

DEPURATION OF TANNERY EFFLUENT BY PHYTOREMEDIATION AND INFILTRATION PERCOLATION UNDER ARID CLIMATE



S. Tiglyene¹, A. Jaouad¹, L. Mandi^{1,2}

¹ University Cadi ayyad, Faculty of Sciences Semlalia, BP 2390 Marrakech, Morocco
² National Center for Studies and Research on Water and Energy, University Cadi Ayyad, Marrakech, Morocco E-mail: mandi@ucam.ac.ma



Abstract

The specific aims of this work were on the one hand, to investigate the potential of *Phragmites australis* to remove chromium from diluted tannery wastewater (50%) in comparison to unplanted soil, under arid climate conditions. Dilution is made by well water. On the other hand, to study the treatment of raw tannery effluent by infiltration percolation system. The results indicated that during 13 months of experiment, total chromium undergoes an overall removal of 99% for the two pilots, which provides limpid purified water. The results of the distribution of total chromium in the various strata of constructed red bed indicated a significant accumulation of total Cr reaching 80% in the surface strata for two systems. Furthermore, the results showed that the Cr could migrate also towards deeper levels of the soil. After 13 months of experiment, the soil accumulated high content of chromium: 94% and 98% for the planted and unplanted systems respectively. However, 5% of Cr accumulated in *Phragmites australis*. The treatment of tannery effluent by reed bed combined with infiltration percolation system is a clean approach from an ecological point of view and constitutes a viable economic alternative in comparison to the purely chemical approaches for the treatment of tannery effluents.

Introduction

The leather tannery industry is well known for having a severe negative impact on the environment. In this industry animal hides are transformed into leather in a succession of various complex stages, consuming high quantities of water and using large amounts of such chemicals as lime, sodium chloride and chromium salts. The most dangerous problem of the pollution generated by the tannery industries in Marrakech is the discharge of heavy metal into the environment, mainly the chromium (≈40 tons/year) which is able to disturb the biological breakdown of the effluents (Scandiaconsult International, 1999). Tannery wastewater flows directly into the receiving medium without any preliminary treatment. The objective of this study is to investigate the potential of an helophytic plant *Phragmites australis* (Cav.) Trin ex Steudel to remove chromium from concentrated tannery effluent in comparison to unplanted soil, under arid climate conditions.

Methods

Nine plots were filled to 15 cm in depth and 60 cm with respectively gravel and soil. Three plots were planted with young shoots of *Phragmites australis* (36 stems/m²). Three unplanted plots served for checking. The experimental plots were alimeted exclusively by diluted tannery wastewater (50%) (figure 1). Three plots were alimeted exclusively by raw tannery wastewater, 3 times a week (10 litres per day) (figure 2). The water flowed vertically through of the soil under arid climate conditions.

The soil (88% sand) used for the study is coming from the Tensift river in Marrakech (Table 1). Wastewater used originates from an industrial tannery in the Marrakech region (Table 2). The shoots of *Phragmites australis* were taken from local and natural reed stand (figure 3).



Figure 1: Treatment of tannery effluent by phytoremediation

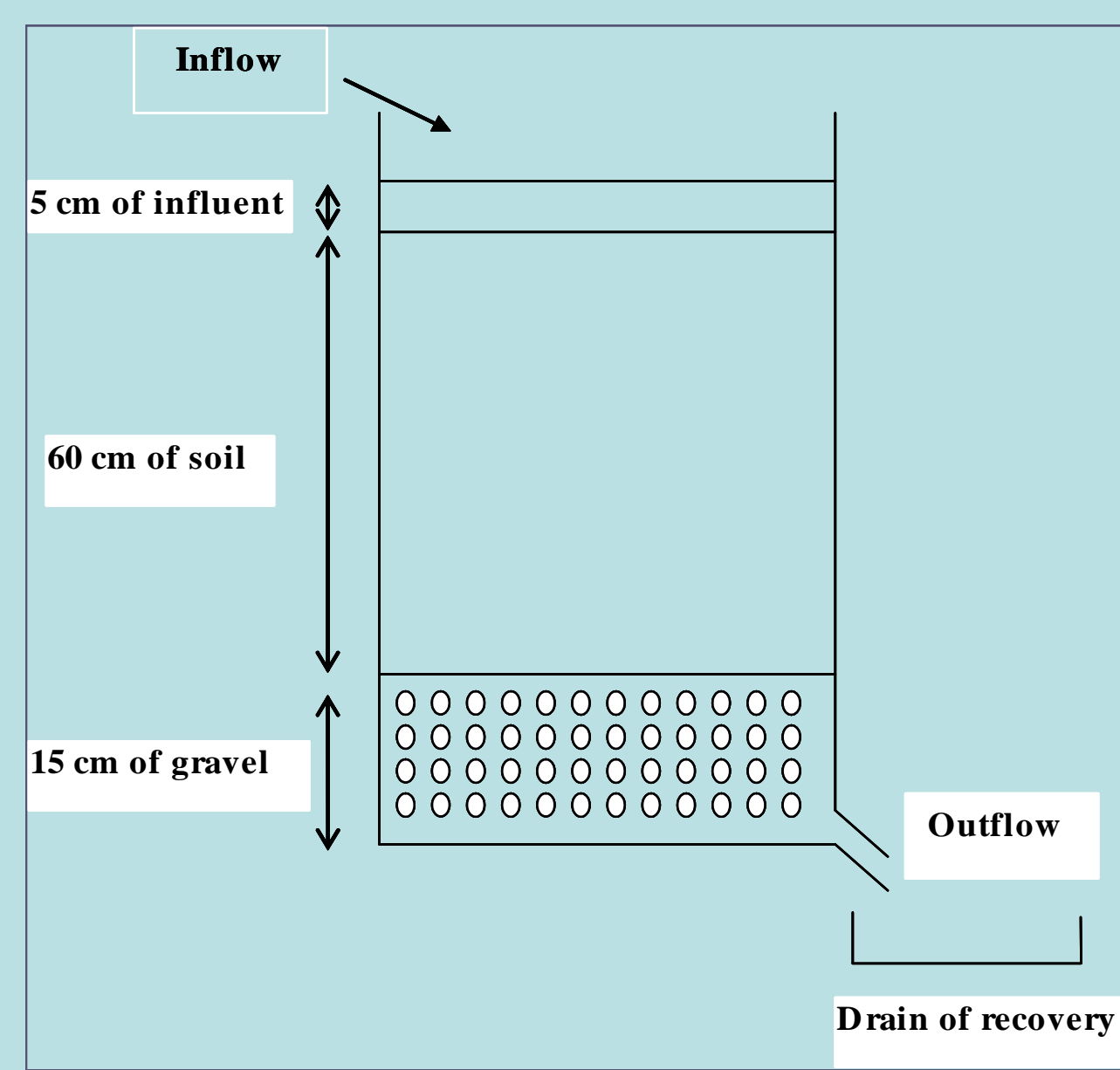


Figure 2: Treatment of tannery effluent by infiltration percolation

Table 1 : Physic-chemical characteristics of soil

pH	% O.M	MES (mg/l)	% Humidity	EC (µs/cm)	Cr (mg/kg)
8.63	4.70	233 ± 24	21	400	0.60

Table 2 : Chemical composition of tannery wastewater

pH	EC (ms/cm)	MES (mg/l)	DCO (mg/l)	Cl ⁻ (g/l)	Cr (mg/l)
4.25 ± 1.16	118 ± 50	233 ± 24	2500 ± 13	2.1 ± 1.3	912.5 ± 23.2

Results

1. Treatment of tannery effluent by phytoremediation

The total Cr undergoes an overall removal of 99 % for the two pilots (Figure 3), which provides limpid purified water (Tiglyene et al., 2005). The analytical results revealed that is a significant accumulation total Cr 80% in the surface horizon (0-5 cm) for PP and UPP systems (Figure 4); (Tiglyene et al., 2008a). Results also show that the Cr could migrate also towards deeper levels of the soil. The soil accumulated high content of Cr: 94% and 98% for the planted and unplanted systems respectively (Table 3).

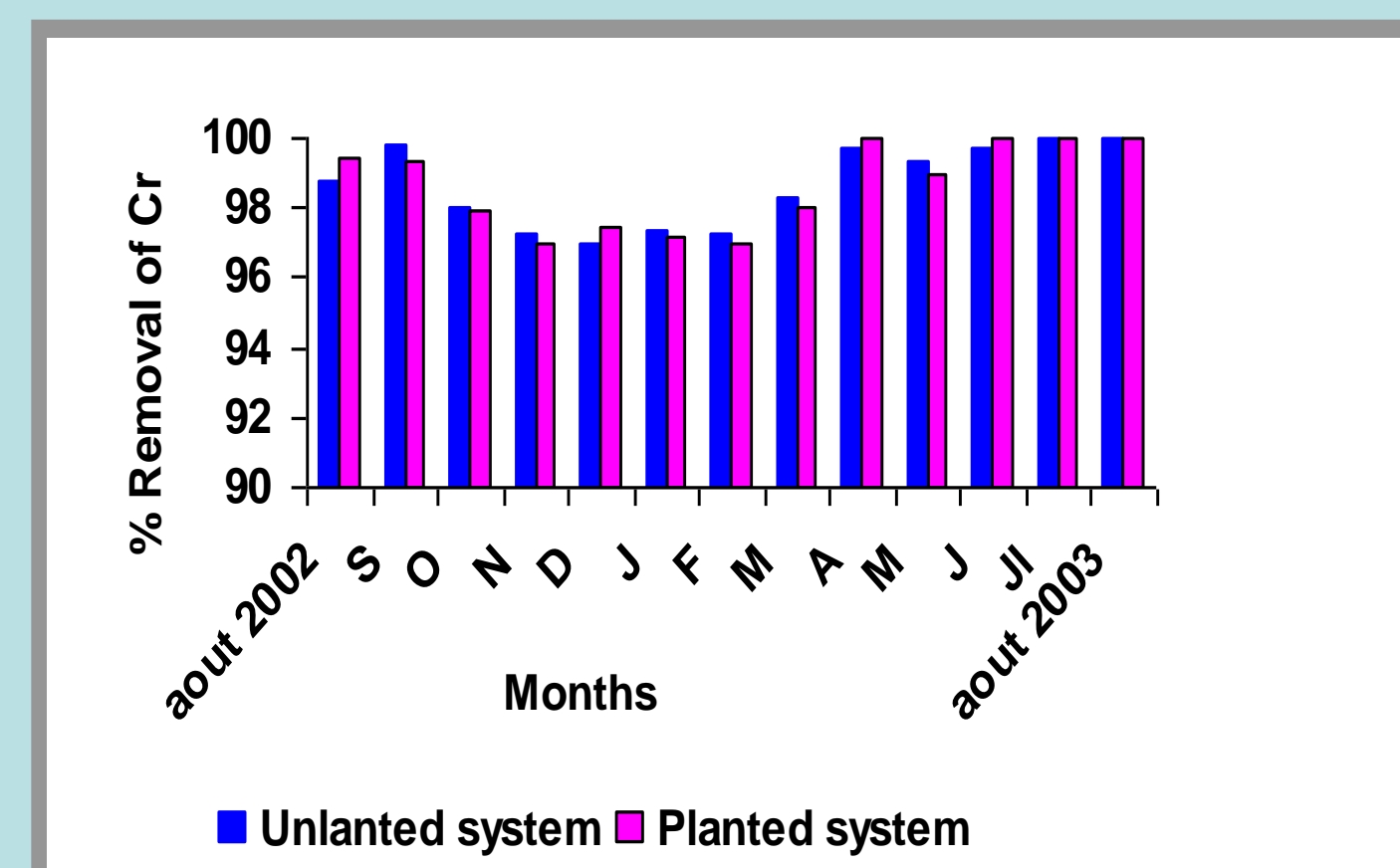


Figure 3 : Total Cr percent removal of two systems

Parts of <i>Phragmites australis</i>	[Cr] mg/kg (dry weight)
leaves	67 ± 19
Rhizomes	70 ± 31
Roots	1690 ± 124

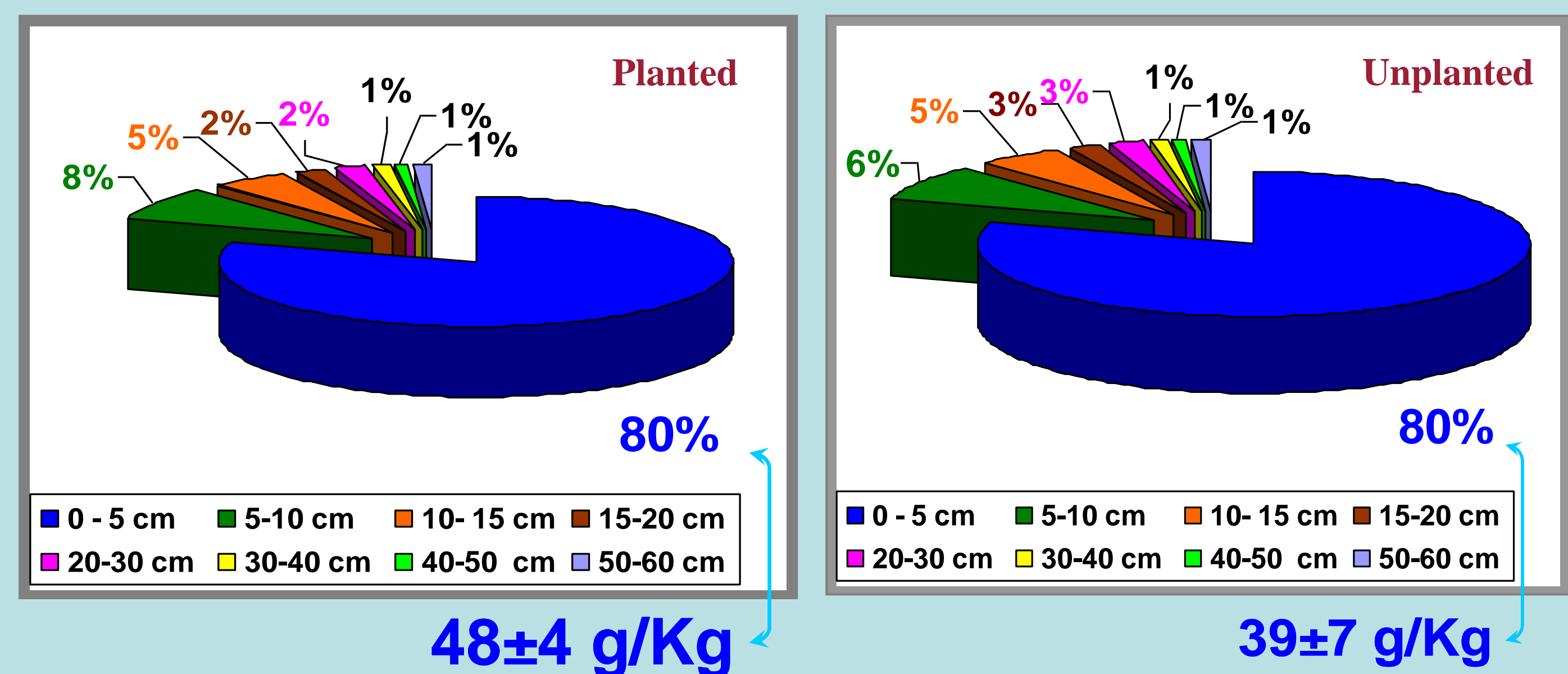


Figure 4 : Total chromium percent in different soil horizons of the planted and unplanted system

2. Treatment of tannery effluent by infiltration percolation

Over seven months of experiment the mean elimination rate for total chromium was 98% (figure 5), (Tiglyene et al., 2008b).

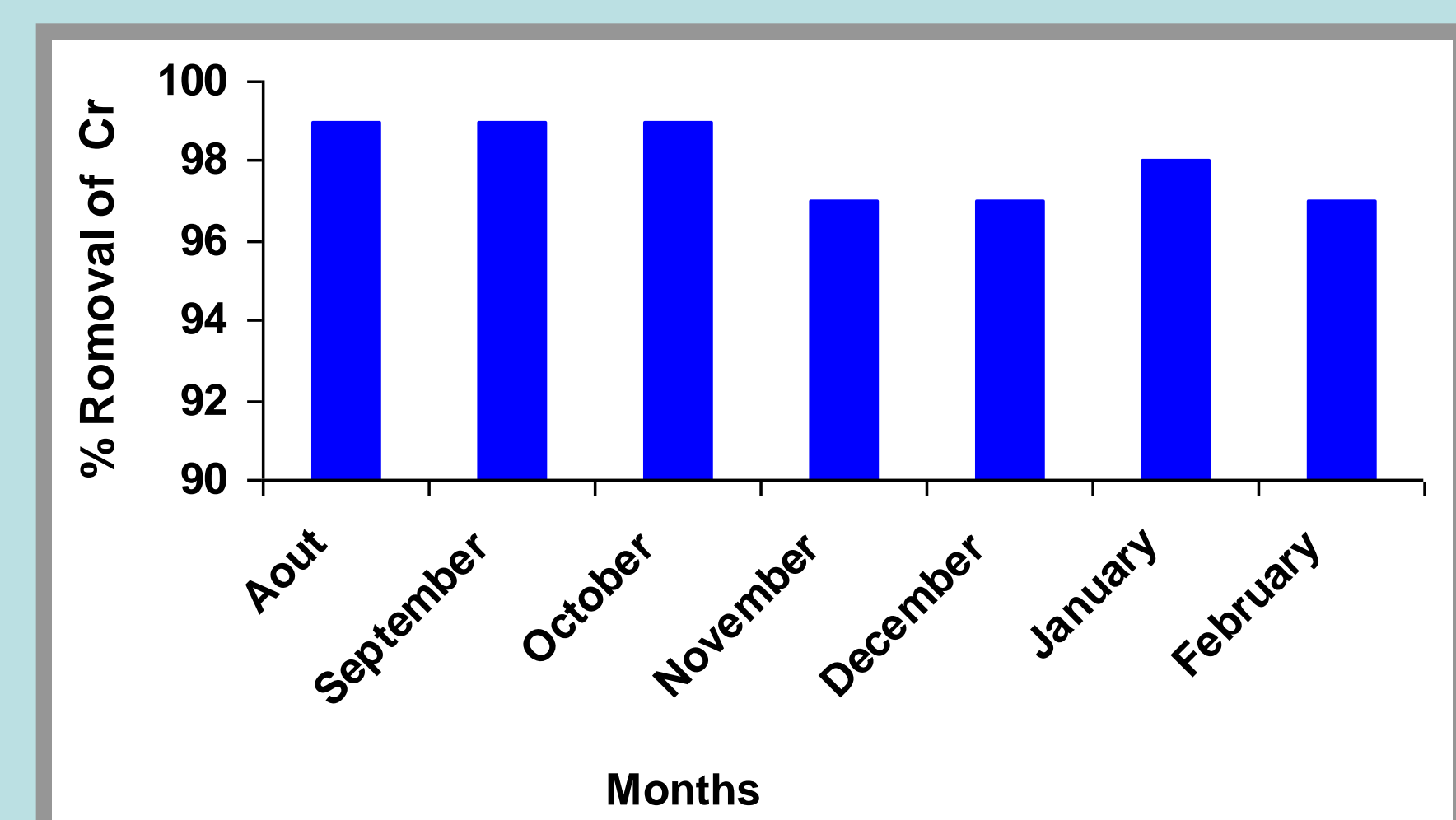


Figure 5 : Total Cr percent removal of two systems

Conclusion

During 13 months of experiment, results indicated that:

- Total chromium undergoes an overall removal of 99% for the two pilots (planted and unplanted).
- There was a significant accumulation of total Cr reaching 80% in the surface strata for the planted system.
- *Phragmites australis* accumulated significantly high amount of Cr in the roots.
- The soil accumulates high content of chromium 94% and 5% of Cr accumulated in *Phragmites australis*, after 13 months of experiment.
- The presence of plant ensures a porosity sufficiency for the percolation of water in the treatment.

Over seven months of experiment, the study of the treatment of raw tannery wastewater by infiltration percolation system showed that, the mean elimination rate for total Cr was 98%.

This work shows clearly that the treatment of tannery effluent by reed bed combined with infiltration percolation system could be the depuration system alternative for raw tannery wastewater in comparison to the purely chemical approaches for the treatment of tannery effluents.

References

- Scandiaconsult International, (1999). Etude de la réduction des rejets industriels sur la qualité des eaux des bassins d'Oum Er Bia et de Tensift, Maroc. Rapport du Ministère du Commerce de l'Industrie et de l'Artisanat, Division de la protection de l'Environnement, 18 p.
- Tiglyene, S., MANDI, L. and Jaouad, A. (2005). Enlèvement du chrome par infiltration verticale sur lits de *Phragmites australis* (Cav.) Steudel. Revue Sciences de l'Eau, 18(2), 117-198.
- Tiglyene, S., Jaouad, A. and Mandi, L. (2008a). Mobilité et spéciation du chrome dans un système à *Phragmites australis* de traitement des eaux usées de tannerie. Revue Sciences de l'Eau, 21(1), 1-16.
- Tiglyene, S., Jaouad, A. and Mandi, L. (2008b). Traitement du rejet du tannage par infiltration percolation : Elimination et spéciation du chrome dans le sol. Revue Environmental Technology, 29(6), 1-12.

Acknowledgements

This work was supported by the EU MELIA project (Mediterranean dialogue on integrated water management), contract n° 517612.