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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 system[4] .

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].

Source:http://www.wecf.eu/english/articles/2005/09/maize_urine.php.
http://www.grida.no/publications/et/ep5/page/2823.aspx

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 1: Urine application rate for corn and lettuce crops.

Treatment/Species	Corn	Lettuce
A	25000 L/ha of neat urine once a week, 8 applications.*	12000 L/ha of neat urine, distributed in 3 applications (15, 30 and 45 days after seeding).
B	10800 L/ha of neat urine, 35 days after seeding.	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.*
C	Irrigated with only water.	20000 L/ha of neat urine, once application 48 days after seeding.**
D	—	Irrigated with only water.

* 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[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).

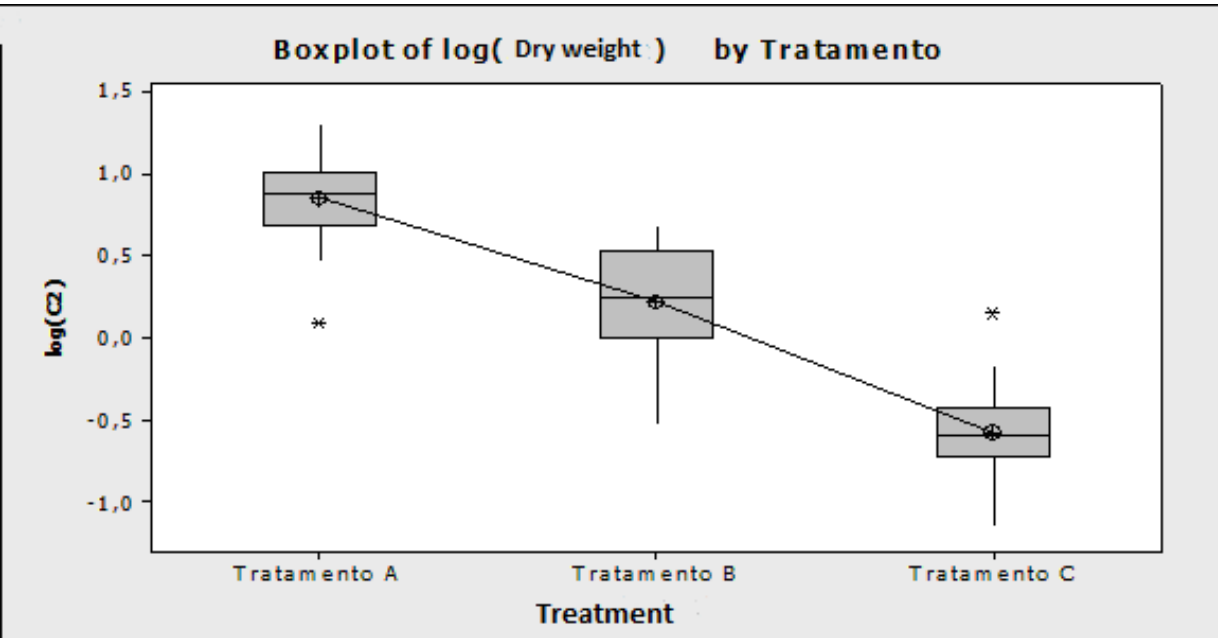
Treatment **A** which received the highest urine concentration (1 L per pot) had a better growth and development, with higher

- Number of leaves; height; leaf area;
- Shoot dry weight; root weight; number of ears.

Plants groups A, B, C

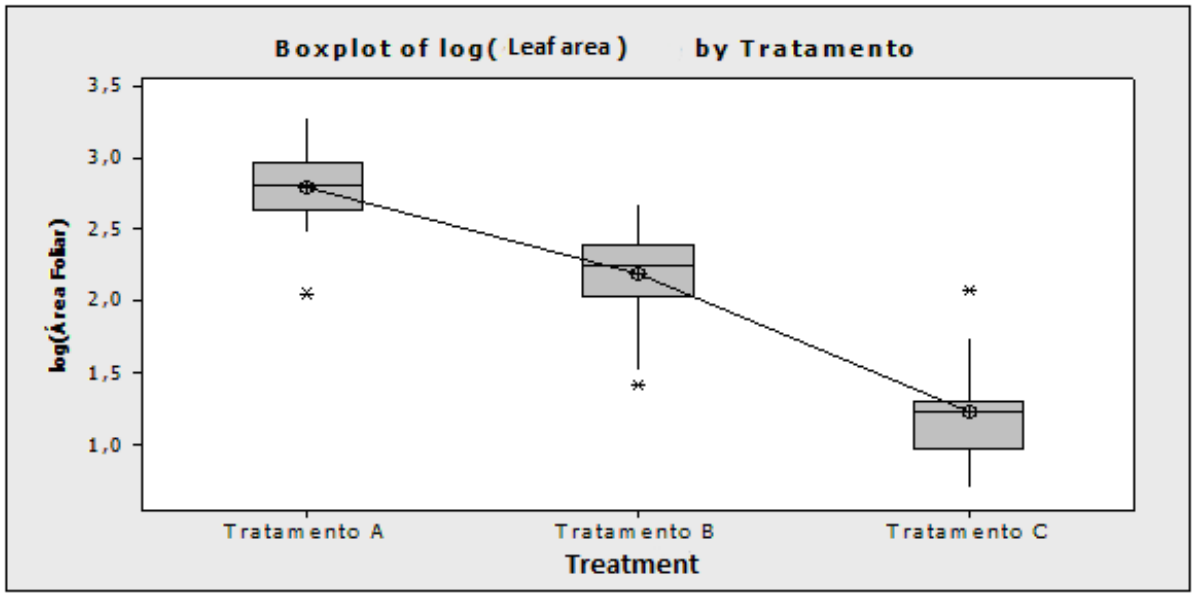
October 20th, 2012

ANOVA - Corn



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.

Results - lettuce

High mortality in all treatments caused by attack of insects (*Doru luteipes* and *Lepdoptera: 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

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

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

Sample	Total Nitrogen (g/Kg)
A	2.32
B	3.48
C	1.93
D	1.54

Nitrogen Content Analysis

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.

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- E-mail: mariana.chrispim@usp.br

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