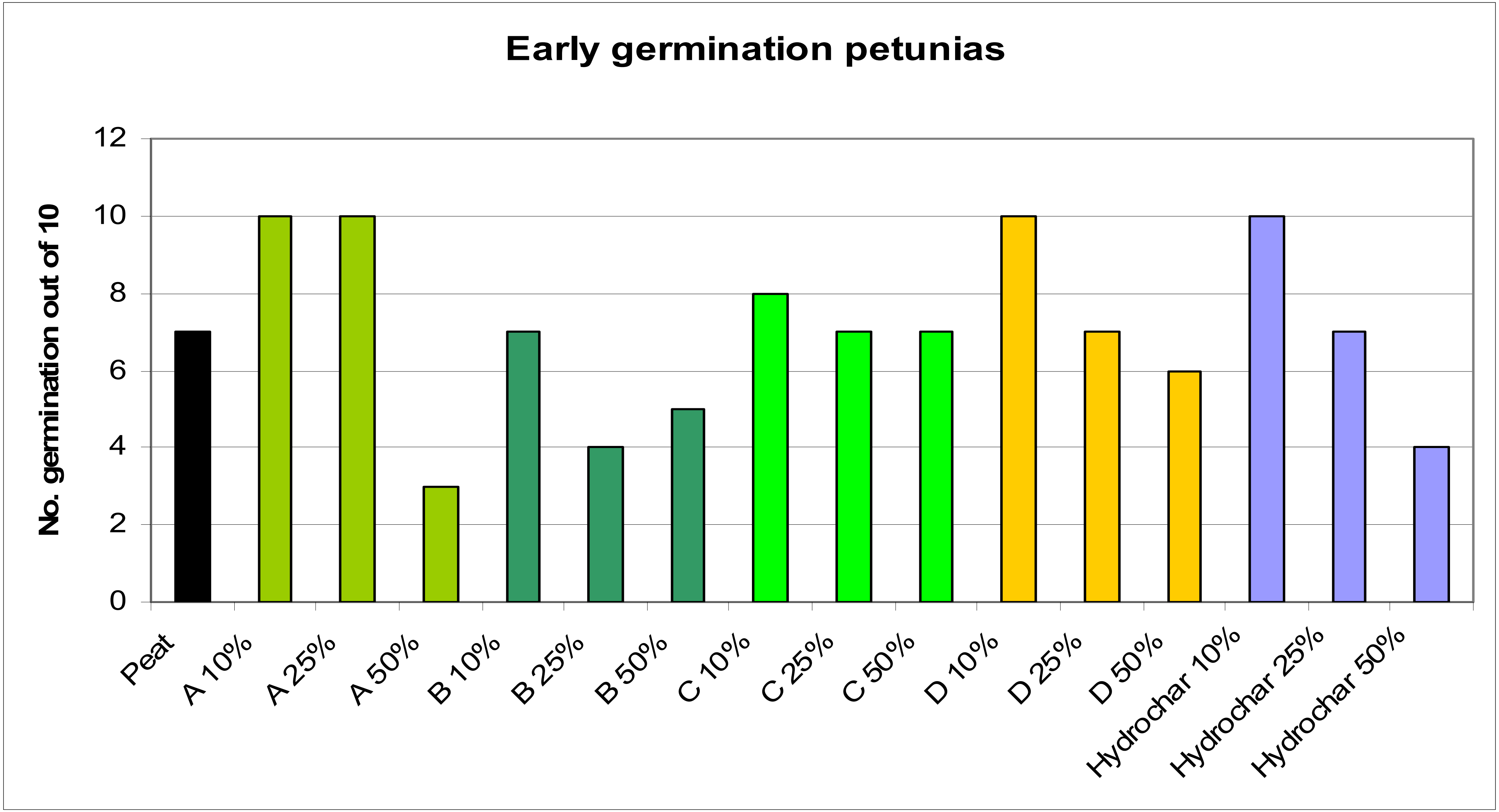

Effect of Biochar & Hyrochar additions on pH of peat
pH
0
1
2
3
4
5
6
7
8
9
Fertilized Peat
A 10%
A 25%
A 50%
B 10%
B 25%
B 50%
C 10%
C 25%
C 50%
D 10%
D 25%
D 50%
Hydrochar 10%
Hydrochar 25%
Hydrochar 50%
Biochar

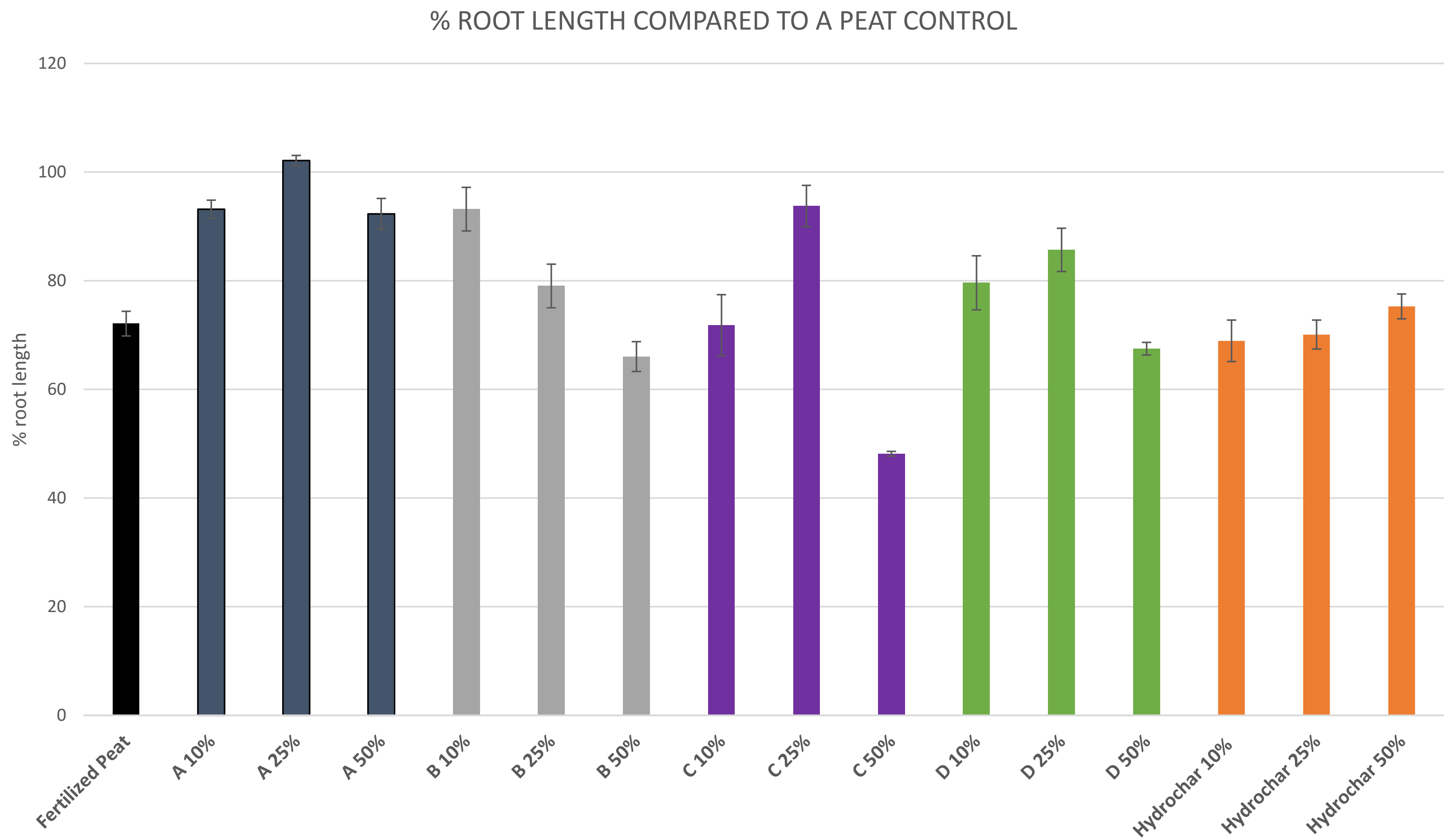
# Effect of Biochar & Hyrochar additions on Electrical Conductivity of peat





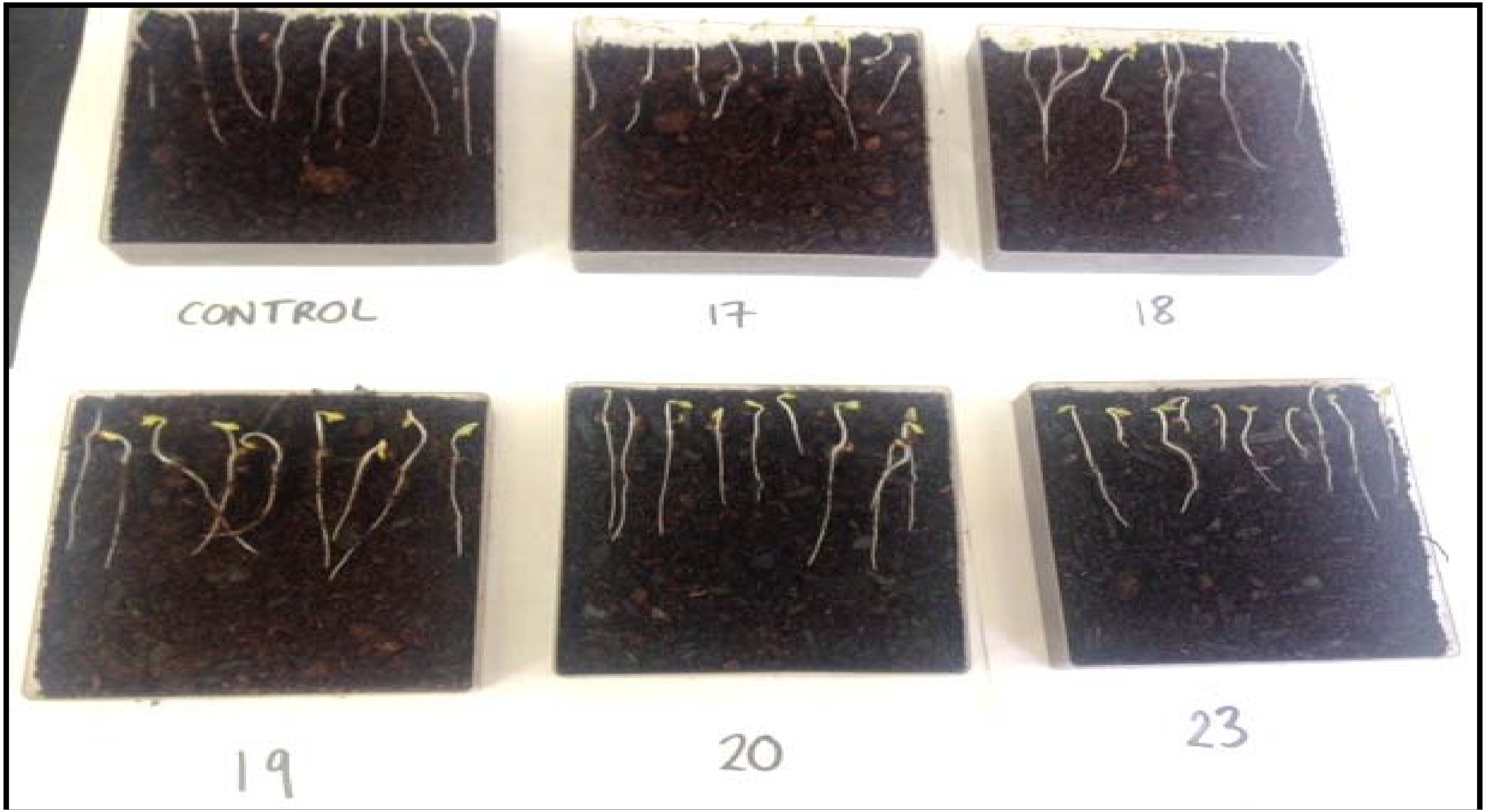
Early germination tomatoes
No.germination out of 10
0
2
4
6
8
10
12
Peat
A 10%
A 25%
A 50%
B 10%
B 25%
B 50%
C 10%
C 25%
C 50%
D 10%
D 25%
D 50%
Hydrochar 10%
Hydrochar 25%
Hydrochar 50%


Early germination petunias
No. germination out of 10
0
2
4
6
8
10
12
Peat
A 10%
A 25%
A 50%
B 10%
B 25%
B 50%
C 10%
C 25%
C 50%
D 10%
D 25%
D 50%
Hydrochar 10%
Hydrochar 25%
Hydrochar 50%

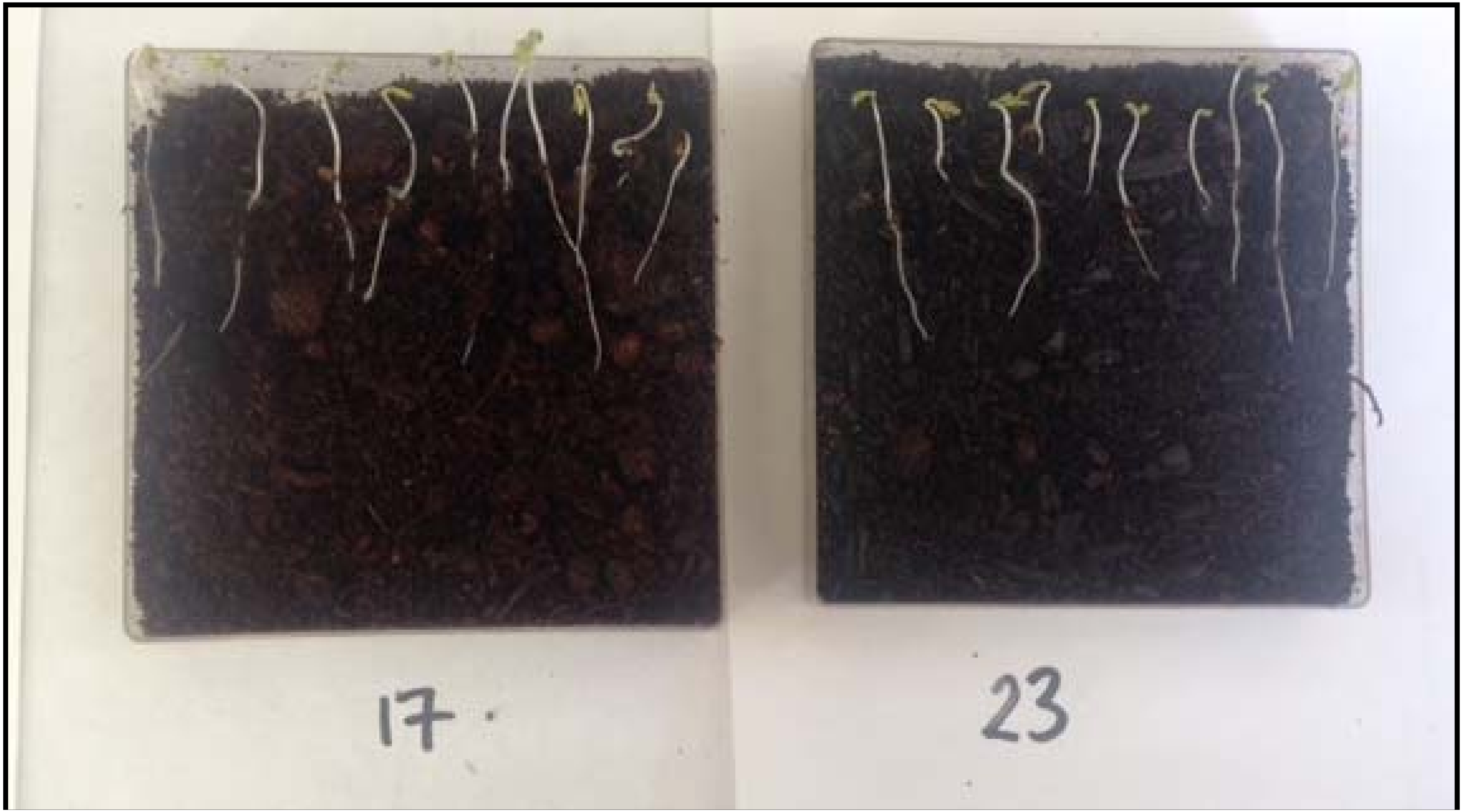


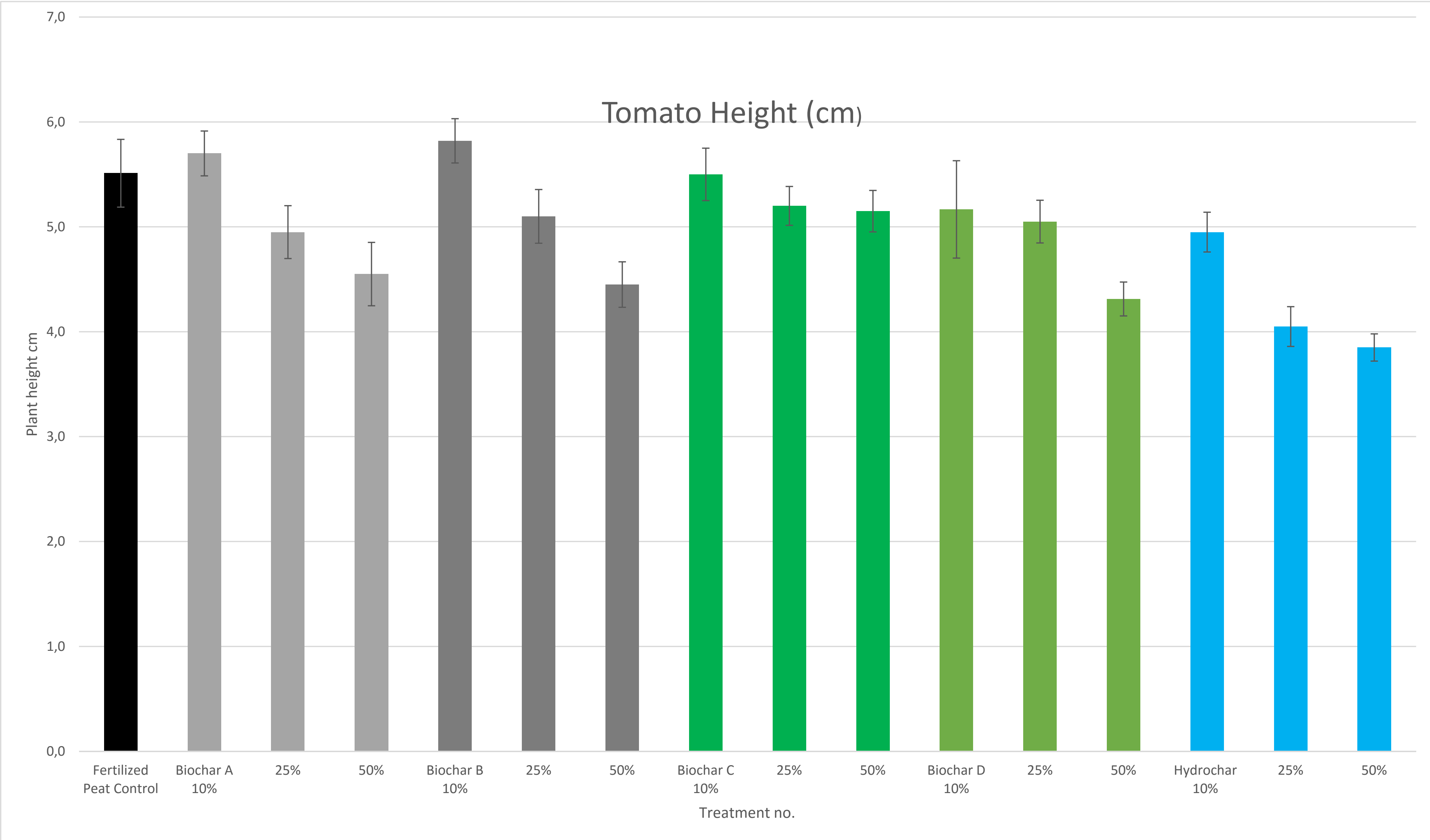
% ROOT LENGTH COMPARED TO A PEAT CONTROL
% root length
120
100
80
60
40
20
0
Fertilized Peat
A 10%
A 25%
A 50%
B 10%
B 25%
B 50%
C 10%
C 25%
C 50%
D 10%
D 25%
D 50%
Hydrochar 10%
Hydrochar 25%
Hydrochar 50%

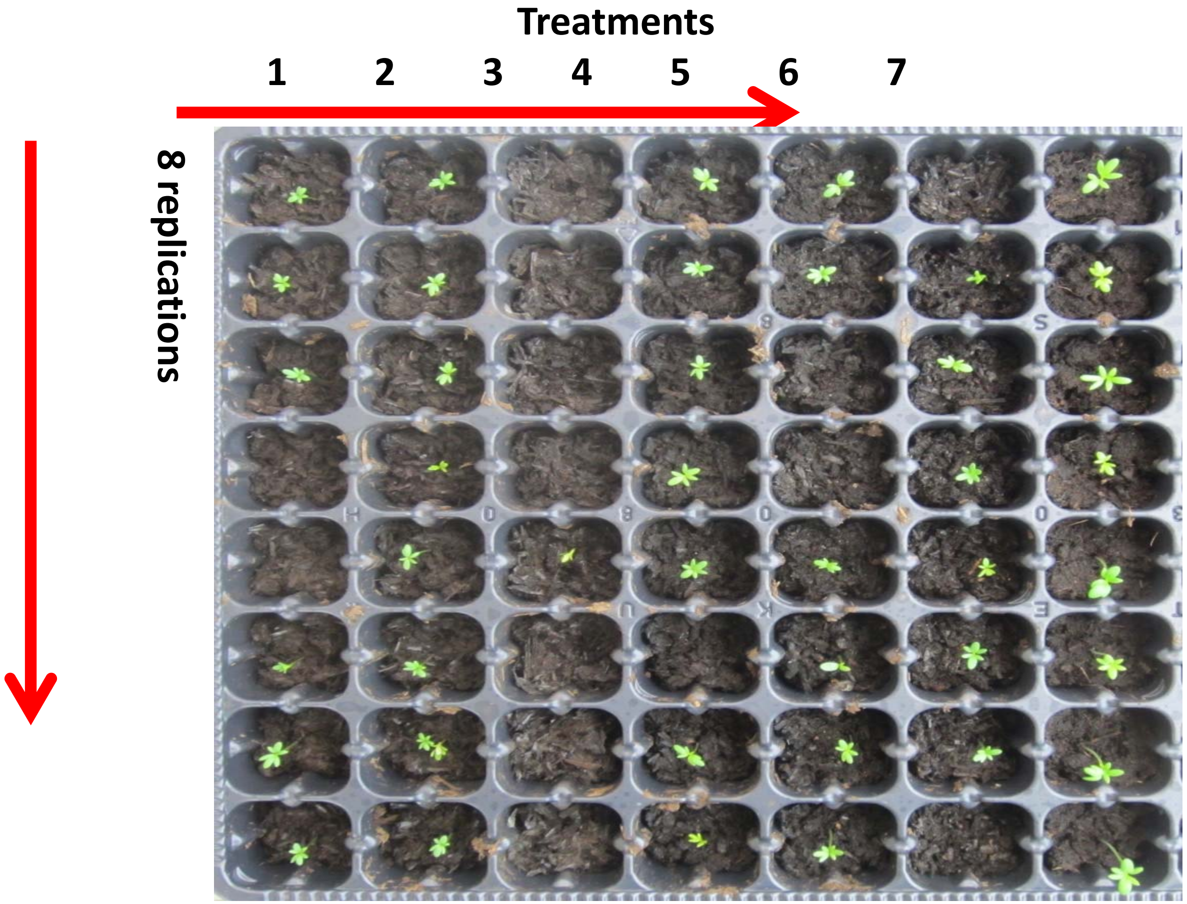
Root development of Cress in various treatments(17 peat.Biochar A,10,25,50% &Biochar C,50%.)



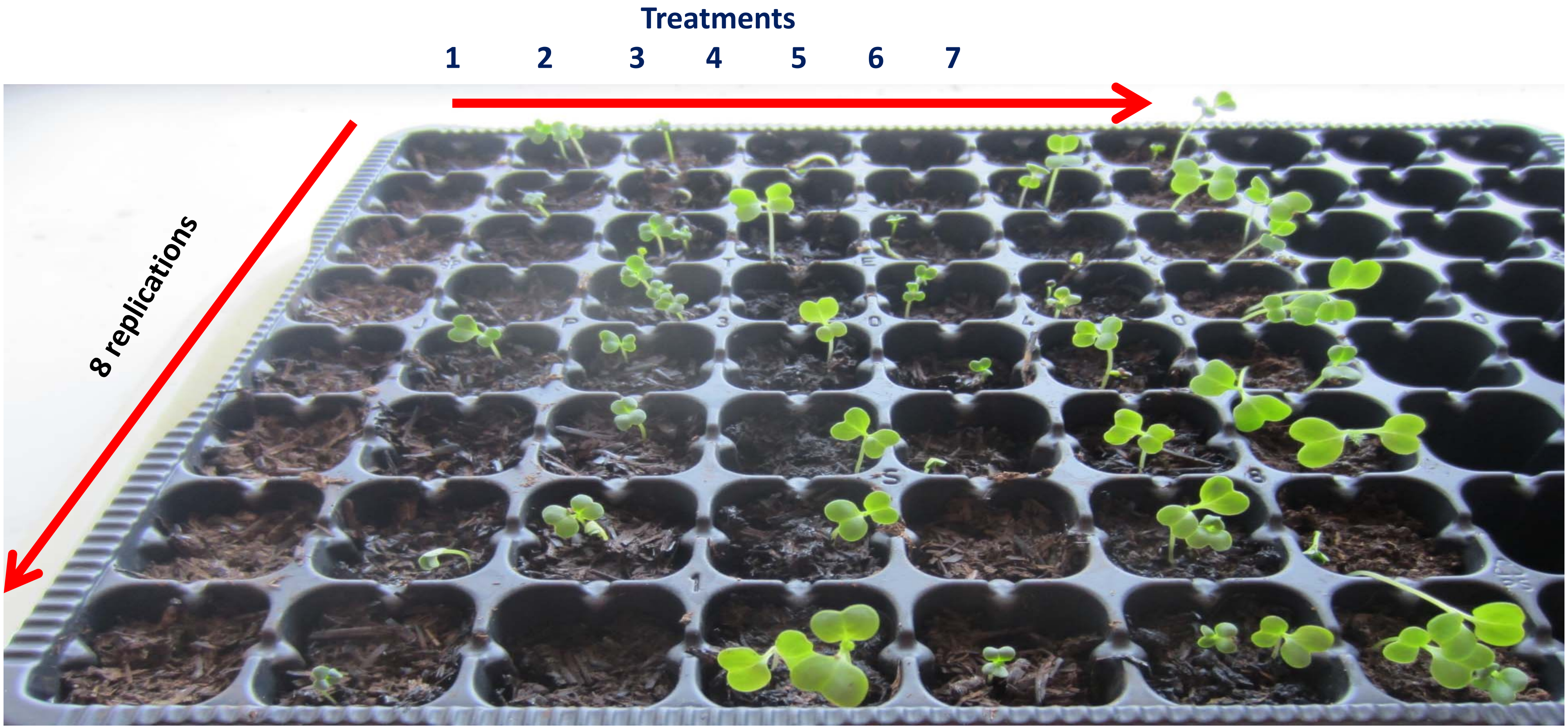
Root Development : Cress




Tomato Height (cm)
Plant height cm
7,0
6,0
5,0
4,0
3,0
2,0
1,0
0,0
Fertilized Peat Control
Biochar A 10%
25%
50%
Biochar B 10%
25%
50%
Biochar C 10%
25%
50%
Biochar D 10%
25%
50%
Hydrochar 10%
25%
50%
Treatment no.




| Treatment | |
|---|---|
| 1 | HTC only 20 day pre-conditioning |
| 2 | HTC only 10 day pre-conditioning |
| 3 | HTC only no pre-conditioning |
| 4 | HTC + compost (4:1) 20 day pre-conditioning |
| 5 | HTC + compost (4:1) 10 day pre-conditioning |
| 6 | HTC + compost (4:1) no pre-conditioning |
| 7 | peat |




| | |
|---|---|
| 1 | HTC only no pre-conditioning |
| 2 | HTC + compost (4:1 400ml HTC + 100ml compost) no pre-conditioning |
| 3 | HTC only 10 day pre-conditioning |
| 4 | HTC + compost (4:1 400ml HTC + 100ml compost) 10 day pre-conditioning |
| 5 | HTC only 20 day pre-conditioning |
| 6 | HTC + compost (4:1 400ml HTC + 100ml compost) 20 day pre-conditioning |
| 7 | peat |

# CONCLUSION

Characterization of Biochar and Hydrochar using *CEN* methods showed:

- Differences between biochar and hydrochar as regards pH ,Electrical Conductivity, Nitrate-N Ammonium- N ,Phosphorus and Potassium.
- Biochar addition at 10, 25, and 50% to peat led in general to decrease, in particularly extractable nitrate, ammonium and phosphorus and EC but increase of potassium and pH
- In some cases there was improvement in early germination of tomato and petunia especially at lower rates of biochar. Biochar at 10% addition(v v) to peat increased fresh weight of tomato seedling. Using the EN test for phytotoxicity there was improvement in root length with the addition of biochar. Untreated hydrochar had no effect and root length was similar to peat.
- Untreated 100% hydrochar based on wheat straw was extremely toxic to lettuce but pre-treatment e.g. moistening and leaving it for a few weeks improved germination but the best treatment was the addition of compost as inoculant with the above pretreatment (moisture/time).