SANIRESCH

Research Project SanitaryRecycling Eschborn (SANIRESCH)
Project component: Agricultural Production / Legal Situation

1. Background

One basic principle of new sanitary systems is reuse and closing nutrient and water cycles. Therefore an appropriate and efficient reuse of nutrients and water - preferably in agriculture - is quite important. In the project several aspects of agricultural reuse were examined.

2. Material and methods

Two products of the GIZ sanitary system were evaluated more closely: (1) GIZ-urine collected from urinals and toilets, after storage and (2) struvite (Magnesium-Ammonium-Phosphate, MAP) produced from this urine.

To evaluate the fertiliser potential of the new products from the GIZ sanitary system, field experiments were conducted in the years 2010-2012 at the field research centre of Bonn University, at Campus Kleinaltendorf. The area is situated in the lower Rhine basin, 20 km west of Bonn, and due to fertile soils and a favourable climate (yearly mean: 9.2 °C, 596 mm precipitation), one of the famous fruit production areas in Germany. There, stored GIZ-urine and produced struvite were applied to different field crops, e.g. summer wheat, maize, fava bean and miscanthus (see Figure 1).

To find out more about the plant uptake of unwanted – potentially toxic – substances from urine, controlled conditions were provided in the greenhouse. Selected pharmaceuticals and hormones were spiked into urine and added to the soil of wheat seedling growing in 10 L-pots. Agents were added in a concentration found in urine (0.5 mg l^{-1}) and 10 times higher. Furthermore, the impact of urine and its components on germination was evaluated for different seeds (wheat, sunflower, fava bean) in germination experiments in the greenhouse.

3. Results and discussion

3.1 Fertiliser properties

Urine and MAP proved excellent fertiliser properties.

- Yields were generally higher compared to the variation without any fertiliser application.
- In comparison to commercially available mineral fertiliser (Calcium ammonium nitrate and Triplephos, respectively), yields of wheat, maize and fava bean did not differ significantly.

Figure 1: Harvest of wheat fertilised with urine.

3.2 Pharmaceutical residues

- In grain samples from the field experiment no pharmaceuticals could be detected. Estrogenic activity was equal in all samples irrespectively of the fertiliser applied.
- No pharmaceuticals were detected in variants of the pot experiment fertilised with urine only.
- One out of four additionally applied pharmaceuticals was determined in corn and stalks: Carbamazepine in grain at concentrations of 5 µg kg^{-1} after application of a typical urine concentration and 30 µg kg^{-1} at a 10x higher concentration.
- The analysis of the other three active ingredients spiked to urine, diclophenac, atenolol and verampamil was negative (below the limit of detection of 1 µg kg^{-1}).

So, technically, pharmaceutically active agents may pass into the plant. However, the concentrations are quite low. Comparing the amount of carbamazepine found in wheat grain with medical prescriptions, a person consuming the average German amount of ~100 kg cereals a^{-1}, would have to eat wheat for more than hundred years to reach the amount of one tablet given per day to a person suffering from epilepsy (400 mg d^{-1} and more).

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3.3 Impact on Germination

Figure 2: Germination test with sunflower (left) and wheat (right).

Urine inhibited germination of seeds when applied directly to the seeds; this effect was not visible in the field where the fertiliser was buffered by soil (see Figures 2 and 3).

- Highest germination rates were achieved with diluted urine (1:100) - slightly higher than those seeds watered with tap water. Undiluted urine inhibited germination completely.
- Pharmaceuticals – applied even in 100-times higher concentrated than usually found in urine – did not cause any negative effect on plant germination.
- pH variations influenced germination of some seeds: wheat germination was partially reduced at alkaline pH (pH 9, 11).
- A strong influence of salts on germination was evident when salts typically present in urine (especially NaCl, NH4NO3, K2HPO4) were at concentrations of GIZ-urine.

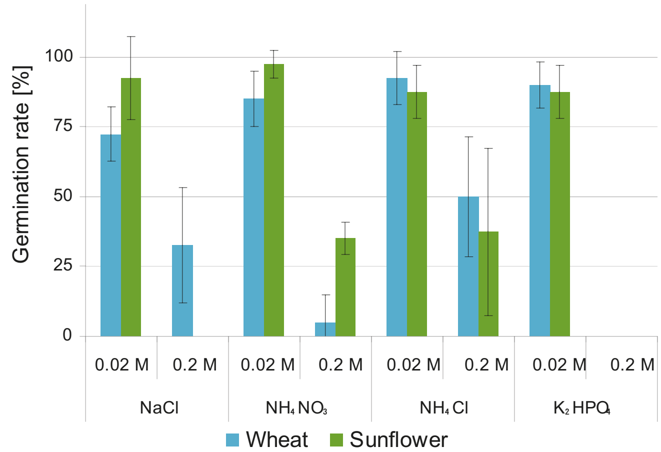

Figure 3: Salt effects on germination.

3.4 Legal Situation

To apply urine or urine based products as a fertiliser in Germany, it needs to be approved in the "positive list" of the German Düngemittel Verordnung (DüMV, 2000) which it is not right now. For being accepted in that list, a request has to be made to the Federal Ministry of Food, Agriculture and Consumer Protection (BMEVL). The application needs to give details on origin, nutrient concentrations and has to prove that the product is non-hazardous. Regarding the appraisal, experts of the Düngemittelbeirat are supporting the ministry.

4. Conclusions

Technically, urine and struvite out of urine contain valuable nutrients, both proved excellent fertiliser properties. For being a tradable product, the legal acceptance still needs to be gained.

5. Major references

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