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Research Article

Household Wastewater Potentiality for Irrigation in Tomato Crop Field in Bangladesh

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Abstract: This study was carried out to examine the reuse potential of wastewater for irrigation based on growth water and nutrient use of tomato during January to June, 2016. There were five treatments such as control (T_1 = 100% tap water), T_2 (100% drain water), T_3 (50% tap water + 50% drain water), T_4 Landry grey water (1g wheel powder per 3 L of tap water) and T_5 Landry grey water (2g wheel powder per 3 L of tap water). The tomato yield and yield contributing parameters, branches per plant, number of leaves per plant were influenced statistically significantly by wastewater containing treatments as compared to control but the plant height, number of flowers per plant and number of fruits per plant did not influenced significantly among different treatments by wastewater. The highest number of branches per plant, leaves per plant and fruits per plant were observed in T_2 (100% drain water) treatment both in vegetative and reproductive stage. However, the highest plant height was found in T_3 treatment and number of flowers per plant was observed in T_4 Treatment. Considering the chemical properties of soil, T_3 treatment (50% tap water + 50% drain water) contained maximum amount of essential plant nutrients as compared to other treatments. The yield of tomato increased with the increasing of plant height, branch number, number of leaves, number of flowers and number of fruits per plant. However, the relationship of number of branches per plant, number of leaves per plant and number of fruits per plant with the yield of tomato were statistically significant.

Keywords: Household, Irrigation, Potentiality, Tomato, Wastewater.

INTRODUCTION

Uses of water have been increasing globally at more than twice than the increase of population in last century. Around 700 million people in 43 countries suffer today from water scarcity. By 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world's population could be living under water stressed conditions (Anonymous, 2018). So, the water scarcity as one of the major worrying matter for the new millennium. From our total water availability, we use about 70% water for agriculture. By 2020 we shall need 17% more water than is available if we are to feed the world (Kirby, 2000). The global water shortages and food security issues related to over population demand shifting of fresh water away from agriculture to more vital and sustainable uses. Therefore, search for new water resources for irrigation is required, among which the reuse of household wastewater for agricultural purposes may be one of the best ways to solve this problem. Agricultural wastewater may be defined as the combination of the liquid carried wastes from institutions, residences and commercial and industrial establishments (Cheremisinoff, 2002).

Wastewater irrigation has long been adopted in the developing and developed countries, due to its high fertility as well as due to lack of infrastructure and facilities for disposal of wastewater effluent (Munir and Mukhtar, 2003). As freshwater sources become scarcer, wastewater use has become an attractive option for conserving and expanding available water supplies.

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There are various types of wastewater that contain different types of substances. For instance, laundry grey water contains different levels of suspended solids, salts, nutrients, organic matter and pathogens (Howard *et al.,* 2005). The use of wastewater in agriculture has both positive and negative potential impacts on crop production, public health, soil resources and ecosystems (Scott *et al.,* 2004; Hussain *et al.*, 2002). The use of wastewater effluent for irrigation has many-fold benefits for farmers such as the availability of excess amount of nutrient rich water and prevention from environmental pollution caused by disposing wastewater off into drainage and irrigation networks. Wastewater irrigation also serves as a "natural" treatment method. The wastewater is also considered the best substitute of the freshwater shortages (Munir and Mukhtar, 2003). Application of wastewater to cropland and forest lands is attractive option for disposal, because it can improve the physical properties and the nutrient content of soils. Wastewater irrigation provides water, N and P, as well as organic matter to the soils (Kiziloglu *et al.,* 2008). Tomato is the most important winter vegetables in our country. It is a sensitive crop and shows all types of symptoms easily. The fate of surfactants in wastewater irrigated soil-plant system is not well known. Moreover, there is limited information available on the interaction of wastewater with soil which is very important to know the impact of use of wastewater on environment. So, the present field study was conducted using a popular tomato variety as a test crop to determine the effect of wastewater on the growth, water, and nutrient use of the tomato crop.

MATERIALS AND METHODS

The pot experiment was conducted in the experimental field of Agriculture Farm, Department of Environmental Science, and soil samples were analyzed in Humbolt laboratory, Department of Soil Science, Bangladesh Agricultural University, Mymensingh during the winter season 2015-2016 (from 30th December, 2015 to 19 March, 2016). The single factor experiment was laid out in randomized completely block design (RCBD) with three replication having five treatments, thus the total number of pots was 15 (3x5). Each pot was filled by 10 kg of soil with the mixture of proper nutrient and maintains the proper pot spacing and cultural operation was done when necessary. The test crop under experiment was tomato (Lycopersicon esculentum), variety Roma VS tomato. Household wastewater used as irrigation purpose based on the following treatments.

T1= Control (tap water 100%); T2= Wastewater (100%); T3= Tap water (50%) + Wastewater (50%); T4= Landry grey water (1g wheel powder per 3 L of tap water); T5=Landry grey water (2g wheel powder per 3L of tap water) Plant height (cm), No. of leaf/ plant, No. of branches/plant, No. of flowers/plant, No. of fruits/plant data were collected on growth and yield attributes at different days after transplanting. Initially soil samples were collected from the each treated pot. Soil Ph, Electrical conductivity, Total nitrogen content, Available phosphorus content, Exchangeable potassium content parameter of soil sample were determined after harvesting plant. The total contents of pH, N, P, and K were determined following standard methods used for soil analyses.

The analysis of variance for various crop characters and also for the nutrient content of the soil were done in Randomized Complete Block Design (RCBD) design following the principle of statistics and the mean results in case of significant F value were adjusted by the Duncan's Multiple Range Test (DMRT) with the help of a computer package M-STAT (Gomaze and Gomaze, 1984).

RESULTS AND DISCUSSION

Effect of Wastewater on Morphological & Physiological Characteristics of Tomato Plant

Plant Height

The plant height was recorded at different growth stages of Tomato plant such as vegetative stage and reproductive stage. The average plant height at various growth stages is shown in table 1. The plant height influenced significantly not significant due to the application of wastewater (table 1). However, the highest plant height was found in T3 (46.00 cm at vegetative stage and 37.13 cm at reproductive stage) treatment while the lowest plant height was observed in T1 (39.00 cm at vegetative stage and 32.74 cm at reproductive stage) treatment (Table 1).

Number of Branches per Plant

The average number of branches per plant at various growth stages is shown in Table 1. Among all stages, the highest number of branches was observed in T2 (37.33 at vegetative stage and 27.85 at reproductive stage) treatment while the lowest was observed in T5 (24.00 at vegetative stage) and in T1 (21.41 at reproductive stage) treatment (Table 1). The number of branches per plant influenced significantly at 5% level of probability at vegetative stage and not significantly at reproductive stage.

Table 1: Effect of various treatments of household wastewater on plant height, no. of branches/plant, no. of leaves/plant, no. of flowers/plant, no. of fruits/plant at vegetative and reproductive stage of Tomato plants

Treatments	Plant height (cm)		Number of branches plant^{-1}		Number of leaves plant^{-1}		Number of flowers plant^{-1}		Number of fruits plant^{-1}	
	Vegetative stage	**Reproductive stage**	**Vegetative stage**	**Reproductive stage**	**Vegetative stage**	**Reproductive stage**	**Vegetative stage**	**Reproductive stage**	**Vegetative stage**	**Reproductive stage**
T_1	39.00	32.74	25.33 b	21.41	147.67 ab	145.22	26.33	16.00	15.00	16.33
T_2	45.33	36.35	37.33 a	27.85	181.67 a	174.19	25.67	15.33	21.33	23.00
T_3	46.00	37.13	25.00 b	22.30	139.33 b	141.63	22.33	12.00	13.00	13.33
T_4	43.67	35.72	31.33 ab	27.11	160.67 ab	168.41	30.67	20.33	15.00	15.33
T_5	41.33	33.72	24.00 b	22.11	126.67 b	134.18	18.33	8.00	12.00	13.00
$LSD_{(0.05)}$	-	-	**7.377**	-	**34.72**	-	-	-	-	-
Level of significance	**NS**	**NS**	**	**NS**	*	**NS**	**NS**	**NS**	**NS**	**NS**
CV (%)	**20.24**	**13.97**	**13.70**	**16.34**	**12.20**	**10.92**	**58.12**	**58.12**	**33.38**	**38.75**

Note: T1= 100% tap water (control); T2= 100% drain water; T3= 50% tap water + 50% drain water; T4= Landry grey water (1g wheel powder per 3 L of tap water); T5= Landry grey water (2g wheel powder per 3 L of tap water); *= Significant at 5% level of probability; **= Significant at 1% level of probability; NS= Non-significant

Number of Leaves per Plant

The average number of leaves per plant at various growth stages is shown in Table 1. Among all stages, the highest number of leaves was observed in T2 (181.67 at vegetative stage and 174.19 at reproductive stage) treatment while the lowest was observed in T5 (126.67 at vegetative stage and 134.18 at reproductive stage) treatment (Table 1). The number of leaves per plant influenced significantly at 5% level of probability at vegetative stage and not significantly at reproductive stage.

Number of Flowers per Plant

The average number of flowers per plant was recorded at different growth stages of Tomato plant such as vegetative stage and reproductive stage. The average number of flowers per plant at various growth stages is shown in Table 1. The average number of flowers per plant influenced significantly not significant due to the application of wastewater (Table 1). However, the highest number of flowers per plant was found in T4 (30.67 at vegetative stage and 20.33 at reproductive stage) treatment while the lowest was observed in T5 (18.33 at vegetative stage and 8.00 at reproductive stage) treatment (Table 1).

Number of Fruits per Plant

The average number of fruits per plant was recorded at different growth stages of Tomato plant such as vegetative stage and reproductive stage. The average number of fruits per plant at various growth stages is shown in table 1. The average number of fruits per plant influenced significantly not significant due to the application of wastewater (Table 1). However, the highest number of fruits per plant was found in T2 (21.33 at vegetative stage and 23.00 at reproductive stage) treatment while the lowest was observed in T5 (12.00 at vegetative stage and 13.00 at reproductive stage) treatment (Table 1). Kabir *et al.*, (2008) Conducted pot experiment to study the effects of sewage sludge and nitrogen fertilization on the growth, yield, nutrient and heavy metal uptake into rice straw (Oriza setiva L cv. BRRI dhan-36). The application of sewage sludge increased leaves dimensions, leaf area index, accumulated above ground dry matter, tillering capacity and plant height of barley (Hordeum vulgare L.) and oat (Avena sativa L.) genotypes, evaluated in pots experiment reported by (Bouzerzour *et al.*, 2002).

Segura *et al.*, (2004) reported advocated the re-use of wastewater in arid and semiarid region of the world. They reported that significantly higher yield of melon and tomato were obtained when the crops were irrigated with effluents in the greenhouse crops. In another study by Akitaka et al (2002) reported that tomato growth, yield and quality was not affected by the addition of treated wastewater compared to tap water.

Effect of Various Treatments of Wastewater on Chemical Properties of Soil & Plant Environment

The highest soil pH was found in T5 (7.03) treatment while the lowest pH was found in T2 (6.49) treatment (Table 2). The soil pH was gradually increased in all treatments compared to control (T1) treatment except T2 treatment (Table 2). The soil pH measured from different treatments was statistically significant at 1% level of probability (Table 2). The highest EC was found in T5 (278.00 ppm) treatment while the lowest EC was found in T1 (194.20 ppm) treatment (Table 2). The soil EC was higher in all treatments compared to control (T1) treatment. The soil EC measured from different treatments was statistically not significant. Soil pH was significantly lower when wastewater application and they attributed this decrease to the high content of ammonium in wastewater, which its nitrification would serve as a source of hydrogen ions thus causing a decrease in soil pH observed by Mohammad and Mazahreh (2003). The wastewater had a non-significant effect on sand content of soil (Table 2). The highest level sand content was found in T5 (29.33%) treatment and the lowest level was found in T2 and T3 (23.00%) treatments.

Table2. Effect of various treatments of wastewater on chemical properties of soil and the plant environment

Treatments	pH	EC (ppm)	Sand%	Silt%	Clay%	Moisture%	P mmol/L	K mmol/L	Na mmol/L
T_1	6.54b	194.20	24.67	66.67	8.67	2.23	0.232	1.591 a	1.170
T_2	6.49b	220.73	23.00	68.33	8.67	2.50	0.226	1.112 c	1.157
T_3	6.71ab	209.00	23.00	68.33	8.67	2.27	0.246	1.513ab	1.136
T_4	7.0 2a	230.67	27.33	62.67	10.00	2.40	0.230	1.316 bc	1.109
T_5	7.03a	278.00	29.33	62.00	6.67	2.67	0.241	1.609 a	1.097
$LSD_{(0.05)}$	0.3261	-	-	-	-	-	-	0.2455	-
Level of significance	**	NS	NS	NS	NS	NS	NS	**	NS
CV (%)	2.56	22.50	30.00	11.24	16.09	12.42	4.17	9.15	4.74

Note: T1= 100% tap water (control); T2= 100% drain water; T3= 50% tap water + 50% drain water; T4= Landry grey water (1g wheel powder per 3 L of tap water); T5= Landry grey water (2g wheel powder per 3 L of tap water); **= Significant at 1% level of probability

The wastewater had a non-significant effect on silt content of soil (Table 2). The highest level silt content was found in T2 and T3 (68.33%) treatments and the lowest level was found in T5 (62.00%) treatment. The wastewater had a non-significant effect on clay content of soil (Table 2). The highest level clay content was found in T4 (10.00%) treatment and the lowest level was found in T5 (6.67%) treatment. The wastewater had a non-significant effect on moisture content of soil (Table 2). The highest level moisture content was found in T5 (2.67%) treatment and the lowest level was found in T1 (2.23%) treatment. The concentration of P in plant system influenced significantly non-significant due to application of wastewater at the time of tomato cultivation. The highest level of P content was recorded in T3 (0.246 mmol/L) treatment while the lowest was recorded in T2 (0.226 mmol/L) treatment (Table 2).

The concentration of K in plant system influenced significant at 1% level of probability due to application of wastewater at the time of tomato cultivation. The highest level of K content was recorded in T5 (1.609 mmol/L) treatment while the lowest was recorded in T2 (1.112 mmol/L) treatment (Table 2). Table 2 also showed that, concentration of Na in plant system influenced significantly non-significant due to application of wastewater at the time of tomato cultivation. The highest level of Na content was observed in T1 (1.170 mmol/L) treatment while the lowest was recorded in T5 (1.097 mmol/L) treatment.

Upadhyay *et al.*, (2013) reported that the sludge application resulted in an increase in available nitrogen, phosphorus, potassium and organic matter content. Sludge application also significantly increased the yield of carrot.

Wastewater irrigation not only provides water, N and P but also organic matter (OM) to the soils (Siebe, 1998). Misra *et al.*, (2010) suggested that laundry greywater has a promising potential for reuse as irrigation water to grow tomato, once that compared with tap water irrigated plants, greywater irrigated plants substantially uptake greater quantity of Na (83%) and Fe (86%). All decomposed drained soil containing treatment showed significantly higher N, P, K and organic matter content than control (Sharmin, 2010). The above result suggests that the use of wastewater released optimum level of nutrient elements particularly N that resulted in maximum yield and yield contributing characters.

CONCLUSION

Results of the cultivation experiment showed that the yield and yield contributing characters like plant height, number of branches per plant, number of leaves per plant, number of flowers per plant, number of fruits per plant and fruits weight influenced by different treatments. Number of branches per plant and number of leaves per plant influenced significantly by different treatments. In this experiment our main limitation was the cultivation of tomato only in pot oriented and the concentration of heavy metals in wastewater was not analyzed. However, there are some plausible inferences that we can draw from the data we have obtained. Considering chemical properties of soil specially soil PH, T2 treatment (100% drain water) results were suitable for cultivation of tomato. From the above discussion, we can say T2 (100% drain water) treatment may one of good source of alternative to irrigation.

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