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Review Paper: Human Urine as a Fertilizer

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ABSTRACT: Research on urine as a fertilizer is carried out all over the world, in settings ranging from very applied demonstration trials to rigorous scientific studies. The use in agriculture of excreta from urine-diversion toilets can be an alternative solution to the lack of sanitation and high costs of mineral fertilizers inherent to developing countries. As Human Urine contains NPK (Nitrogen, Phosphorous, and Potassium) as well as other micro-nutrients which are present in organic fertilizer, urine can be used as a fertilizer. The purpose of this review paper is to provide the knowledge of urine as a fertilizer and also reveals the application of adequate human urine volume based on plants fertilizer requirement is a better option for its reuse. Thus suggests the effect of salts, pathogens and pharmaceutical products as well as The Fertilizing Ability of Urine.

KEYWORDS: Urine, Soil, Fertilizer, Chemical, Nitrogen, Phosphorous, Potassium.

I. INTRODUCTION

Apart from with no trouble existing carbon dioxide and light, plants necessitate primarily water, adequate soil structure for the roots to grow in, and nutrients in appropriate quantities for their growth. Meanwhile nutrients are taken up from the soil by the plants and finally leave the fields with the harvested products, it is essential that these nutrients be swapped in an amount corresponding to the amount swapped during the harvest. It is important to note that fertilization growths crop yield [24]. The chemical fertilizers contain NPK and the global NPK fertilizer demand is increasing day by day and is basically affected by population and economic growth, agriculture productions, price and governances [6]. The rise in fertilizer demand leads ineluctably to the instability of its price. However, in the mid-2008, this global nutrients consumption has decreased drastically due to mainly the economic crisis, and therefore the phosphate rock commodity price has increased up to 700 % from 2007 to 2008[6]. High fertilizer price causes low yields and less agricultural productions, especially in marginal area of developing, where tools are limited and accessibility of fertilizer when needed is currently a great concern. More concerning is the global peak of phosphorus production which is forecasted to occur around 2030[19].

The loss of soil fertility is inherent in all agricultural systems. Nutrients are taken up from the soil through the plants that are harvested, then transported, eaten, and finally excreted. In former centuries, it was therefore a common run through to compensate the nutrient loss by returning the consumed nutrients through the application of animal manure, human excreta, and comp [22]. Thus, there is a need to consider alternative sources of fertilizer. Urine is one of those alternatives due to the fact that it could be readily available and cheap [20].

II. LITERATURE REVIEW

Niter, J. N. 2015, has study the effect of different sources of urine on soil chemical properties. The experiment was arranged in completely randomized design (CRD) for analysis of cattle urine and goat urine. The results obtained show that the effect of different sources of urine on total nitrogen, available phosphorus and exchangeable Ca and Mg when compared with the Control. . Organic carbon obtained in human urine treated pot was 22% each higher than the ones recorded in cattle and goat urine treated pots .It was obtained in different sources of urine relative to the Control. This experiment also gives result that human urine treatment produced taller plants.

Joseph M. Makaya, 2014, he studies to evaluate the hygienic quality of urine used as fertilizer through an ecological sanitation system in Ouagadougou peri-urban areas. Chemical and microbiological analyses were performed in urine

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samples taken before and after thirty (30) days of storage in jerry cans exposed to sunlight. The concentrations of 7.0 g/l; 3.5 and 9.6 g/l of ammonia nitrogen for mean, minimum and maximum respectively, are obtained in unstored urine samples. These concentrations did not practically vary with the storage.

Moustapha Sene 2013, His study was carried out to evaluate the effects of extra urine application in plant and soil. Thus, pot test was conducted in greenhouse using synthetic urine, Komatsuna and sandy soil. 34.86 ml of synthetic urine (U-V0) which contained 140 mg-N and corresponded to N-based standard requirement for Komatsuna, 69.72 ml of synthetic urine (U-2V0), 104.58 ml of synthetic urine (U-3V0).

Ryan Shaw 2010, submitted report to explores current research on urine fertilizer and several aspects of urine fertilizer projects done by Peace Corps volunteers in Mali, West Africa. Peace Corps volunteers in Mali, West Africa are using a pilot project approach (based on the development philosophy outlined in *Two Ears of Corn* by Roland Bunch) to propagate the use of small urine collection systems in a sustainable way. The urine fertilizer trials teach people about small-scale experimentation. Trials also teach people about the value of urine as a fertilizer and the value of closed-loop sanitation. These urine fertilizer projects can easily be adapted to other communities and have the same effect

III. THEORY

Urine is a liquid product of the human body that is secreted by the kidneys. Human kidney is the main excretory organ and thus urine contains most of the nutrients present in human food which have not been utilized for new cell growth or energy consumption. It consists of 95% water with the remaining 5% made up of soluble wastes and excess substances of the human body like urea, creatinine, and dissolved ions [22]. Application of urine can be scheduled as usually done with nitrogen fertilizers. Any scheduling of urine fertilization must take the transportation into account. In comparison with common fertilizers, the nutrient density of urine is low. Urine should be applied according to the needs of the plants. Good availability of nutrients is important in the early stages of cultivation, though once the crop enters its reproductive stage nutrient uptake diminishes. From a health perspective this is good since increased time between application and harvest decreases risk of pathogen transmission [3].

For the average person, a year’s worth of urine contains about 3.5kgof nitrogen and nearly 0.5kg of phosphorus – that’s enough to grow about one year’s worth of food. “The average person flushes the toilet five times a day, and four of those times are just for urine. This means that 80% of our flush water—or over 4,000 gallons of clean water each year per person—is used just to get rid of urine! That is a lot of clean water used to transport ‘liquid gold’ into the sewer, where it becomes pollution. If we save it instead of flushing it, we can harvest a valuable resource that we can use in agriculture.”[11]. Urine has a fertilizers of N/P/K 18:2:5 [15]. And for urine mixed with flush water, the ratio can be N/P/K/S 15:1:3:1[21].

.For example, to provide 1 kg of nitrogen, we only needs about 2 kg of urea, but almost 150 litres of urine [4].

Elements	Per litre	Per person & year
Nitrogen	7 g	3.5 kg
Phosphorus	1 g	0.5 kg
Potassium	2 g	1.0 kg
Sulphur	1 g	0.5 kg
Magnesium	80 mg	40 g
Calcium	200 mg	100 g

Table 1: Approximate plant nutrient content of human urine [4]

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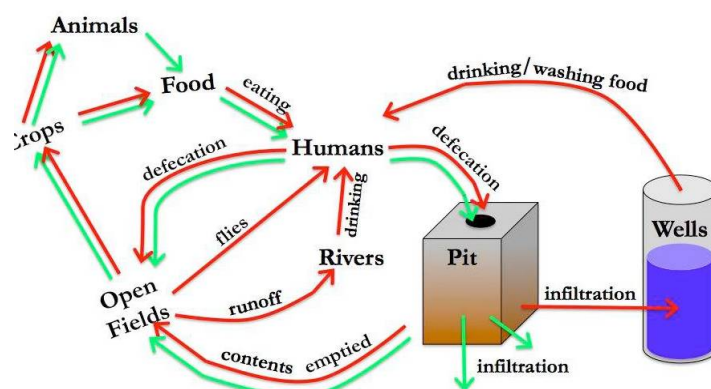


Figure.1 Nutrient and pathogen mobile in typical expanding world sanitation systems, with people defecating in pits or fields. Green arrows indicate nutrient travel; red arrows indicate pathogen travel [23].

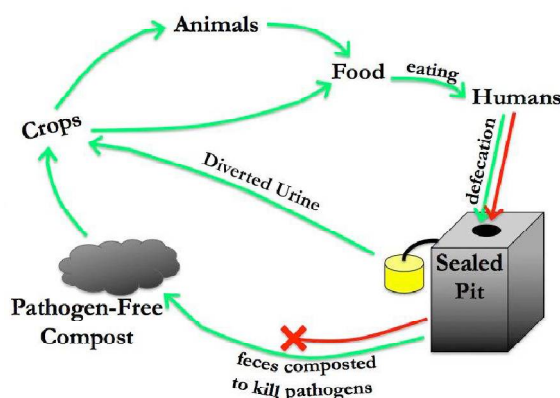


Figure.2: Closed-loop sanitation, in which human excreta are ideally turned back into plant nutrients efficiently and safely. Green indicates nutrient travel; red indicates pathogen travel [23].

Human urine contains some harmful substances namely salts [13-17-18], pathogens [8-9] and pharmaceuticals [25-26].

Effects of Salts

Salinity of human urine a potential problem associated with the use of urine based fertilizer is salinity and sodicity. The perceived risk of urine-fertilized soils becoming saline and/or sodic is related to the content of soluble salts especially Na^+ and Cl^- inherently in urine. Soil salinity is a worldwide threat to crop production [2], as it affects plants through osmotic stress, ion toxicity and nutritional imbalances [16]. Human urine contains a various salts and the most predominant among them is sodium chloride. Consequently, applications of human urine as liquid fertilizer in agriculture may have potential to accumulate sodium (Na) ions in soil and eventually be detrimental for plant growth and production, especially in dry land when urine is planned to be reused at several years' scales. Besides, it has been reported earlier that salts including chlorides may be toxic to some plants and consequently there has been concern about the toxicity of human urine [9-19].

Effects of Pathogens

In healthy individual, urine is sterile in the bladder [9]. However, in general pure human urine contains very few enteric microorganisms [8]. The pathogens traditionally known to be excreted in human urine are Salmonella typhus, Salmonella paratyphi, and Shistosomahaematobium. Infections by *S. typhi*, and *S. paratyphi* only cause excretion in

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urine during the phase of typhoid and paratyphoid fevers when bacteria are disseminated in the blood [7]. Besides, the risk of microbial contamination is diminished by the fact that pathogenic microbes do not survive in soil for a long time [7]. Therefore, the reuse of urine in tropical area seems to present low risk of pathogen contamination [19].

Effects of Pharmaceuticals products

Human urine contains pharmaceuticals filtrates even after protracted storage of urine as a treatment step [26]. Thereby, the reuse of human urine is associated with a risk of transfer of pharmaceutical filtrates to the agricultures fields. About 70 % of pharmaceuticals taken in are excreted in urine and is accounting for 50 % of the ecotoxicological risk. Slight is known in the fate of pharmaceuticals (anti-malarial drug, antibiotics and so fourth) present in urine regarding their accumulations in soil, transfer in ground water and uptake in plants [19].

Importance of Nitrogen

For many plants, “The use of N is usually higher than the total use of the other nutrients” [12]. Even if plants are growing, unsatisfactory nitrogen in soils will lower the protein content of many plants and feeder crops [5]. Nitrogen, therefore, is vital for both the growth of plants that will provide valuable vitamins and nutrients for the people consuming the plants, and nitrogen is also essential in the amount of protein that will be used up. Plants consume a large amount of nitrogen from the soil, and when plant material is removed during harvest, the nitrogen goes with it. Large nitrogen losses also occur when people burn their fields after harvest, for example [1]. An optimum amount of nitrogen is therefore rarely present in farming systems, with soils being particularly deficient in nitrogen and other nutrients [23].

The Fertilizing Ability of Urine

Chief motive that urine is an applicable fertilizer is because the majority of the highly obtainable nutrients in urine exist in the form that plants can use without difficulty. 75%to 90 % of the nitrogen in urine is in the form of urea, which becomes primarily ammonium ions in an aqueous solution of near neutral pH. This ammonium can be biochemically shifted to nitrate (NO₃⁻) in the presence of oxygen [14]. Phosphorus is excreted as phosphate ions [12]. The majority of potassium, sulfur, and most minerals are also present as free ions [14]. These nutrients are directly available to plants in these forms without processing. As with chemical fertilizers, urine is therefore a dilution of fast-acting plant nutrients that can work quickly to nourish plants [14-23].

Storage of urine

Storage of urine allows its use when the nutrients are most needed. Further, during the storage period, chemical processes kill pathogens. In tropical climates, urine should be stored for about three months before application. If storage is not possible, then the fresh urine should only be applied to tall standing crops. Examples of such crops are: banana, plantain, papaya, oranges, avocado and mango [4].

The merits of Urine as a Fertilizer

1. There are many reasons that urine works so well as a fertilizer. Human urine contains very few, if any, pathogens but contains the majority of plant fertilizing nutrients [5]. This high nutrient, low pathogen combination means that urine can be used very easily and safely to increase the yields of food crops. Add to this the ease and low cost of separating urine in most developing world sanitation systems and it is easy to see why the use of urine fertilizer could mean very real benefits for farmers and families with small gardens [19].
2. May encourage income generation (improved yield and productivity of plants).
3. Reduces dependence on costly chemical fertilizers.
4. Low risk of pathogen transmission.
5. Low costs. [10]

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Demerits of human urine as a fertilizer:

1. In undiluted fresh human urine, the following elements were found, nitrogen 7-9 g/L, phosphorus 0.20-0.21 g/L, potassium 0.9-1.1g/L, sulphur 0.17-0.22g/L, Calcium 13-16 mg/L and Magnesium 1.5-1.6mg/L. Some plant micronutrients, i.e. copper, zinc, iron and boron were also found in fresh urine at levels of micrograms per liters [13-22].
2. Urine is heavy and difficult to transport.
3. Smell may be offensive.
4. Labour intensive.
5. Risk of soil salinization if the soil is prone to the accumulation of salts.
6. Social acceptance may be low in some areas. [10]

IV. CONCLUSION

Urine is a well-balanced nitrogen-rich quick acting Liquid as a fertilizer has major impact on economy of agriculture, and also as advanced and innovative fertilizer replacing the conventional one, in this sense urine fertilizer is the perfect example. Human urine performed better in terms of improving soil fertility trend and as well as agronomic parameters compared to other sources thus greatly reduces the capital cost. Therefore, we suggest that it is better to apply an adequate amount of urine based on plant nitrogen requirement.

As urine can be stored and collected easily thereby decreasing handling and storage cost whereas chemical fertilizer decreases the soil fertility and added chemicals affects the soil property and human health. Keeping all these points in mind urine is proving as a finest fertilizer in all aspects.

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