Effect of grey water application on physicochemical properties of tomato growing soil

Prabhakar DK, Singh AK, Sarkar S, Kumar A and Kumar R

Abstract
A field study was conducted on “Effect of grey water application on physicochemical properties of tomato growing soil” during Rabi season of 2017 at RPCAU, Pusa Farm. Soil samples (0-15cm) were investigated for physical and chemical properties, viz., bulk density, texture, porosity, pH, EC, organic carbon (OC), available nitrogen, phosphorous, potassium, sulphur, boron. Use of grey water significantly improves the soil properties like bulk density, pH, organic carbon, nitrogen, phosphorous, potassium, boron in soil. The concentration of nutrient like N, P, K and B was recorded highest viz. 389.0 kg ha\(^{-1}\), 182.9 kg ha\(^{-1}\), 176.7 kg ha\(^{-1}\) and 0.46 mg kg\(^{-1}\) respectively in 100% grey water applied soil. All chemical parameters and nutrient contents were found higher in grey water than ground water treated soil. Application of grey water can be a good choice for plant nutrient enrichment in farmland.

Keywords: Grey water, soil physical properties, soil chemical properties, tomato growing soil

Introduction
The increasing population, industries and agricultural activities require a great amount of water resulting in depletion of ground water day by day. Hence, farmers are now opting to use grey water in Irrigation of forest trees, agricultural crops and also for other industrial works only after complete processing. India is an agricultural country where water plays important roles. Many of the states of India are always dry such as Rajasthan, Maharashtra etc. In those area of crises, water is delivered by water tank. Agricultural crops are wasted in want of water. Due to the fact farmers tend to commit suicide. India’s cultivation depends on rain. The economic conditions of majority of the farmers are very poor and they cannot afford heavy expenditure on irrigation, large scale tree cutting and improper management of rain water leads water crises. Rain water management are not proper, so whole water directly go into ocean. In this situation, grey water can be a cheap and good alternative source of fulfilling the water demand for irrigation of agricultural crops. Grey water is specifically wash water and is used after complete processing. India is an agricultural country where water in Irrigation of forest trees, agricultural crops and also for other industrial works only after complete processing. India is an agricultural country where water in Irrigation of forest trees, agricultural crops and also for other industrial works only after complete processing. India is an agricultural country where water in Irrigation of forest trees, agricultural crops and also for other industrial works only after complete processing. India is an agricultural country where water in Irrigation of forest trees, agricultural crops and also for other industrial works only after complete processing. India is an agricultural country where water in Irrigation of forest trees, agricultural crops and also for other industrial works only after complete processing. India is an agricultural country where water in Irrigation of forest trees, agricultural crops and also for other industrial works only after complete processing.
Materials and Methods
A short-term experiment study was conducted in an on-going research project under AICRP on IWM at south Panangiri plot of Crop Research Center, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, situated at 25°30’ N latitude, 85°40’ E longitude and 52.00 meter above mean sea level, in sub-tropical humid climate. The soil of the experimental site belongs to order Entisol, suborder Fluvents, great group Ustifluent and is taxonomically characterized as Calcioxerths. The experiment was laid out in a Randomized Block Design (RBD) in three replications by taking different proportion of fresh water and grey water for irrigation purpose into consideration, seven different treatments were made which includes, Irrigation by 100% fresh water (T1), Irrigation by 75% fresh water + 25% grey water(T2), Irrigation by 50% fresh water + 50% grey water(T3), Irrigation by 25% fresh water +75% grey water(T4), Irrigation by 100% grey water(T5), Alternate irrigation by fresh and grey water(T6), Two irrigation by fresh water followed by one grey water(T7). The seeds of tomato crop cultivar were sown in well pulverised raised nursery beds, and 25 days old seedlings were planted. Nutrient like N, P2O5 and K2O were applied in the form of urea, di-ammonium phosphate (DAP) and muriate of potash (MOP). Tomato crops was fertilized @ 120, 80 and 80 kg of N, P2O5 and K2O per hectare, respectively irrespective of the treatments. The crop was grown utilizing the soil moisture and subsequently irrigation was applied at 15days interval by mixing both normal and grey water as mentioned in the treatment details. For control of late blight in tomato Mancozeb @ 2g/liter was applied. Imidacloprid @ 1ml/liter was applied for control of curling activity in the soil due to the increased availability of organic carbon in grey water constituents (Roessner et al. 2006) [11]. Results revealed that highest N content was increased with application of 100% grey water T5 (389.1 kg ha−1) followed by T4 375.2 and T2 255.7 kg ha−1. There were no significant differences in nitrogen has been analysed after harvest of plants for any of the treatments although there was a trend of higher N in soil irrigated with 100% grey water the control. Similar trend of the results were also obtained when lettuce crop were irrigated with grey water as reported by Wiel-Shafran et al. (2006) [14]. This might be due to the fact that detergent and quality of water also affect the amount of N accumulated in soil. Phosphorus of soil was significantly influenced by different grey water application with maximum p content obtained with 100% (T5) followed by 75% grey water in combination with 25% fresh water (T4) followed by T3 50% grey water + 50% fresh water application. Wiel-Shafran et al. (2006) [14] suggested that this accumulation of P in soil is correlated to the concentrations present in the grey water. N and P where also higher in dark grey water application (0.471%) followed by 75% + 25% ground water (T4) and alternate irrigation (T6). The results indicated that higher EC values may be due to because of higher concentration of detergent leading to higher EC of irrigation waters. Similar results were reported by Pinto et al., 2010; Wiel-Shafran et al., 2006 and Anwar, 2011 [14, 2]. Soil organic carbon varied from 0.332 to 0.471% with maximum content in soils treated with 100% grey water application (0.471%) followed by 75% grey water in combination with 25% ground water application (0.380%) are presented in. The results suggested that grey water irrigation would lead to direct effects on soil chemistry, such as elevated pH, excessive salinity, or a build-up of organic compounds, and to indirect effects, most notably the modification of microbial activity in the soil due to the increased availability of organic carbon in grey water constituents (Roessner et al. 2006) [11].

Results and Discussion
Results showed treatment T3 recorded highest bulk density value amongst all the treatments followed by T7, T6, T2, T1, T4, T5 and varied from 39.70 to 48.53% pore space of soil. As percent unit pore space is negatively correlated with bulk density therefore, percent pore space has increased in the treatments having lower bulk density (Anwar, 2011) [2]. All soil samples are characterized as loamy sand type based on proportion of sand, silt and clay. The pH of soil under different grey water treatments ranged between 8.30 and 8.93 (Table 1). It was obvious from the table that soil pH of T5 was found maximum in the plot where received 100% grey water followed by T4 irrigated with 75% grey water in combination with ground water and followed by alternate irrigation with grey and ground water T5 thrice. Similar increase of pH was found by Qishlaqi et al. (2008) [10]. This might be due to the fact that grey water caused higher bicarbonate (HCO3) concentration in soil which could rise the pH. HCO3 raises the pH by causing Ca2+ and Mg2+ ions to form insoluble minerals leaving Na+ ion incomputable in solution (Bauder et al., 2014) [3]. The EC values varied from 0.153 to 0.717 dSm−1 and high EC values were obtained in all the treatments over control, which is considered safe for growth of all crops. It was also observed that 100% grey water (T5) recorded highest EC values among all the treatments followed by 75% + 25% ground water (T4) and alternate irrigation (T6). The results indicated that higher EC values may be due to because of higher concentration of detergent leading to higher EC of irrigation waters. Similar results were reported by Pinto et al., 2010; Wiel-Shafran et al., 2006 and Anwar, 2011 [14, 2].
table indicated that $T_2$ has significantly higher sulphur compare to control ($T_1$). It was noticed that plot receiving 100% grey water yielded lowest sulphur content in the soil. This might be due to the fact that the excess of sulphur added via grey water may result in acidification of the soil may lead to lower content of sulphur in soils treated with 100% grey water. The boron content of soil under different grey water treatments ranged between 0.292 and 0.455 mg/kg. It was observed that plot receiving 100% grey water ($T_5$) showed highest B content followed by $T_1$ and $T_3$. The results indicated that there was significant increase in B content in all the treatment over control. This might be due to presence of various types of shampoos as well as one of the organic hard soaps used in bathroom. The highest level detected was 0.2 mg kg$^{-1}$ in one organic shampoo.

### Conclusion

In general high buildups of nutrients were taken place in soils due to application of grey water in comparison to other nutrients. Bulk density of soil was increased while pore spaces of the soil were decreased with application of grey water. The pH of soil under different grey water treatments ranged from 8.3 to 8.9 and the EC values in all the treatments were lesser than 0.153 dS m$^{-1}$, which is considered safe for growth of all crops. Irrigation with 100% grey water resulted in overall higher concentration of all plant nutrients content in soil. Gray water can be used as efficient resource for plant nutrient supply, which can also help to reduce pollution and improves our soil.

### References