Human Urine as Fertilizer: Feasibility study of use in corn and lettuce cultivation in a university campus in Brazil

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Outline

- Brazil, University of São Paulo, School of Arts Sciences and Humanities
- Background: Sanitation issues in developing countries; Sustainable Sanitation; Human Urine as fertilizer.
- Objectives
- Methodology
- Results corn and lettuce experiment
- Conclusions
Brazil

• Human Development Index: 0.718 (84TH)¹.
• Life expectancy: 73.5 years.
• High inequality, 16.2 million Brazilian citizens under the line of extreme poverty (monthly income = US$ 45 or less)².

• São Paulo – 11.2 million inhabitants.
• Participates in more than 10% of the GDP of Brazil.
• In urban area 131,146 households without improved sanitation facilities.
• 796,960 households without public water supply system⁴.
University of São Paulo (USP)

- Public university (no tuition). The major institution of higher learning and research in Brazil.
- More than 246 undergraduate courses and 239 Graduate Programmes.
- Ranked into the best 100 universities in the world (World Reputation Ranking)\(^5\).
- 7 campi in Sao Paulo State
Sanitation issues in developing countries

- Diarrhea is the main cause of infant mortality in developing countries, totalizing more than 4 billion of cases per year \(^6\).
- In Brazil, nearly half of municipalities without sewage collection and disposal service.
- Existing sanitation solutions cause many impacts to environment.
- Thus, the sanitation technologies should be adjusted to each local situation, considering economic, cultural and social aspects.
Sustainable Sanitation

- Alternatives to conventional wastewater treatment have been suggested and the aims are often the reuse of nutrients from excreta as a fertiliser after its segregation.

- In many countries (Sweden, Germany, Mexico, China, Zimbabwe and others) there are specific methods for treatment of faeces and urine to use in agriculture.
Human urine as fertilizer

• Experiences testing application of urine as fertilizer in cultivation of several species have proved positive results from urine fertilizer\(^7\).
• Urine contains \(N, P\) e \(K\) \(^8\).
• In household level, the urine storage is not necessary (very low risk)\(^9\).
• In urinals faecal cross-contamination is excluded\(^10\).

Research objectives

- to evaluate the use of human urine as fertilizer for corn and lettuce cultivation and the effects on soil and plants;
- to recommend appropriate dosages for a better development of these species.
Methodology

- Urine Collection from a waterless urinal (Uridan®), installed in a male toilet of university campus.

- System with a sealant liquid (blocking fluid) which is biodegradable and constitutes an effective odour barrier.
Experiments with corn and lettuce planting were conducted in *campus* greenhouse.

<table>
<thead>
<tr>
<th>Treatment/Species</th>
<th>Corn</th>
<th>Lettuce</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>25000 L/ha of neat urine once a week, 8 applications.*</td>
<td>12000 L/ha of neat urine, distributed in 3 applications (15, 30 and 45 days after seeding).</td>
</tr>
<tr>
<td>B</td>
<td>10800 L/ha of neat urine, 35 days after seeding.</td>
<td>75000 L/ha of diluted urine (1:3 urine to water ratio), twice a week during first month; dilution 1:5 during the second month; and in third month dilution 1:5, once a week.*</td>
</tr>
<tr>
<td>C</td>
<td>Irrigated with only water.</td>
<td>20000 L/ha of neat urine, once application 48 days after seeding.**</td>
</tr>
<tr>
<td>D</td>
<td>____</td>
<td>Irrigated with only water.</td>
</tr>
</tbody>
</table>

* Based on Morgan (2007).
** Based on Guadarrama, Pichardo and Oliver (2002).
Methods

- Small-scale experiment (flower pots).
- Applied to soil in dug holes, 10 cm from each plant and 10 cm depth\textsuperscript{15}.
- Topsoil

- Urine Storage only for treatment B of corn.
- Plant biological parameters were measured, data were analyzed by ANOVA.
- Before and after cultivation period it was made physicochemical soil analysis.
Results - Corn

Through statistical analysis, we concluded that there was significant difference between treatments (p-value < 0.05).

Treatment A which received the highest urine concentration (1 L per pot) had a better growth and development, with higher Number of leaves; height; leaf area; Shoot dry weight; root weight; number of ears.
Plants groups A, B, C

October 20th, 2012
ANOVA - Corn

Boxplot of log(Dry weight) by Tratamento

Boxplot of log(Leaf area) by Tratamento

shoot dry weight

Leaf area
Results

Association with: higher nutrient uptake; lower hydric deficit and higher photosynthetic capacity \(^{16}\).

- Soil analysis indicated that physicochemical characteristics did not vary significantly among the groups.
- Soil fertilized with the highest dosage had the lowest pH and the highest electrical conductivity.
High mortality in all treatments caused by attack of insects (*Doru luteipes* and *Lepidoptera: Gracilariidae*). Group B had the highest mortality.

Statistical analysis showed for all biological parameters the plants belonging to treatment B showed best results. Control group showed the lowest values of biological characteristics.
Lettuce: groups B and D

Plants of group B (fertilized with urine).

Plants of group D, non-fertilized (watered only with tap water).

December 7th, 2011
### Soil Analysis

<table>
<thead>
<tr>
<th>Group</th>
<th>pH</th>
<th>B</th>
<th>Cu</th>
<th>Fe</th>
<th>Mn</th>
<th>Zn</th>
<th>P</th>
<th>S</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6.5</td>
<td>0.3</td>
<td>4.4</td>
<td>19.3</td>
<td>0.8</td>
<td>1.9</td>
<td>54.7</td>
<td>0</td>
<td>5.5</td>
<td>79.8</td>
<td>27.1</td>
</tr>
<tr>
<td>B</td>
<td>5.6</td>
<td>0.4</td>
<td>5.2</td>
<td>20.0</td>
<td>6.7</td>
<td>2.3</td>
<td>67.6</td>
<td>0</td>
<td>6.5</td>
<td>61.4</td>
<td>22.1</td>
</tr>
<tr>
<td>C</td>
<td>6.7</td>
<td>0.3</td>
<td>3.9</td>
<td>21.4</td>
<td>1.7</td>
<td>1.9</td>
<td>53.6</td>
<td>0</td>
<td>4.9</td>
<td>77.2</td>
<td>23.4</td>
</tr>
<tr>
<td>D</td>
<td>6.8</td>
<td>0.3</td>
<td>3.1</td>
<td>19.9</td>
<td>1.1</td>
<td>1.6</td>
<td>49.3</td>
<td>0</td>
<td>3.9</td>
<td>69.3</td>
<td>20.9</td>
</tr>
</tbody>
</table>

Units: P (mg/dm³); K (mmol/dm³); Ca (mmolc/dm³); Mg (mmol/dm³); B, Cu, Fe, Mn, Zn (mg/dm³)

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<table>
<thead>
<tr>
<th>Sample</th>
<th>Total Nitrogen (g/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.32</td>
</tr>
<tr>
<td>B</td>
<td>3.48</td>
</tr>
<tr>
<td>C</td>
<td>1.93</td>
</tr>
<tr>
<td>D</td>
<td>1.54</td>
</tr>
</tbody>
</table>
Payback study

- Payback period considering replacement of all flush urinals of *campus* with waterless urinals.
- Simple Payback: 9 months.
- Discounted Payback: 10 months.
- Annually the economy in water bills would be about: U$ 46,966.00.
Final Remarks

- Both in corn and lettuce cultivation the treatments that received urine doses developed significantly better than the control group and had higher values in all of the biological parameters measured.

- Based on this study the dosages of groups A and B are recommended for corn cultivation.

- For lettuce cultivation the doses of group B and group C are recommended.

- The high mortality in treatment B might be due to the following causes: soil salinity, low soil pH.
Acknowledgements

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- Thank you!
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- E-mail: mariana.chrispim@usp.br
References


4. INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Censo demográfico 2010.


References


