WETLAND LAB SCALE INVESTIGATIONS FOR LEACHATE TREATMENT

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SUMMARY: This research tested the feasibility of landfill leachate phytotreatment using sunflowers and *Pennisetum Purpureum*. Leachate was treated in columnar reactors placed in a greenhouse in which temperature and light exposition were controlled. Diluted landfill leachate was used to irrigate the essences, which were subjected to increasing contaminants loads. The results can be expressed by the removal efficiencies of each tested analytical parameter. The presence of contaminants did not inhibit the growth of species and high pollutants removal efficiencies were maintained throughout the experimental trial.

1. INTRODUCTION

Our society is still mainly based on the use of fossil fuels for energetic purposes. The sources of renewable energy are acquiring, day by day, considerable interest as they promote the transaction from the current elevated consumption of fossil fuels to a sustainable use of "green power". Several alternative sources are nowadays exploited such as wind, solar, geothermal and biomass (Panwar et al., 2011).

Biodiesel and bio-ethanol are alternative and sustainable fuels derived by vegetable oils, animal fats or waste vegetable oils. Biodiesel can be produced by a variety of energy crops including sunflowers; bio-ethanol can be produced by fast-growing essences including *Pennisetum Purpureum* (Basha S.A. et al., 2009) These plants might be used to treat contaminated wastewater, such as landfill leachate: plants contribute to the removal of contaminants; seeds or biomasses are used to produce renewable energy. In this way, phytoremediation allows the closure of the loop of matter (Lavagnolo M. C. et al., 2011).

Landfill leachate contains heavy metals, salts, nitrogen compounds and various types of organic matter (Christensen et al., 1992). Generation of leachate occurs when moisture enters the refuse in a landfill, dissolves the contaminants into the liquid phase and produces moisture content sufficient to initiate liquid flow. Leachate quality varies from one landfill to another, and over space and time even in the same landfill, with fluctuations depending on short and long-term periods due to variations in climate, hydrogeology and waste composition (Kjeldsen et al., 2002).

Phytoremediation is characterised by biological treatments, in which plants develop a key role for the direct action of bacteria that colonize the root system and rootstock. Practically, it consists of mitigating pollutants' concentration in contaminated soil or water with plants able to immobilize, degrade or sequester contaminants (Pilon-Smits, 2005). Phytotreatment represents a cost-effective, in situ technology; on the other hand the involved processes are quite slow and not always fully reliable as they depend on a plant's ability to grow in a stressed environment which is not ideal for its development.

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2. MATERIALS AND METHODS

2.1. Research programme

The experiment was performed at the Laboratory of Environmental Engineering (LISA) of the University of Padua.

Phytotreatment was tested in 8 columnar reactors (diameter: 25 cm; height: 100 cm) placed in a greenhouse in which light and temperature were continuously controlled. Four units were treated with diluted landfill leachate: in two of them sunflowers were grown, in the others Pennisetum Purpureum essences were grown. Four units were used as control: one without plants, irrigated with tap water; one without plants, irrigated with landfill leachate; one with sunflowers and the last one with Pennisetum Purpureum, both irrigated with tap water and nutrients. The substrate used was locally available soil, enriched with sand and fine gravels.

2.2. Feeding water characteristics

The irrigation dose was maintained equal to 1 L/unit/day (from Monday to Friday) throughout the entire duration of the experimental trial. Table 1 summarizes the feeding characteristics.

Table 1. Feeding water characteristics (leachate irrigated reactors)

Period	*Lasting days*	*Main pollutants concentration (mg/ L)*		
		TKN	*COD*	*P*
1	7	50	49	0.3
2	7	100	98	0.5
3	7	150	147	0.7
4	7	200	196	1
5	7	250	245	1.2
6	7	300	294	1.4
7	7	300	294	1.4
8	7	300	294	1.4

3. RESULTS AND DISCUSSION

3.1 COD removal

COD was provided at progressively increasing loads up to week 6 ranging from almost 200 mgO_2/week to 1470 mgO_2/week (Figure 1). Then the applied loads remained constant.

Performances of reactors were excellent, with removal efficiencies (based on weekly loads) above 85% for most of time.

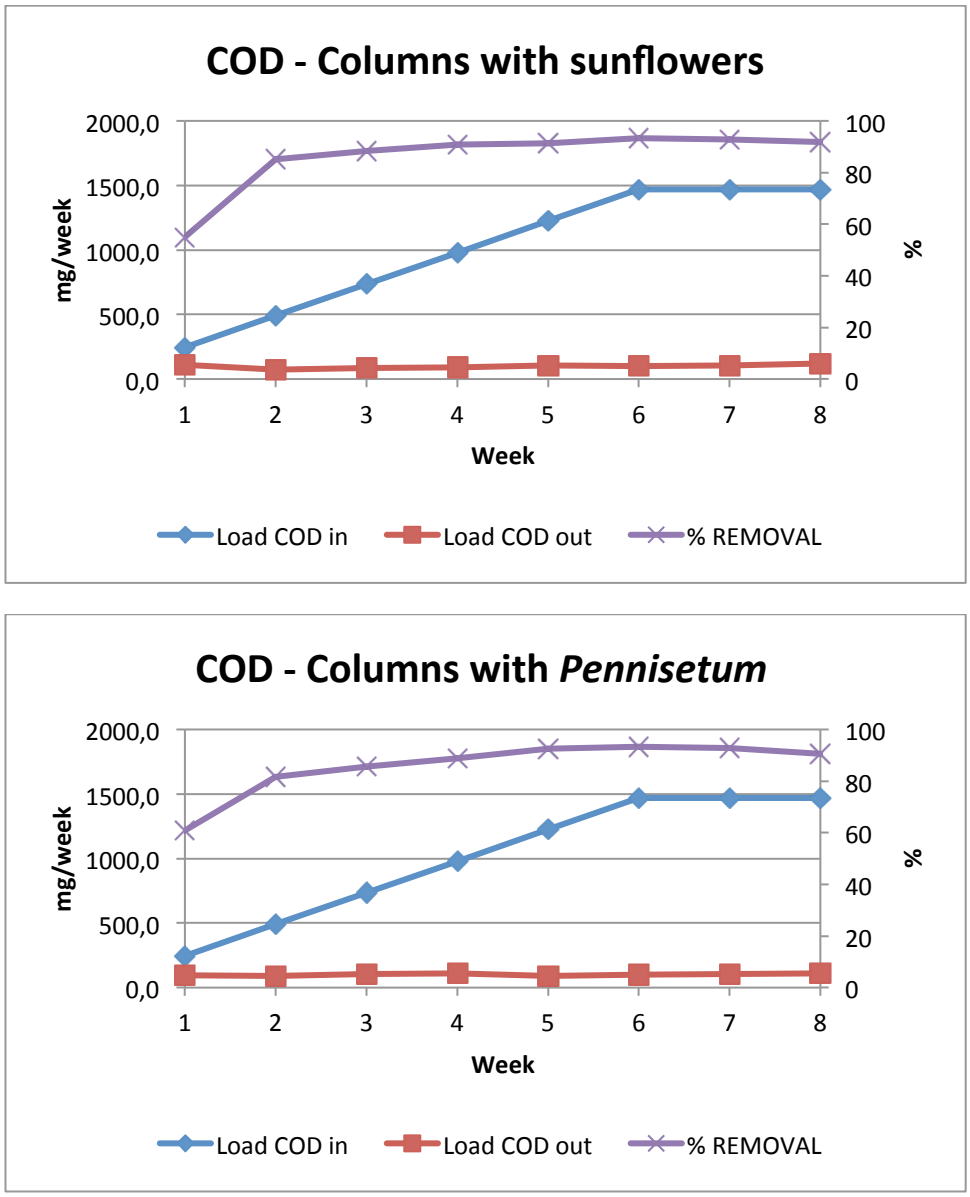

Figure 1. COD input and output weekly loads and removal efficiencies (average results for the leachate irrigated units)

3.2 Nitrogen removal

As for the COD, nitrogen was provided at progressively increasing loads up to week 6 ranging from almost 200 mgO_2/week to 1500 mgO_2/week (Figure 2). Then the applied loads remained constant. Nitrogen removal efficiency proved to be always higher than 50% in columns with sunflowers, even if it decreased over time. A similar trend was detected in columns with *Pennisetum Purpureum*, in which the decrease was even more evident (efficiency below 50% during the last week).

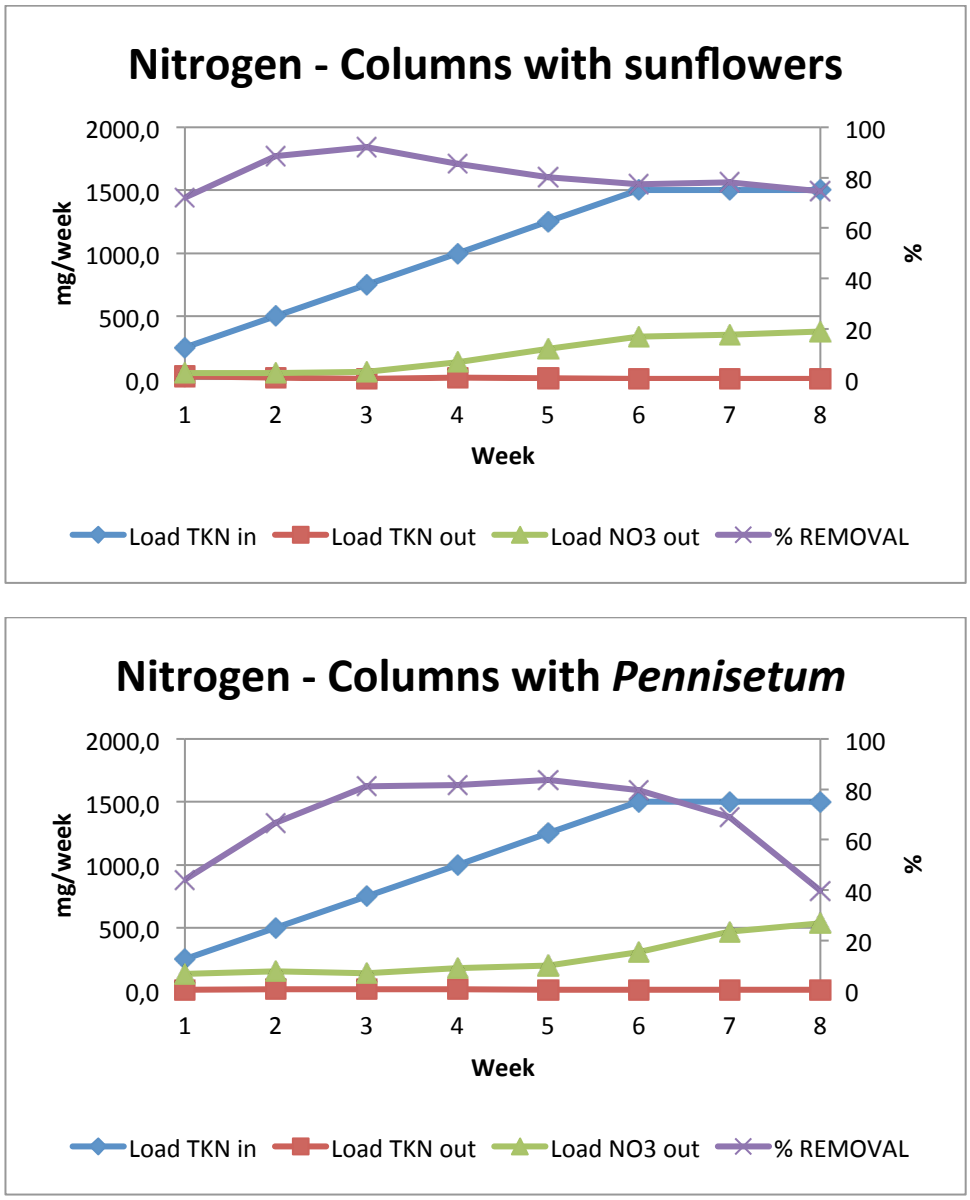

Figure 2. Nitrogen input and output weekly loads and removal efficiencies (average results for the leachate irrigated units)

3.3 Phosphorous removal

Phosphorus removal displayed excellent performances for the whole experimental period (Figure 3), with the only exception of the initial weeks in units in which sunflowers were grown. No dependence on input load or specific vegetal essence was noticed.

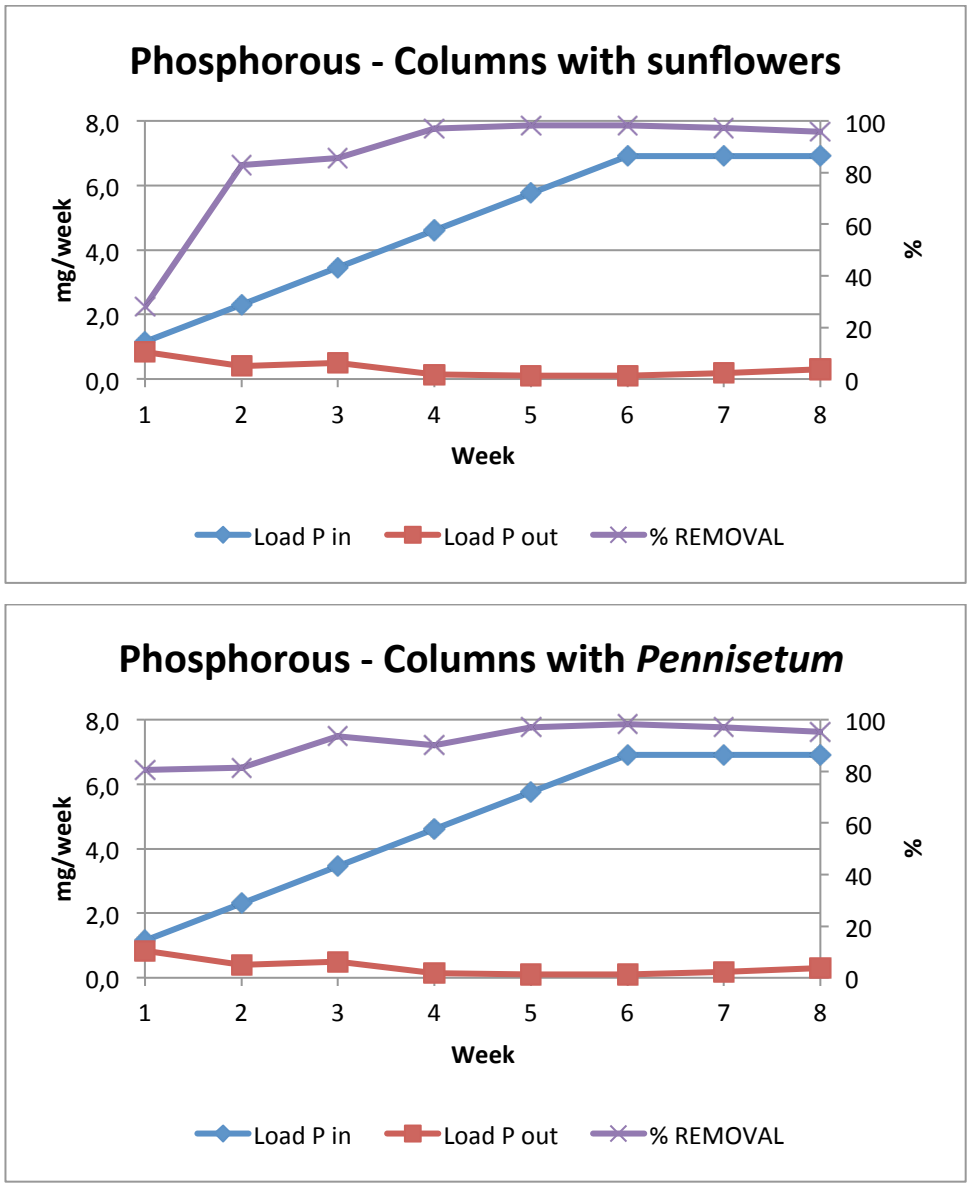

Figure 3. Phosphorous input and output weekly loads and removal efficiencies (average results for the leachate irrigated units)

4. CONCLUSIONS

The research proved the feasibility of landfill leachate phytotreament with sunflowers and *Pennisetum Purpureum*.

In general, plants growth was not affected in negative way by the leachate irrigation: crops irrigated with leachate, in fact, developed higher biomass and seeds than control plants.

The next step of the experiment will be the completion of the nitrogen mass balance to evaluate the final distribution in the system components: plants, substrates and effluents.

In parallel, the study of kinetics of nitrogen removal will be performed, in order to identify the kinetic parameters controlling the process.

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