

Effect of Human Urine and Cattle Urine on Growth and Yield of Tomato (*Solanum lycopersicum*) in Red, Laterite and Black Soils of Karnataka, India

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ABSTRACT

The experiment was conducted under green house in the Department of Soil Science and Agricultural Chemistry, University of Agriculture, G.K.V.K., Bangalore, to evaluate the levels of nitrogen as well as human urine and cattle urine as nutrients sources on tomato crop (*Solanum lycopersicum*). The treatments consisted the recommended dose of NPK through fertilizers (control), 1.5 and 2 times the recommended dose of N through fertilizers plus recommended dose of P and K, recommended dose of N, 1.5 and 2 times the recommended dose of N through human urine as well as cattle urine and balanced P and K through fertilizers. Significantly higher plant height (87.2 and 80.2 cm, respectively), number of branches (5.90 and 5.80, respectively), and number of leaves (40.8 and 36.2) at harvest were recorded with 2 times the recommended dose of N (Nitrogen) through human urine to tomato crop as soil application for red and laterite soil, respectively. Whereas, in black soil, higher plant height (93.9 cm), number of branches (6.90), number of leaves (41.5) and total dry matter accumulation (249.8 g plant⁻¹) were recorded with 2 times the recommended dose of N application through chemical fertilizer. Application of 2 times the recommended dose of N through human urine in red and laterite soil recorded the significantly higher fruit yield (3.6 and 3.4 kg plant⁻¹, respectively) at harvest.

Keywords

Fertilizers,
Human urine, Cattle
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Levels etc.

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Introduction

Modern agriculture gets the nitrogen it needs from ammonia- producing plants that utilize fossil fuels such as natural gas, LPG or petroleum naphtha as a source of hydrogen. This energy- intensive process dumps carbon dioxide into the atmosphere and consumes a finite hydrocarbon resource. Modern agriculture gets the phosphorous it needs from phosphorous- bearing rocks. But these reserves are rapidly dwindling and increasingly contaminated with pollutants

such as cadmium. On a yearly basis a human produces roughly 500 liters of urine and 50 liters of feces, and these two products contain enough nutrients to grow most of the plants that this person needs as food.

But instead of utilizing these 550 liters as a valuable resource, we mix it with roughly 15,000 liters of water and all goes down the drain. Before it reaches the sewage plant, if there is one, this slurry gets mixed with

hundreds of pollutants along the way. The conventional sewage plant rarely retains or destroys all bacterial and viral contaminants, it produces a large amount of sludge generally unfit for agriculture, and it causes severe pollution in freshwater and seawater ecosystems.

This end of pipe solution recycles nothing. It takes valuable resources and transforms them into pollutants. As fertilizer prices rise throughout the world, and as water becomes an increasingly scarce commodity, this approach is not sustainable and makes no sense.

The nutrients in urine are in the forms which are readily available to plants. The nitrogen is in the form of urea which readily degrades to ammonium and nitrate forms and phosphorous, potassium and sulphates are in ionic forms. This makes urine a unique biogenic fertiliser.

Soil-plant-environment system should be free from economic exploitation and overuse and misuse of the inputs. No doubt, the use of mineral fertilizers and pesticides was a boon in the past, but their non-judicious use is being considered a bane in the present scenario, causing for a shift towards organic farming which has its own limitations. It is now time to reanalyse the production advantage to the cost of nature destruction, where impairment of soil physical, chemical and biological properties are the key problems associated with indiscriminate and over use of synthetic fertilizers and pesticides.

The judicious use of naturally available resources like human urine (anthropogenic liquid waste) and cattle urine help in maintaining yield stability through correction of marginal deficiencies of macro and micro-nutrients, enhancing efficiency of applied nutrients and providing favorable soil

chemical and physical conditions and reducing the environmental pollution.

Therefore judicious use of anthropogenic liquid waste in the areas of agriculture will increase, it might be insured that the quality and fertility of soils are not negatively affected in the long term perspective. This means in the practice that there is a need for research on efficiency and impact of these nutrient sources on different types of soils.

Taking all these factors into consideration, under greenhouse condition a pot-culture experiment was conducted to evaluate the effect of application of human and cattle urine on growth and yield of tomato in red, laterite and black soils.

Materials and Methods

A pot culture experiment was conducted under greenhouse condition in the Department of Soil Science and Agricultural Chemistry, at College of Agriculture, GKVK, UAS, Bangalore.

The red soil was collected from the field at D-block, ZARS, UAS, GKVK, Bangalore. The laterite soil was collected from the Seed Farm Unit, ZARS, UAS, Bramhavar (coastal area), and the black soil was collected from farmer's field near Nanjanagud, Mysore district.

The soil samples were analyzed for physical and chemical properties and found initial physico-chemical properties of red, laterite and black soils are given in Table 1. Fifteen kilogram of soil was weighed on to a polyethylene sheet and calculated quantity of fertilizers was added as per the treatment and same was transferred to the pots. Then one month old tomato seedlings were transplanted and watering was done to reduce the transplanting shock on seeding and for better establishment of the crop.

Simultaneously human urine was collected from Kannada medium High school, Doddaballapura by using specialized structure which separates fecal matter and urine and the cattle urine was collected from farmers cattle shed in Doddaballapura area at early hours of the day. Stored the urine for one month before soil application, meanwhile before soil application draw the sample both human and cattle urine and subjected for elemental analysis. Based on the chemical characteristics of the urine calculate the quantity of urine required for soil application as nutrient sources. The chemical composition for human urine was 0.30, 0.17, 0.18 per cent, N, P₂O₅ and K₂O, respectively and cattle urine had 0.25, 0.12 and 0.16 per cent N, P₂O₅ and K₂O, respectively.

The quantity of human and cattle urine was calculated based on the nitrogen content of urine and dosage of nitrogen recommended for the crop was 250: 250:250 kg of NPK ha⁻¹. Total volume of urine, quantity of fertilizers and the quantity of nutrients (kg ha⁻¹) added through human urine, cattle urine and fertilizer to tomato crop as per the treatments was used has been presented in Table 2.

The total volume of human urine/ cattle urine required per hectare to meet the recommended dose of nitrogen (kg/ha) was calculated by using bellow mentioned formula.

Volume of human/ cattle urine (m³ ha⁻¹) = (Recommended dose of nitrogen × 100) / (Per cent total nitrogen in human/ cattle urine × 1000)

The calculated quantity of gypsum was applied as basal dose only in case of treatments receiving the human urine and cattle urine with gypsum as per the treatment details to overcome the effect of sodium if

any on soil physical and chemical properties. The quantity of gypsum applied was 6.45 kg per cubic meter of urine, which was arrived at by considering the per cent sodium percent in urine (an average of 0.3 per cent Na).

The treatments consisted the recommended dose of NPK through fertilizers (control), 1.5 and 2 times the recommended dose of N through fertilizers plus recommended dose of P and K, recommended dose of N, 1.5 and 2 times the recommended dose of N through human urine as well as cattle urine and balanced P and K through fertilizers. The design of the experiment was carried out by using completely randomized design (CRD) with three replications.

Recorded the data on plant growth attributes viz., plant height, number of branches plant⁻¹, number of leaves plant⁻¹ and total dry matter (g/plant) of tomato at harvest. Recorded the observations on number of fruit per plant at 60, 90 days after transplanting and at final harvest, fresh weight (g fruit⁻¹) and the fruit yield (kg plant⁻¹). The experimental data were analysed statistically.

Results and Discussion

Growth attributes

Plant height (cm)

Significantly higher plant height was recorded in red soil with application of 2 times the recommended dose of nitrogen through human urine (T₆) at harvest (87.2 cm) which was on par with 2 times the recommended dose of nitrogen through cattle urine (T₉), 2 times the recommended dose of nitrogen through chemical fertilizers (T₃) and 1.5 times recommended dose of nitrogen through human urine (T₅), cattle urine (T₈) and fertilizers (T₂). The treatment receiving recommended dose of nitrogen through

chemical fertilizers (T₁) recorded significantly lower plant height of 78.1 cm and it was on par with recommended dose of nitrogen through human urine (T₄) and cattle urine (T₇). Similar trend was observed at harvest of tomato crop in laterite soil also. In black soil, significantly higher plant height (93.9 cm) at harvest of tomato crop was recorded with application of 2 times the recommended dose of nitrogen through chemical fertilizers (T₃) and it was on par with 2 times the recommended dose of nitrogen through human urine (T₆) and cattle urine (T₉) and 1.5 times recommended dose of nitrogen through fertilizers (T₂), human urine (T₅) and cattle urine (T₈).

Significantly lower plant height (85.7 cm) was recorded with recommended dose of nitrogen through cattle urine (T₇) and it was on par with recommended dose of nitrogen through human urine (T₄) and chemical fertilizer (T₁) treatments (Table 3). The similar trend of results was observed by Jonsson (1997), Sridevi *et al.*, (2009) and Guadarrama *et al.*, (2001).

Number of branches (plant⁻¹)

Significantly maximum number of branches plant⁻¹ (5.90 plant⁻¹) at harvest of tomato crop in red soil was recorded in treatment receiving 2 times the recommended dose of nitrogen through human urine (T₆) which was on par with T₉, T₃, T₅ T₈ and T₂. Recommended dose of nitrogen through chemical fertilizer to crop (T₁) recorded significantly lower number of branches plant⁻¹ (5.15) and it was at par with T₄ and T₇.

The same trend was observed at harvest of tomato crop in laterite soil also. In case of black soil, significantly maximum number of branches plant⁻¹ (6.90 plant⁻¹) at harvest of crop was recorded in treatment receiving 2 times the recommended dose of nitrogen through chemical fertilizer (T₃) which was on

par with T₆, T₉, T₂, T₅ and T₈. Treatment receiving recommended dose of nitrogen through cattle urine to crop (T₇) recorded significantly lower number of branches plant⁻¹ (5.13) and it was at par with T₄ and T₁ (Table 3). These results are in agreement with the findings of Peter Morgan (2004) and Kedar Man Prajapati, Deepak Raj Gajurel (2003) who used source separated human urine as the nutrient source for the vegetable plants particularly broadbean, blackgram and green pea.

Number of leaves (plant⁻¹)

In red soil, significantly maximum number of leaves plant⁻¹ (40.8) at harvest in red soil was recorded with application of 2 times the recommended dose of nitrogen through human urine (T₆) which was on par with T₉, T₃, T₅ T₈ and T₂. Application of recommended dose of nitrogen through chemical fertilizer (T₁) recorded significantly lower number of leaves plant⁻¹ (29.6) and it was at par with T₄ and T₇. Similar trend was observed at harvest of tomato crop in laterite soil. In case of black soil, significantly higher number of leaves plant⁻¹ (41.5) was noticed at harvest with the application of 2 times the recommended dose of nitrogen through chemical fertilizer (T₃) and it was on par with T₆, T₉, T₂, T₅ and T₈. Application of recommended dose of nitrogen through cattle urine (T₇) recorded significantly lower number of leaves plant⁻¹ (29.5) and it was at par with T₄ and T₁ (Table 3). These results are in agreement with the findings of Peter Morgan (2004) and Kedar and Deepak (2003) used the source-separated human urine for the vegetable plants particularly broad bean, black gram and green pea and studied actual nutrient uptake by vegetable plants from source separated human urine and chemical fertilizers in soil media with different dilution or loading rate in the same condition can be investigated in terms of bio-mass growth.

The treatment details are as follows

- T₁** : Control-Recommended dose of NPK
- T₂** : 1.5 times the recommended dose of N through fertilizer + Recommended dose of P and K
- T₃** : 2 times the recommended dose of N through fertilizer + Recommended dose of P and K
- T₄** : Recommended dose of N through Human urine + Balance P & K through fertilizer
- T₅** : 1.5 times the recommended dose of N through Human urine + Balance P & K through fertilizer
- T₆** : 2 times the recommended dose of N through Human urine + Balance P & K through fertilizer
- T₇** : Recommended dose of N through Cattle urine + Balance P & K through fertilizer
- T₈** : 1.5 times the recommended dose of N through Cattle urine + Balance P & K through fertilizer
- T₉** : 2 times the recommended dose of N through Cattle urine + Balance P & K through fertilizer

Where: N-Nitrogen; P-Phosphorus; K-Potassium.

Note: Balance of P and K were supplied through single superphosphate (SSP) and Muriate of potash (MOP), respectively.

Table.1 Physico- chemical properties of the red, laterite and black soils

Parameters	Red soil	Laterite soil	Black soil
I. Physical properties			
Textural class	Sandy Loam	Gravelly sandy loam	Clay
II. Chemical properties			
pH (1:2.5)	6.19	4.97	8.43
EC (dS m ⁻¹)	0.18	0.09	0.29
Organic Carbon (%)	0.39	0.63	0.57
Available N (kg ha ⁻¹)	225.15	210.09	378.4
Available P ₂ O ₅ (kg ha ⁻¹)	21.01	12.03	18.63
Available K ₂ O (kg ha ⁻¹)	318.54	115.93	515.30

Table.2 Total volume and quantity of nutrients (kg ha⁻¹) added through human urine, cattle urine and fertilizer to tomato crop as per the treatments

Treatments	HU/CU (m ³ ha ⁻¹)	Fertiliser			Human urine			Cattle urine			Balance P and K through fertilizer	
		N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	P ₂ O ₅	K ₂ O
T ₁	-	250	250	250							-	-
T ₂	-	375	375	357							-	-
T ₃	-	500	500	500							-	-
T ₄	83.3				250.0	141.7	150.0				108.3	100.0
T ₅	125.0				375.0	212.5	225.0				162.5	150.0
T ₆	166.6				500.0	283.3	300.0				216.7	200.0
T ₇	100.0							250.0	120.0	160.0	130.0	90.0
T ₈	150.0							375.0	180.0	240.0	195.0	135.0
T ₉	200.0							500.0	240.0	320.0	260.0	180.0

Table.3 Plant height (cm), number of branches, number of leaves and total dry matter (g/plant) of tomato at harvest as influenced by graded levels of human urine, cattle urine and fertilizer in three different soils

Treatments	Red soil				Laterite soil				Black soil			
	Plant height	No. of branches	No. of leaves	Total dry matter	Plant height	No. of branches	No. of leaves	Total dry matter	Plant height	No. of branches	No. of leaves	Total dry matter
T ₁	78.1	5.15	29.6	164.5	72.6	4.16	26.3	153.5	87.3	5.43	30.3	194.5
T ₂	83.1	5.60	36.7	213.3	76.8	5.15	31.7	200.1	91.9	6.30	38.0	238.7
T ₃	84.8	5.74	38.0	227.3	78.0	5.47	34.3	212.3	93.9	6.90	41.5	249.8
T ₄	78.3	5.23	31.2	174.0	72.9	4.33	26.8	162.2	86.5	5.17	29.7	191.9
T ₅	84.5	5.70	37.3	217.6	77.6	5.35	34.0	201.4	90.8	6.24	37.2	235.7
T ₆	87.2	5.90	40.8	236.7	80.2	5.80	36.2	218.6	93.3	6.60	40.3	243.5
T ₇	78.2	5.18	30.6	171.6	72.8	4.23	26.4	158.9	85.7	5.13	29.5	188.5
T ₈	84.3	5.67	36.5	215.7	77.0	5.27	33.7	201.0	90.1	6.05	36.7	233.0
T ₉	85.3	5.82	38.9	234.6	78.8	5.60	36.0	216.4	92.4	6.41	38.3	238.2
S.Em ±	1.11	0.09	1.04	6.02	0.86	0.16	1.10	4.37	1.15	0.25	1.28	4.59
C.D. (P=0.01)	4.57	0.38	4.28	24.68	3.54	0.67	4.52	17.91	4.71	1.04	5.27	18.81

Table.4 Number of fruits of tomato as influenced by graded levels of human urine, cattle urine and fertilizer in three different soils

Treatments	Number of fruits per plant								
	Red soil			Laterite soil			Black soil		
	60 DAT	90 DAT	At harvest	60 DAT	90 DAT	At harvest	60 DAT	90 DAT	At harvest
T ₁	32.6	39.9	42.6	30.0	36.7	37.5	37.6	45.7	48.3
T ₂	42.8	48.1	48.8	39.4	44.3	44.9	46.4	52.9	54.5
T ₃	44.4	51.2	52.2	40.8	47.1	48.0	50.3	57.5	57.7
T ₄	34.2	41.5	43.9	31.4	38.2	37.9	36.9	44.2	47.8
T ₅	43.3	48.5	49.8	40.3	44.9	47.8	47.2	52.4	54.0
T ₆	45.9	52.5	52.7	44.4	49.1	51.8	50.1	56.6	56.9
T ₇	33.5	40.2	43.4	30.8	37.0	37.7	35.9	43.9	46.9
T ₈	42.9	48.4	49.4	39.5	44.5	45.8	47.1	52.2	53.7
T ₉	45.5	52.3	52.5	43.8	48.0	49.6	48.8	56.3	55.3
S.Em ±	0.94	1.13	1.49	1.27	1.52	1.74	0.82	1.17	1.21
C.D. (P=0.01)	3.85	4.63	6.13	5.21	6.23	7.15	3.37	4.80	4.94

Where: DAT= Days after transplanting

Table.5 Yield of tomato as influenced by graded levels of human urine, cattle urine and fertilizer in three different soils

Treatments	Red soil		Laterite soil		Black soil	
	Fresh weight (g fruit ⁻¹)	Fruit yield (kg plant ⁻¹)	Fresh weight (g fruit ⁻¹)	Fruit yield (kg plant ⁻¹)	Fresh weight (g fruit ⁻¹)	Fruit yield (kg plant ⁻¹)
T ₁	50.8	2.2	50.1	1.97	60.4	2.24
T ₂	62.2	3.0	59.8	2.86	66.9	3.36
T ₃	66.3	3.5	63.8	3.21	72.2	3.67
T ₄	51.8	2.3	50.6	2.17	59.5	2.10
T ₅	63.2	3.1	62.6	3.14	68.1	3.30
T ₆	68.8	3.6	68.3	3.45	71.9	3.53
T ₇	51.0	2.2	50.3	2.01	57.9	2.03
T ₈	62.9	3.1	60.5	3.05	67.3	3.27
T ₉	68.4	3.6	65.9	3.32	71.5	3.45
S.Em ±	3.24	0.17	2.19	0.15	1.38	0.16
C.D. (P=0.01)	13.29	0.70	8.97	0.62	5.67	0.68

Total dry matter accumulation (g plant⁻¹)

Significantly higher total dry weight plant⁻¹ was recorded in treatment with 2 times the recommended dose of nitrogen through human urine (T₆: 236.7 g plant⁻¹) and it was at par with T₉, T₃, T₅, T₈ and T₂. Significantly lower total dry matter (164.5 g plant⁻¹) was recorded with application of recommended dose of nitrogen through chemical fertilizers (T₁) which was on par with T₄ and T₇. Similar result was observed at harvest of tomato crop grown in laterite soil. Accumulation of total dry matter (g plant⁻¹) in tomato crop grown in black soil showed significant differences among the treatments at harvest.

Application of 2 times the recommended dose of nitrogen through chemical fertilizers (T₃) recorded significantly higher total dry weight (249.8 g plant⁻¹) and it was on par with T₆, T₉, T₂, T₅ and T₈ over recommended dose of nitrogen through chemical fertilizer (T₁:194.5 g plant⁻¹), human urine (T₄:191.9 g plant⁻¹) and cattle urine (T₇:188.5 g plant⁻¹). This has been the consequence of slow and steady release and better availability of nutrients and higher nutrient uptake observed due to application of human urine in three split doses during the crop growth period in addition to the presence of all essential nutrients in human urine and cattle urine which might have stimulated the growth of vegetable crops. Høglund (2001) and Simons and Clemens (2004) recorded similar observations on improved yield and yield attributing characters due to human urine application in rice, barley and vegetable crops like chard, turnip, carrot and fruit crops like banana, orange (Table 3).

Yield and yield parameters of tomato

Number of fruits plant⁻¹

Number of fruits plant⁻¹ recorded at 60, 90 DAT and at harvest, was significantly higher in 2 times the recommended dose of nitrogen through human urine (T₆: 45.9, 52.5 and 52.7 plant⁻¹, respectively) and it was at par with T₉,

T₃, T₅, T₈ and T₂ but was found significantly superior over rest of the treatments (T₁, T₄ and T₇). Significantly lower number of fruits plant⁻¹ was recorded with application of recommended dose of nitrogen through chemical fertilizers to soil (T₁: 32.6, 39.9 and 42.6 plant⁻¹) and it was at par with T₄ and T₇. Similar trend was observed in laterite soil. In case of black soil, number of fruits plant⁻¹ varied significantly among the treatments at 60, 90 DAT and at harvest of tomato crop (Table 4). Significantly higher number of fruits plant⁻¹ was recorded with 2 times the recommended dose of nitrogen through chemical fertilizers (T₃: 50.3, 57.5 and 57.7 plant⁻¹, respectively) and it was on par with T₆, T₉, T₂, T₅ and T₈. Significantly lower number of fruits plant⁻¹ was recorded with application of recommended dose of nitrogen through cattle urine to soil (T₇: 35.9, 43.9 and 53.7 plant⁻¹) which was on par with T₁ and T₄. Høglund (2001) and Simons and Clemens (2004) recorded similar observations on improved yield and yield attributing characters due to human urine application in rice, barley and vegetable crops like chard, turnip, carrot and fruit crops like banana, orange (Table 4).

Fresh weight (g fruit⁻¹)

Fruit weight of tomato differed significantly among the treatments. Fruit weight at harvest, was significantly higher in treatment receiving 2 times the recommended dose of nitrogen through human urine (T₆: 76.3 g fruit⁻¹) and it was on par with T₉, T₃, T₅, T₈ and T₂. Significantly lower fruit (58.3 g) weight was recorded with recommended dose of nitrogen through chemical fertilizers (T₁) which was at par with T₄ and T₇. Similar results were also observed in laterite soil also. In black soil, application of 2 times the recommended dose of nitrogen through chemical fertilizers (T₃) showed significantly higher fruit weight (81.5 g fruit⁻¹) which was at par with T₆, T₉, T₂, T₅ and T₈. Recommended dose of nitrogen through cattle urine to crop (T₇) recorded significantly lower fruit weight (67.2 g fruit⁻¹) and it was at par with T₄ and T₁ (Table 5).

Fruit weight (kg plant⁻¹)

Application of 2 times the recommended dose of nitrogen through human urine (T₆) recorded significantly higher mean fruit weight (3.6 kg plant⁻¹) in red soil condition and it was significantly superior over recommended dose of nitrogen through chemical fertilizers (T₁) and cattle urine (T₇) to soil (2.2 kg) but it was at par with T₉, T₃, T₅, T₈ and T₂. Similar trend was also noticed in tomato crop grown in laterite soil also. In black soil, fruit weight varied significantly due to graded levels of human, cattle urine and fertilizer. Significantly higher fruit weight was recorded in 2 times the recommended dose of nitrogen through chemical fertilizers (T₃: 3.67 kg), which was significantly superior over T₁, T₄ and T₇ but was on par with rest of the treatments (Table 5). In black soil, higher yield was recorded with application of 2 times the recommended dose of N through chemical fertilizer but was on par with application of human urine and cattle urine which might be due to higher pH of soil leading to loss of applied nitrogen through volatilization. Olga Singurindy *et al.*, (2006) observed ammonia volatilization during the first day of the treatments, with volatilization rate closely related to evaporation rates in both sand textures (fine and coarse). Sand texture caused reductions in the urine evaporation rate and therefore in NH₃ volatilization rates. Urine evaporation increased air-filled pore space, thereby improving aeration conditions in the sand that contribute to nitrification and dominance of N₂O production. Moreover, evaporation of urine, enriched with dissolved N₂O, increased total N₂O emission.

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