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Human urine as a low cost and effective nitrogen fertilizer for bean production

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Abstract

The overuse and misuse of chemical fertilizers attributed to critical environmental and health problems such as Chronic Kidney Disease (CKD) in Sri Lanka. Therefore, there is a growing trend among present researches to explore low cost, effective fertilizer substitutes for inorgnaic fertilizers in cropproduction. Human urine is a liquid waste rich in essential plant nutrients such as nitrogen, phosphorous and potassium. This study was conducted to explorethe possibility of utilizing human urine in edible crop production as a low cost and effective nitrogen fertilizer.The study was conducted in a greenhouse using bushita bean (*Phaseolus vulgaris* L.) as crop species. Five treatments: T1 (Albert solution), T2 (Agriculture department recommendation for nitrogen (N), phosphorous (P), potassium (K) fertilizers; Urea, TSP and MOP), T3 (Human urine; nitrogen concentration adjusted to 20% less than the nitrogen concentration in T2), T4 (Human urine; nitrogen concentration adjusted similar to T2), and T5 (human urine; nitrogen concentration adjusted to 20% more than the concentration in T2) were applied three weeks after planting. Results revealed that T5 showed the highest increase in plant height, leaf area, root dry weight and total nitrogen content of leaves. Bean yield was significantly higher ($p<0.05$) in plants received T1 and T2 compared to urine-fertilized treatments. Even though, bean yields of urine-fertilized treatments (T1, T2 and T3) not directly comparable to that in the industrial-fertilized treatments (T1 and T2) were at a satisfactory level. The urine treatments were more cost effective than T1 and T2. Based on the results, we suggest that urine can effectively be used as a nitrogen fertilizer substitute in agricultural production.

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1. Introduction

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Plant nutrition is a key factor, which determines plant growth and development, therefore, fertilizer application has become a common practice in agriculture. The macronutrients such as nitrogen, phosphorous and potassium are the frequently required for plant nutrition in large proportions than micronutrients[1]. Though each macronutrient is important for all plants, nitrogen requirement is greater than the total use of other macronutrients and micronutrients together[1]. However, plant nutrients are depleting in the soil at an alarming rate due to unplanned continuous farming practices. Therefore, most of the farmers have adapted to apply chemical fertilizers in order to increase the available nutrients and hence the land productivity.

The Sri Lankan government has been subsidizing fertilizer for more than four decades which has lead to overuse and misuse of fertilizer creating critical environmental and health problems. The subsidy payment constitutes of 2.24% of total government expenditure and it has become a heavy burden for the country. Due to the negative impact of synthetic chemical fertilizers, there is a growing trend to use organic amendments and alternative fertilizer options in agriculture.

Many researchers have tested human urine as a fertilizer resulting in some progress[2]. Human urine carries very low levels of pathogens while containing considerable amounts of major plant fertilizing nutrients: nitrogen (N), phosphorous (P), potassium (K), Calcium (Ca), Sulphur (S) and Magnesium (Mg)[3]. High level of nutrients together with low levels of pathogens makes human urine a potential candidate as a liquid fertilizer. The present study was conducted to evaluate the use of human urine as a low cost and effective nitrogen fertilizer for bean production in Sri Lanka.

2. Methodology

The research was carried out under greenhouse condition at the Faculty of Agriculture, University of Peradeniya (7˚15'N 80˚36'E), situated 496 m above mean sea level in the Mid Country Wet Zone (MCWZ) where mean annual rainfall and temperature are 2500 mm and 28 ˚C, respectively. Bushita bean (*Phaseolus vulgaris* L.) plants were spaced 20 × 15 cm in the experimental plot as a grow bag culture onto whichfive different fertilizer treatments were applied over three weeks after planting. The treatments were: T1 (Treated with Albert solution), T2 (Agriculture Department recommendation for N, P, K fertilizers; Urea, TSP and MOP), T3 (Human urine; nitrogen concentration adjusted to 20% less than the nitrogen concentration in T2), T4 (Human urine; nitrogen concentration adjusted similar to T2), and T5 (human urine; nitrogen concentration adjusted to 20% more than the concentration in T2). The study was laid out as a Completely Randomized Design (CRD) with three replicates per treatment assigning five plants per replicate. Human urine samples were obtained from healthy males between 22-26 age. Fresh urine was diluted with water and dilution factor was decided based on available nitrogen concentration in human urine and nitrogen requirement of the bean plants.

Chemical analyses were undertaken in order to determine the available nitrogen, potassium, phosphorous and sodium concentration in human urine samples. As vegetative parameters, plant height and leaf area were measured. In addition, total nitrogen content of leaves, total dry matter content and bean yield were determined. The results were analyzed using Analysis of Variance (ANOVA) and the means were compared using Duncan Multiple Range Test (DMRT) with the software, SAS at 0.05 probability level.

3. Results and Discussion

The average nitrogen potassium, phosphorus and sodium concentrations of human urine were 3.07±1.15 g/L 1.7±0.2, 0.02±0.004 and 1.17±0.12 g/L, respectively. The nutrient content in urine depends on the food intake, body size, physical activity, the amount of drinking water and environmental factors[4]. It varies between countries, regions, individuals as well as in the time of excretion. One of the previous studies has shown that the average nutrient content of nitrogen, phosphorous and potassium in urine were 3.0, 0.3 and 1.74 g/L, respectively[1]. However, it has been reported that the nitrogen content of human urine in most developing countries could be lower than that of the industrial countries as vegetarian diet contains less protein than the mixed diet of industrial countries[5].

Among the three investigated urine treatments, in most of the cases, T5 showed the best results in terms of plant height, leaf area, root dry weight and total nitrogen content of leaves. Plant height, root dry weight and total nitrogen content of leaves recorded in T5, which contained 20% more nitrogen than T2 (Agriculture department recommendation for N, P, K fertilizers; Urea, TSP and MOP) was significantly greater ($p<0.05$) than the T2 (Figure

1a-e). The growth rate of urine fertilized plants in T5 was slightly better than that of industrial fertilized bean plants in T2.

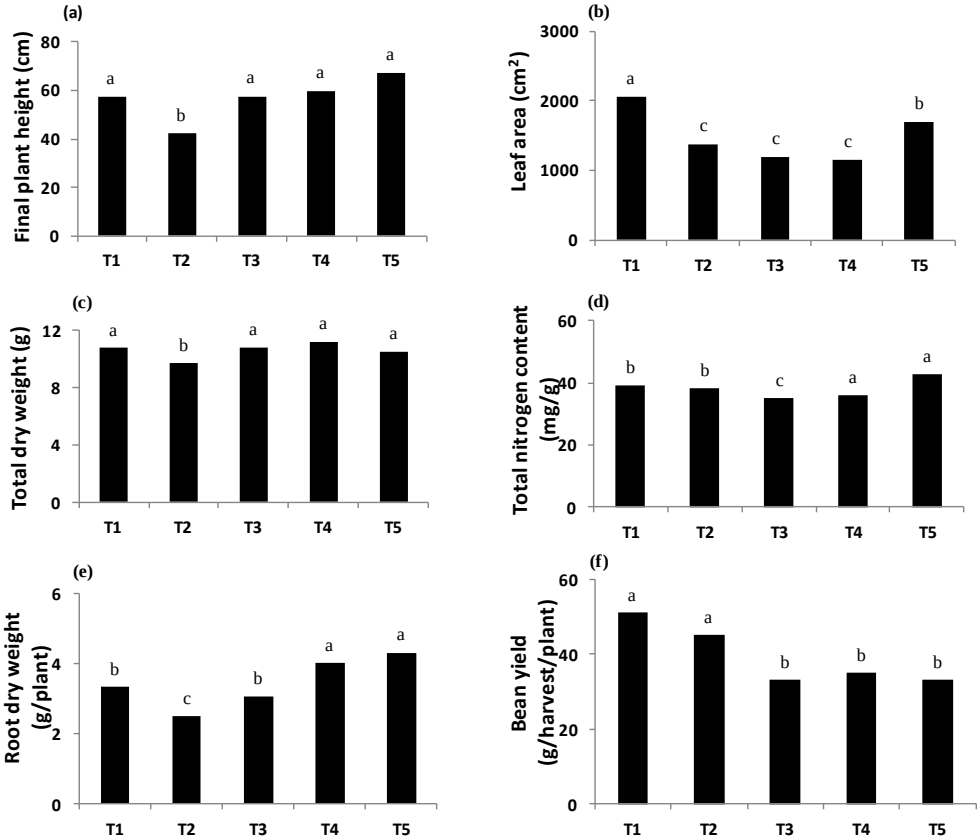

Figure 1: Treatment effect on **(a)** final plant height (cm), **(b)** leaf area (cm^2), **(c)** final dry weight (g), **(d)** total nitrogen content (mg/g), **(e)** bean yield (g/harvest/plant), **(f)** root dry weight (g/plant). Values are means ± SE. Different letters indicate a significant difference at ($P \leq 0.05$). **T1**: Recommended nitrogen dosage using Albert solution, **T2**: Recommended nitrogen dosage using industrial fertilizers, **T3**: Human urine, having nitrogen concentration 20% less than the nitrogen concentration in T2, **T4**: Human urine, having nitrogen concentration similar to T2, **T5**: Human urine contains nitrogen concentration 20% more than the concentration in T2.

Despite the difference between above two treatments (T2 and T5) on plant height, root dry weight and total leaf nitrogen content, the results of other three treatments remained comparable. However, total dry weight was significantly higher in T4 compared to other four treatments. Bean yield was significantly higher in the T1 and T2 compared to urine fertilized treatments (T1, T2 and T3). Even though, bean yields of urine fertilized treatments were not directly comparable to that of the industrial-fertilized treatments (T1 and T2), they were at a satisfactory level (Figure 1f). However, many researchers have shown good results with the urine fertilization comparable to the industrial fertilizers for different plant families[1]. It has been successfully used with cucumber[6] and barley cultivation in Finland.

Most of the nutrients present in the urine are readily available for the plants. Urine is considered to be a well-balanced nitrogen rich fertilizer and 75 – 90 % of the nitrogen present in the urine is in the available forms (either

urea or ammonium), which becomes ammonium ions in an aqueous solution at neutral pH[1]. Phosphorous and potassium present in the urine are in an inorganic form and are directly plant-available[1]. Even though the characteristic smell of ammonia could not be fully eliminated, immediate incorporation into media after dilution would be helpful to reduce the smell considerably.

4. Conclusion and Recommendations

According to the results, though yield produced by urine fertilized treatments were not comparable to the yield of industrial fertilized treatments; it has reached to a satisfactory level. Therefore urine can be considered a liquid fertilizer and a potential nitrogen fertilizer substitute for agricultural production. Thus, nitrogen would be more directly available and effective even in the dry season than the industrial fertilizers which remained undissolved during the dry season. If other nutrients, such as phosphorous and potassium can be supplied together, human urine can be considered as a potential nitrogen fertilizer in plant production.

References

1. Jonsson H, Stinzing AR, Vinneras B, Salmon E. *Guidelines on the use of urine and faeces in crop production*, EcoSanRes publication series report 2004-2, Stockholm Environment Institute, Sweden.
2. Gench R, Miso A, Itchon G, Sayre E. *Low cost sustainable sanitation solutions for Mindanao and the Philippines – A practical construction field guide*. Xavier University press, Cagayan de Oro, Philippines.
3. Esrey S, Anderson I, Hillers A, Sawyer R. *Closing the Loop: Ecological sanitation for food security*. Publications on water resources –no.18, UNDP, Mexico.
4. Paudel P, Shrestha P, Upreti HK. Effect of human urine as fertilizer on crop production. *Agronomy Journal of Nepal* (Agron JN) 20114; 2: 168-172.
5. Schouw NL, Danteravanich S, Mosbaeck H, Tjell JC. Composition of human excreta-a case study from Southern Thailand. *The Science of the Total Environment* 2002;286, 155-166.
6. Heinonen TH, Sjobolom A, Fabritius H, Karinen P. Pure human urine is a good fertilizer for cucumbers. *Bioresource Technology* 2007, 98, 214-217.