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START-UP OF SUB-SURFACE CONSTRUCTED WETLANDS USING *HELICONIA STRICTA* TREATING DOMESTIC WASTEWATER UNDER HIGHLANDS TROPICAL CONDITIONS

Gabriela Guachamín, Alejandra Villamar and **Cristina Almeida***

- Departamento de Ingeniería Mecánica, Facultad de Ingeniería Mecánica, Escuela Politécnica Nacional, Ladrón de Guevara E11-253, 170413, Quito, Ecuador, e-mail: cristina.almeidan@epn.edu.ec

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INTRODUCTION

Wastewater treatment performance by region

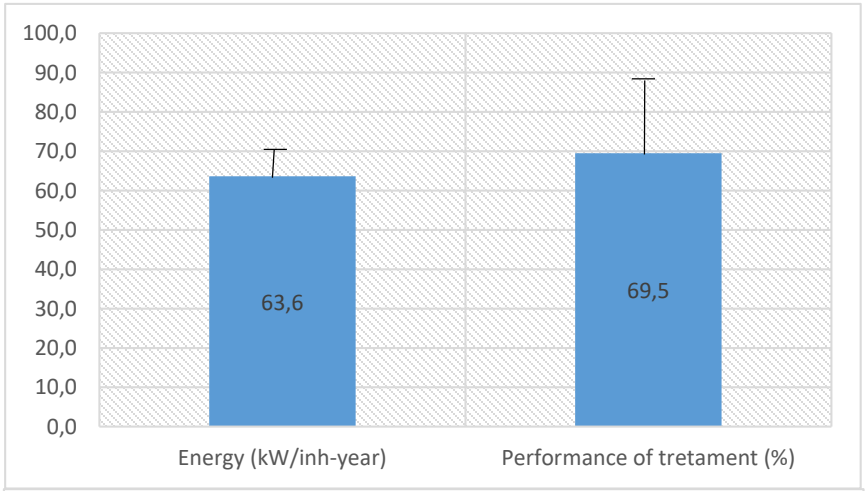
Malik et al. (2015)

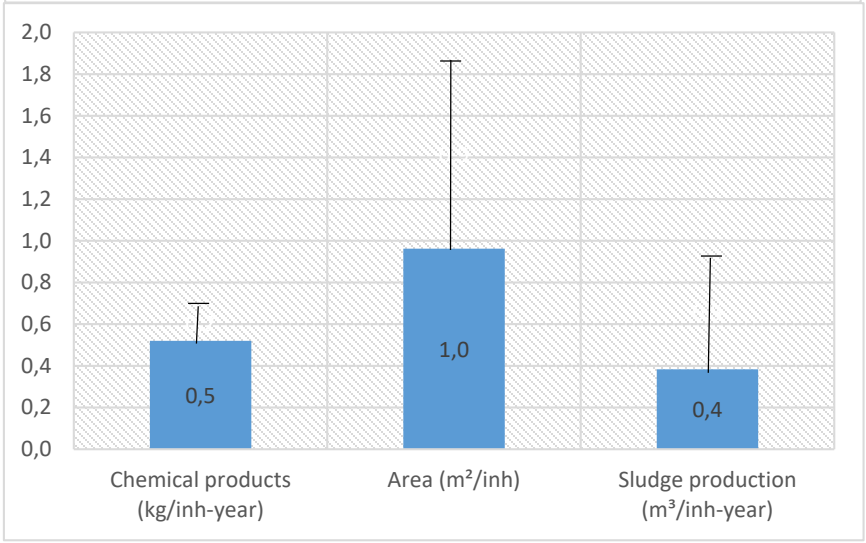
INTRODUCTION

Conventional and non- conventional treatments in Ecuador

- **Pretreatment**
  - Screening
  - Sandbox
- **Primary Treatment**
  - Septik Tanks
- **Secondary Treatment**
  - Anaerobic Filtration
  - Activated sludge system

Average Costs
35-85 USD/inh-year





Constructed wetland

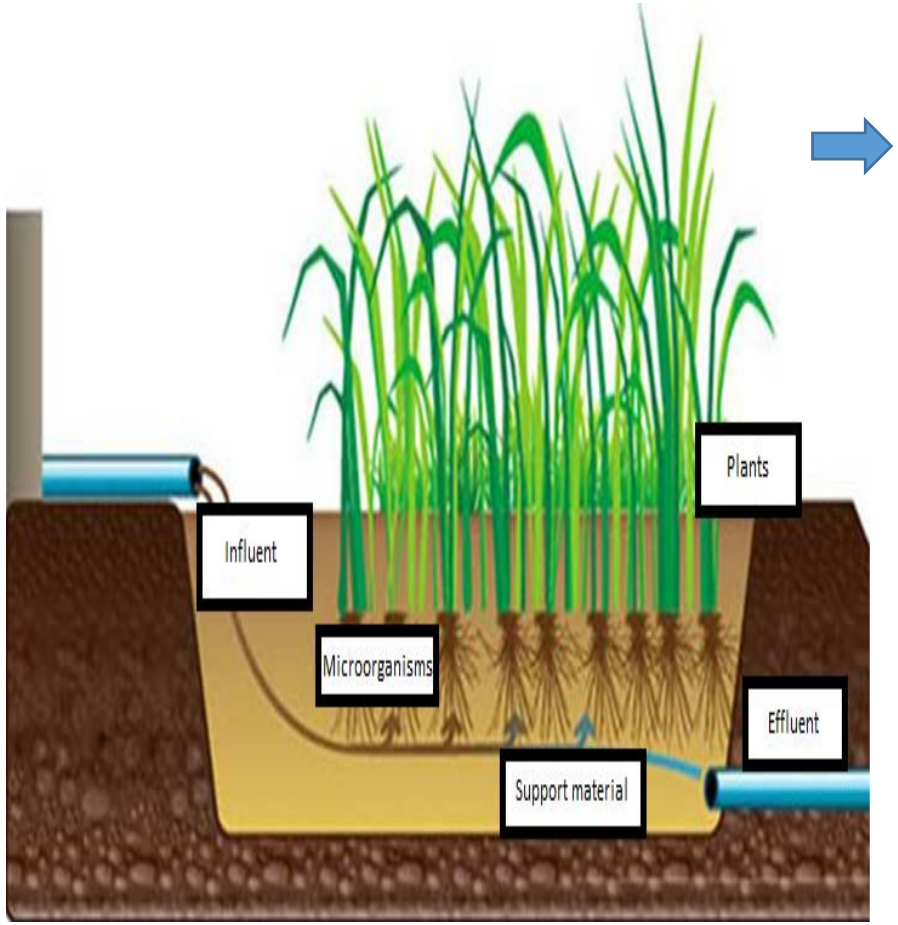
↓

26 USD/inh-year

García and Villamar (2017)

INTRODUCTION

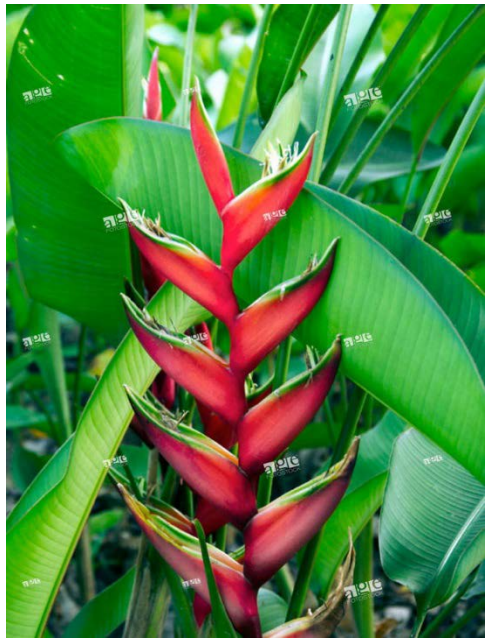
Constructed Wetlands (CW)



>200000 CWs around the world.

Plants → improve the pollutants removal especially those nutrients that are in excess.

Heliconia Stricta in Ecuador



Characteristics

- 57 species
- Adapt easily
- Ornamental plants → Exported

TSS ≈ 88-92%, COD ≈ 40-80%, Nutrientes ≈ 40%, Cr ≈ 94%

Konnerup et al. (2009) and Saumya et al. 2015

OBJETIVE

Determine the behavior and growth of *Heliconia stricta* within a CW used in the treatment of synthetic wastewater.

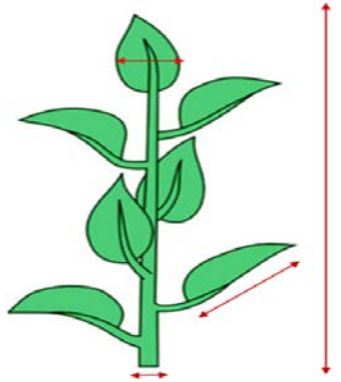
METHODOLOGY

Conditioning Phase

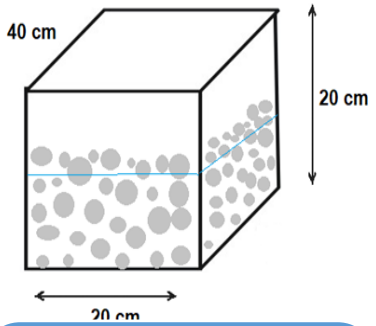
*Original substrate (2 weeks)

*Fed with drinking water

*Stems and the dried leaves → eliminated
*Roots → washed



Allometric measurements



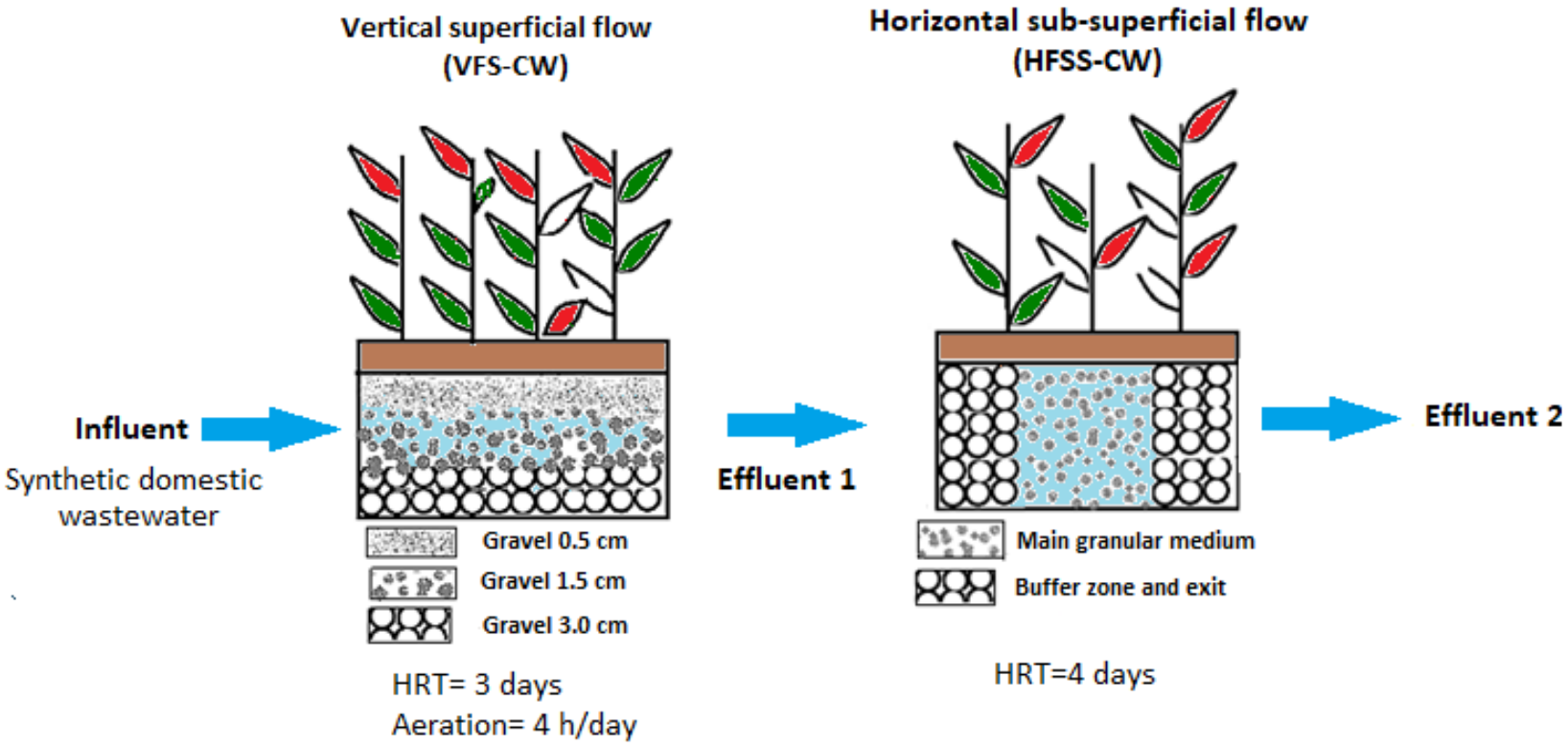
CW

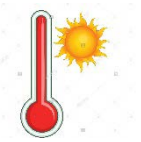
Area= 0.08 m²
Volume= 16 L

EPA (2000)

METHODOLOGY

Experimental model





Experimental conditions

Water temperature ≈ 27 ° C
Brightness= 12 h
pH ≈ 7
Hydraulic load rate= 37.5 L / day m²

Analytical Methods

Influent and effluent water

- Chemical Oxygen Demand
- Nutrients

Plants growth

- Apical height
- Basal diameter
- Leaf number
- Leaf length
- Leaf width Relative abundance
- Plants dry-weight (75°C for 24 h)

Araya (2012), Almeida-Naranjo et al, 2017, APHA-AWWA-WEF (2005), Araya (2012)

RESULTS

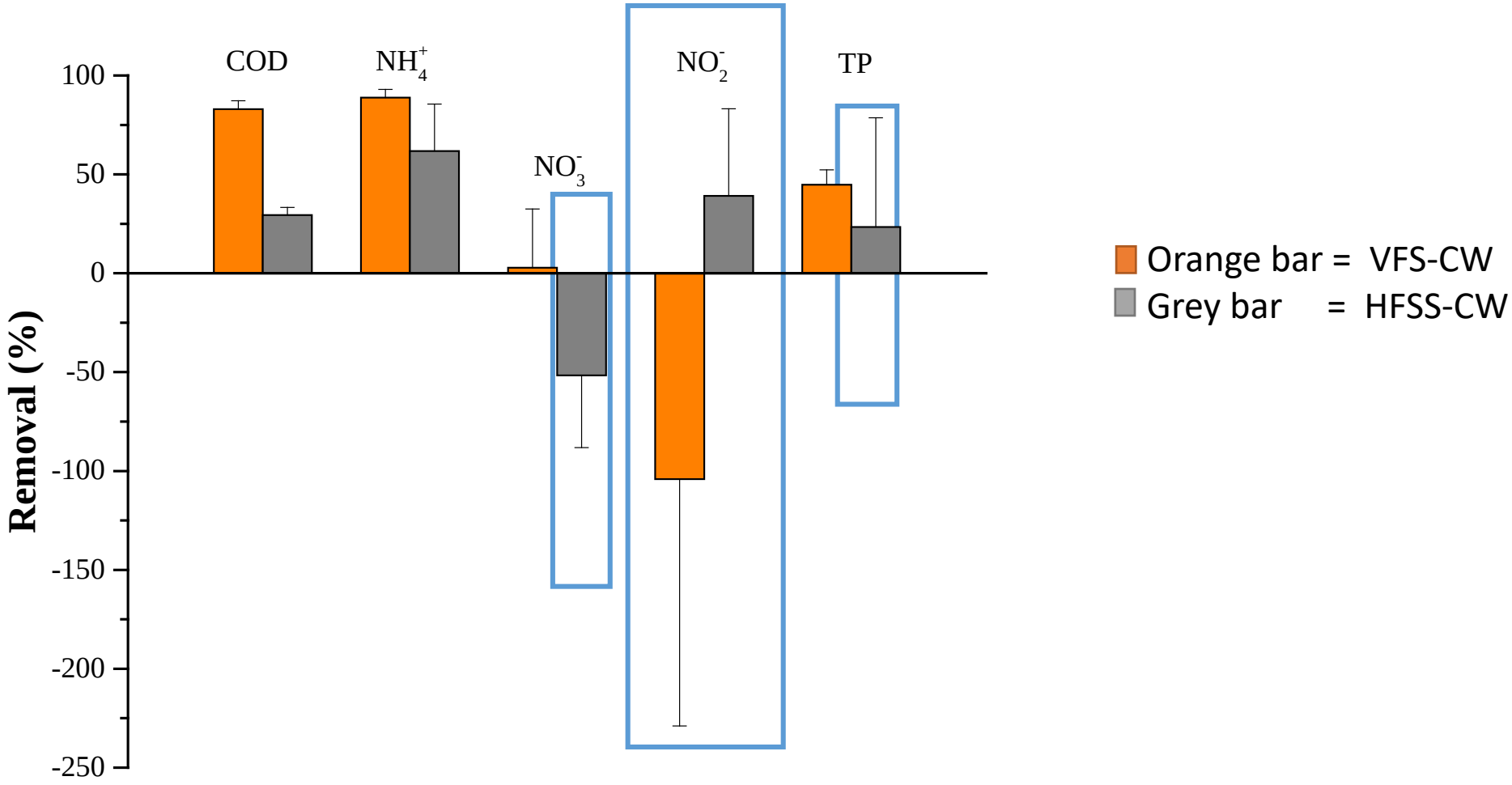
Control Parameters and physical-chemical characteristics of synthetic domestic wastewater (SDW) and Effluents

		SDW	VFS-CW (Effluent 1)	HFSS-CW Effluent 2
Parameter	Unit	Value	Value	Value
Temperature	°C	19.46	23.58	23.53
pH	-	7.47	7.11	7.18
COD	mg L^{-1}	596.00	101.57	78.83
NH_4^+	mg L^{-1}	22.50	2.52	0.80
NO_2^-	mg L^{-1}	0.02	0.03	0.02
NO_3^-	mg L^{-1}	3.35	3.25	5.23
TP	mg L^{-1}	9.30	5.14	4.00

Guachamín (2018)

RESULTS

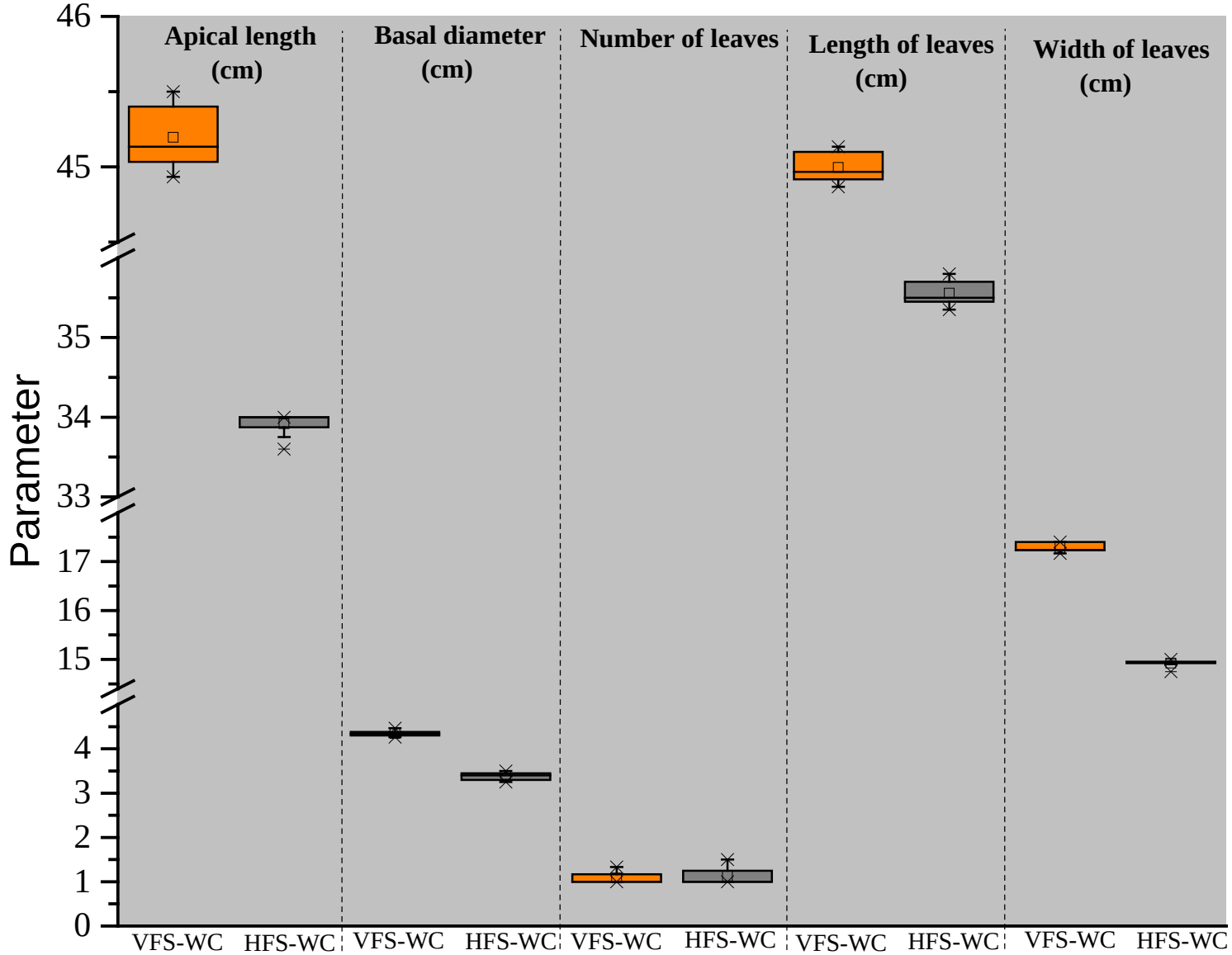
Removal of organic matter and nutrients

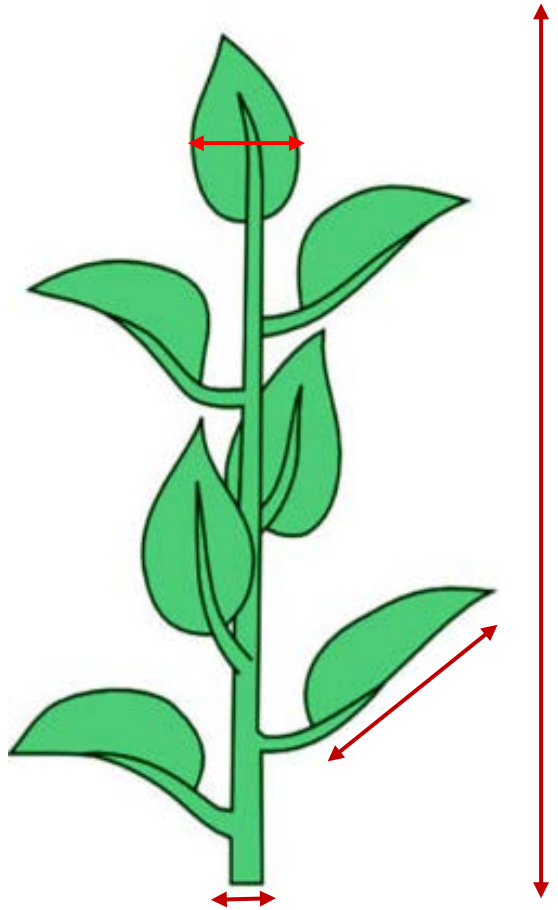


Zurita et al (2009) and Vymazal (2005)

RESULTS

Allometric measurements

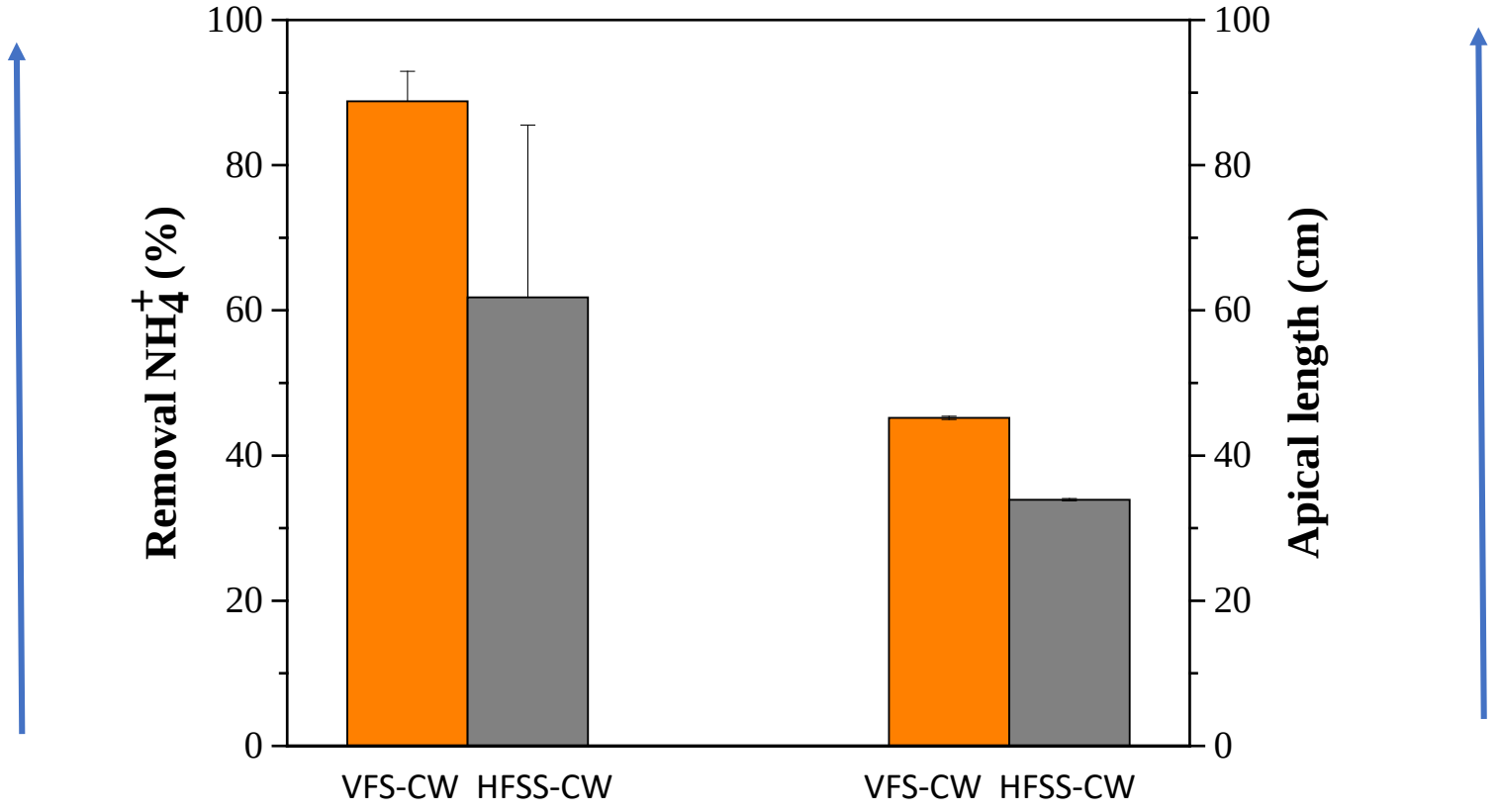




Sosa et al. (2013)

RESULTS

Nutrients removal vs allometric measurements



Zurita et al (2009), García et al. (2008), Vymazal (2005)

CONCLUSIONS

- The removal of COD, $NH4^+$ and TP were 82.6% , 88.8% and 44.8% in VFS-CW and -2.8%, 61.8% and 23.4% in HFSS-CW, respectively. The removal of organic matter and nutrients performance is better in VFS-CW.

- Basal growth values (0.20 cm VFS-CW, 0.25 cm HFSS-CW), leaf growth (0.5 cm VFS-CW, 0.70 cm HFSS-CW) and number of leaves (1 leaf / individual VFS-CW, 1.33 leaves / individual HFSS-CW) were superior in the HFSS-CW. A greater apical growth was obtained in the VFS-CW(0.57 cm VFS-CW, 0.40 cm HFSS-CW).

- The removal of organic matter, nutrients and the *Heliconia stricta* growth are linked to the flow type using in the CWs. In this study the Heliconia stricta growth were favored by the vertical flow.

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Student

Ing. Gabriela Guachamín