GUIDELINES FOR THE USE OF HUMAN URINE AND FAECES IN CROP PRODUCTION

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ABSTRACT

International guidelines have been presented within the Sida financed EcoSanRes programme for the use of human urine and faeces in crop production based on the current knowledge on use of urine and faeces in small and large-scale cultivation. Urine and faeces are each a complete fertiliser of high quality with low levels of contaminants such as heavy metals. A basis for the recommendations for agricultural use is the knowledge of the contents of nutrients in the excreta, the amounts excreted, composition and plant availability of the plant nutrients, as well as the good knowledge of how the product has been sanitised. Urine is a quick-acting nitrogen rich fertiliser that can be applied as it is or diluted. Faeces are rich in phosphorous, potassium, micronutrients as well as organic matter. Well documented research in this area is needed.

INTRODUCTION

Urine and faeces from human beings are valuable resources that deserve a better fate than to end up in surface waters as well as groundwater, where they can cause significant problems. In regions where there is a lack of domestic financing of fertilisers for subsistence production of food, collected urine and faeces can contribute significantly to food security and health. Source separated urine and faeces are collected in sanitation systems designed for this, e.g. urine diverting toilet systems (Johansson et al, 2001). Treatment of urine and faeces in order to minimise the hygiene risk is important, as well as guidelines for how to use the fertiliser in crop production that will enable proper use with minimal risk for users of the system.

MATERIALS AND METHODS

These guidelines for use of urine and faeces in crop production have been produced through collection of experiences, documented as well as undocumented, of reuse of urine and faeces as fertiliser. Countries where human urine and or faeces have been studied are South Africa, Zimbabwe (Morgan, 2003), Ethiopia, Mocambique, Benin, Burkina Faso, Senegal, Cote d´Ivoire, Togo, Mali, Mexico (Guadarrama et al, 2001), China, Sweden (Kirchmann & Pettersson, 1995, Johansson et al, 2001, Rodhe et al, 2004) and Germany (Simons & Clemens, 2004) although many of these experiences are not yet scientifically published. The basis for the work has also been current plant nutrient knowledge through a literature study. A reference group consisting of international experts has been consulted in order to assure the relevance of the guidelines. Dissemination of the guidelines is carried out though the publication of results at conferences, as well as thought the Internet, and the guidelines can be downloaded at www.ecosanres.org. The authors gratefully accept comments, as updating will need to take place continuously.

RESULTS AND DISCUSSION

Recommendations for agricultural use of excreta are based on knowledge of the nutrient content of the excreta, the amounts excreted, and the treatment of the excreta, which influences their properties. Table 1 shows the proposed default values for excreted mass and nutrients from one person on a Swedish diet. Adapting of the guidelines to local conditions is necessary since diets, as well as plant production conditions vary. Excreta should be handled and treated according to hygiene guidelines for safe reuse (Schönning & Stenström, 2004) before use in cultivation.

***Table 1**. Proposed new Swedish default values for excreted mass and nutrients (Vinnerås, 2002).*

Parameter	Unit	Urine	Faeces
Wet mass	kg/person,year	550	51
Dry mass	kg/ person,year	21	11
Nitrogen	g/ person,year	4000	550
Phosphorus	g/ person,year	365	183

Urine and faeces are each a complete fertiliser of high quality with low levels of contaminants such as heavy metals (Palmquist & Jönsson, 2004). Urine is rich in nitrogen, while faeces are rich in phosphorous, potassium and organic matter.

Specific local recommendations for use of urine and faeces in cultivation should be based on local recommendations for fertilisation of crops. Application rates for commercial mineral nitrogen fertilisers (urea or ammonium if available) can be used as a basis for recommendations on the use of urine. Before translating such recommendations to urine, its nitrogen (N) concentration should preferably be analysed. Otherwise, it can be estimated at 3-7 g N per litre. If no local recommendations can be obtained, a rule of thumb is to apply the urine collected from one person during one day (24 hours) to one square metre of land and cropping period. If all urine is collected, it will suffice to fertilise 300-400 m^2 of crop per person and year with N at a reasonable rate. For most crops, the maximum application rate, before risking toxic effects, is at least 4 times this application rate. Urine also contains phosphorus, and it will suffice to fertilise up to 600 m^2 of crop per person and growing season, if the application rate is chosen to replace the phosphorus removed, as for faeces below.

Urine can be applied neat or diluted. However, the application rate should always be based on the desired nutrient application rate and any potential need for supplementary water should be met with plain water. To avoid smells, loss of ammonia and foliar burns urine should be applied close to the soil and incorporated as soon as possible. Irrigation after application of urine is beneficial.

Urine is a quick-acting fertiliser whose nutrients are best utilised if the urine is applied from prior to sowing up until two-thirds of the period between sowing and the harvest. The best fertilising effect is achieved if urine and faeces are used in combination with each other, but not necessarily in the same year on the same area. The amount of urine to be spread can be applied in one large dose or in several smaller doses, and under most circumstances the total yield is the same for the same total application rate.

For faeces, the application rate can be based on the local recommendation for the use of phosphorous-based fertilisers. This results in a low application rate, and the improvement due to the added organic matter is hard to distinguish. However, faeces are often in the smaller scale applied at much higher rates, at which the structure and water-holding capacity of the soil are

visibly improved as an effect of its content of organic matter. Both organic matter and ash are often added to the faeces and they improve the buffering capacity and the pH of the soil, which is especially important on soils with low pH. Thus, depending on the application strategy, the faeces from one person will suffice to fertilise 1.5-300 m^2, depending on whether they are applied according to their content of organic matter or phosphorus. Faeces should be applied and mixed into the soil before cultivation starts. Local application, in holes or furrows close to the planned plants, is one way of economising on this valuable asset.

Pharmaceuticals and hormones are excreted with the urine, and the discussion has been raised whether to restrict use of urine on this account. Documented effects of pharmaceutical residues almost entirely reported for aquatic systems, rather than terrestrial systems. Many reports have been published on adverse effects on organisms in watercourses where wastewater is released. However, soil microorganisms are better adapted to decomposing hormones and other organic substances than are aquatic organisms and the soil-root barrier is very tight against organic molecules. Thus, the risk when using urine from human beings as fertiliser on soil is small, since the microbes in the soil system are good at decomposing the excreted pharmaceutical residues. This will always be a better strategy for the environment than to emit the products into aquatic systems, as is the case for conventional wastewater systems with WC.

Further research on the use of urine and faeces as fertilisers is needed, especially in the following areas:

- Nutrient effects of excreta on crops and soil
- Fertilisation strategies and application techniques when using excreta
- Efficiency of short term storage of urine in soil
- Simple and resource-efficient sanitation techniques for faeces

These guidelines have been developed within the EcoSanRes programme, funded by Sida, the Swedish International Development Cooperation. The full text of the guidelines can be downloaded from www.ecosanres.org.

CONCLUSIONS

- Reuse should be safe, e.g. the hygiene guidelines on use of excreta for crop production (Schönning & Stenström, 2004) should be followed.
- Urine and faeces supplement each other as fertilisers, urine is rich in nitrogen that is quickly available, while faeces is rich in rich in phosphorus, potassium and organics and its nutrients are not that readily available.
- The chemical contamination of urine and faeces is minimal and the levels of e.g. heavy metals are very low. Pharmaceuticals residues are excreted via urine and faeces. However, the soil-root barrier is very efficient and therefore the risk with these substances is probably far smaller than that associated with e.g. insecticides, fungicides and herbicides applied to crops.
- As these fertilisers contain all the elements removed from the field by the crop, their use decreases both the need of soil analyses and the risk for soil depletion.
- Reuse of urine and faeces as fertilisers essentially eliminates the risk that their nutrients pollute the environment and it enables sustainable crop production.

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