Reclaimed packaged mineral water effluent for growth and yield of *Abelmoschus esculentus* L. under different concentrations

G. Mala, G. Antony Leema Rose, J. Irene Wilsy and M. Reginald Appavoo*

Department of Botany & Research Centre, Scott Christian College (Autonomous) Nagercoil, (Affiliated to Manonmanium Sundaranar University, Tirunelveli), Kanniyakumari- 629 003, Tamil Nadu, India.

Abstract

Agriculture is mostly dependent on rain water and it is affected by some climatic irregularities. Industry releases huge amount of wastewater each day and there is demand for irrigation, the water has not yet been used and the quality of the waste water has not yet been determined whether it is used for irrigation purposes. Recycled water especially industrial effluent can be used in agriculture. The aim of the present study was to evaluate the effluent of Romana mineral water Bottling Factory at different concentrations (control, 20, 40, 60, 80 and 100%) for crop cultivation. The pH of the waste water was nearly about neutral but it contained an enough amount of nitrogen, phosphate, chloride, calcium, carbonates, bicarbonates suspended and dissolved solids when compared with fresh water. Accordingly an experiment was conducted to evaluate the effect of effluent on growth and yield of *Abelmoschus esculentus*(Okra).Different growth parameters such as shoot length, root length, and plant fresh , dry weight was measured.

Key words: *Abelmoschus esculentus* L., Packaged mineral water effluent, Growth parameter , yield.

Introduction

Water is one of the most important components used in all types of industry. Majority of industries are water based and considerable volume of waste water is discharged to the environment either treated or inadequately treated leading to the problem of surface and ground water pollution. An effluent treatment plant is a unit plat where using multiple methods waste water is treated for its reuse or safe disposal to the environment. This process reduces the demand of fresh water while keeping environment clean (Jagatheesan *et al.*,2011).

Agriculture is the major cornerstone for the economic development of India. Agricultural production that depends on rain is mostly aimed at self-provision and this kind of production system is severely affected by climatic irregularities. To alleviate the recurrent drought problems, the appropriate management and utilization of water resource is paramount importance. An effective method to reduce vulnerability of climatic irregularities is to use irrigation for the agricultural production Rahmato, 1999.

Agriculture in India is dependent on rainfall but; the required amount is not available at the right time for effective crop production. Therefore, sustainable solution for such problems necessitates an integrated management of available water resources (Shomar *et al*., 2014.). The reuse of waste water, especially Industrial effluent, in agriculture should be an integral component of the strategy. However, without proper management, based on knowledge of the possible harmful effects to plants and soils, prolonged use of such water will be challenging (Huma *et al.,* 2012). Therefore, it will be beneficial to study possible impacts of the effluent before recommending for irrigation (Thamizhiniyan *et al* ., 2009). After assessment of the beneficial and harmful effect of the effluent on crops at different concentration. In this present study, attempt has been made to identify the effect of romana distilleries industry effluent on growth of *Abelmoschus esculentus*.

MATERIALS AND METHODS

Collection of water sample

The effluents were collected in plastic cans from the effluent discharging point of packaged drinking water, Romana distillery industries, Kodamadi. Packaged drinking water was analyzed for different physicochemical parameters such as total solids (TS), total suspended solids (TSS), total dissolved solids (TDS), BOD (Winkler`s method), COD (Winkler`s method), Bicarbonate content, Hardness of water (EDTA titration methods), Calcium, Chloride (Van Slyke method) and phosphates (Fiske Subbarrow method), were estimated using standard methods laid down in APHA (2005).

Collection of seeds

Commercially available lady´s finger seeds (*Abelmoschus esculentus* L.) were obtained from the Agricultural department, Kallakad.

Seed sterilization: Procedure

The seeds were first washed with tap water and then surface sterilized with 0.1% mercuric chloride for 30 seconds. It was then washed several times with sterile distilled water to remove any trace mercuric chloride (Sasikala and Poongodi).

Effluent treatment

The seeds were soaked in the corresponding effluent (diluted) sample for 30 minutes. The experiment was conducted using different concentrations such as 20%, 40%, 60%, 80%, 100% and control pot without effluent treatment.

Growth Parameters

The shoot lengths (cm) of the seedlings were recorded from the tenth day after the emergence of third leaf onwards. Fresh and dry weight (mg) shoot and root length (cm) of the seedlings were determined after 10 days. The seedlings were uprooted and washed thoroughly with distilled water and length of shoot and root length were measured. The fresh weight was taken, and the plants were then packed in paper envelops and oven dried for 36 hours at 70ºC. The dry weight of the seedlings and was also recorded (Sasikala and Poongodi 2013).

Yield

Abelmoschus esculentus fruits were collected in every 2 days by multiple harvesting from 45th day to 55th day. Yield was the mean value of 10 days.

RESULTS AND DISCUSSION

Physico – chemical parameter

The physico-chemical parameters of packaged drinking water are presented in the Table 1. The present investigation the color of the packaged drinking water effluent was found to be almost clear. Color is a very important factor of the aquatic life for making food from sunlight. Thus, photosynthetic activity reduced due to dark coloration and aquatic ecosystem is totally changed. Color also affects the other parameters like temperature, BOD etc. Temperature is important for its effects on certain chemical and biological reactions taking place in water and in organisms inhabiting aquatic media and will depend upon seasons and time of sampling. No specific limit for temperature is prescribed by WHO for the water quality use for the domestic purpose. In the present investigation the temperature of the effluent was found to be 28°C.pH of the packaged drinking water effluent was found to be slightly alkaline i.e., 7.10. From the past studies it is concluded that free CO2 in the water is partly responsible for the increased or initial pH reading (Park, 1997).

Table No.1: Physico - chemical characteristics of packaged drinking water effluent

S.No	Parameters	Values
1	Colour	Almost clear
2	Odour	Un detectable
3	PH	7.10
4	Electic conductivity dS/m	0.28
5	Temperature(˚c)	28
6	Total solids(mg/l)	790
7	Total dissolved solids(mg/l)	750
8	Total suspended solids(mg/l)	40
9	Calcium (mg/l)	13
10	Chloride (mg/l)	0.80
11	Phosphate (mg/l)	0.88
12	BOD (mg/l)	34.3
13	COD(mg/l)	85

14	Bicarbonate content (m.e/l)	2
15	Hardness (mg/l)	25

The average values of various physico-chemical characteristics of the jute mill waste water exhibited high chemical oxygen demand (85mg/l), total dissolved solids (750 mg/l), chloride (0.80 mg/l) and Bicarbonate (2 m.e/l). In this study, packaged drinking water had no negative effect on seed germination of okra. Polluted water does not inhibit seedling germination and growth at low concentration (Panasker, 2011). However, several researchers reported heavily polluted wastewaters will affect both germination and growth of seedlings (Nagda,2006).The present investigation revealed that the effluent of Packaged drinking water bottling factory, both diluted and undiluted, has no effect on germination of *Abelmoschus esculentus*.

Growth parameter

In pot culture experiment, The root length of okra as influenced by different concentrations of wastewater are presented in table 2. The result revealed that the root length of okra was positively affected by different concentrations of effluent at all growth stages. The highest root length of 8.13, 23.5, 25 and 28 were recorded in 80% concentration of effluent treatment and the lowest recordings of (6, 21.2, 23.1 and 24.3) were obtained in control groups on days 10, 20, 30, and 40 respectively. The effluent had positive effect on development of roots and root length values were recorded in all the effluent treatments over control. The minimum mean root length value (24.3cm) was noted in control irrigated crops. The promotion of seedling growth may be due to the presence of plant nutrient in the effluent (Dhanam, 2009). On the 10^{th} , 20^{th} , 30^{th} and 40 day after planting mineral water effluent treated plants showed a maximum shoot length of 9.10 , 24.6, 39.5 and 49.6 cm in the 80% concentration but reduced in higher concentration of the effluents. Mineral water factory effluent beneficial effects on stem growth. This might be due to the availability of nitrogen, which plays an important role and stimulates the growth of stem and other essential nutrients like Ca, Mg and P in the wastewater (Khan,2003).

Table 2.Growth parameters of *Abelmoschus esculentus* L.treated with mineral water effluent

Sl.No	Parameters	Effluent concentration	10 days	20 days	30 days	40 days
1	Root length (cm/plant)	Control	6 ± 0.32	21.2 ± 0.15	23.1 ± 0.58	24.3 ± 0.66
		20%	6.2 ± 0.20	22.8 ± 0.99	23.5 ± 0.20	25.2 ± 0.08
		40%	7 ± 0.66	23.2 ± 0.02	23.9 ± 0.04	25.1 ± 0.29
		60%	7.5 ± 0.20	23.4 ± 0. 42	24.3 ± 0.24	25.4 ± 0.16
		80%	8.13 ± 0.15	23.5 ± 0.15	25 ± 0.30	28 ± 0.29
		100%	6.1 ± 0.11	22.9 ± 0.20	23.8 ± 0.52	25 ± 0.21
2	Shoot length (cm/plant)	Control	5.6± 0.20	20.2 ± 0.16	30.1 ± 0.16	40.2 ± 0.17
		20%	5.9 ± 0.37	22.5 ± 0.12	32.8 ± 0.09	41.3 ± 0.15
		40%	6.9 ± 0.11	23 ± 0.99	34.3 ± 0.02	42.8 ± 0.20
		60%	7.3 ± 0.15	23.2 ± 0.25	35.5 ± 0.32	45.6 ± 0.04
		80%	9.10 ± 0.30	24.6 ± 0.04	39.5 ± 0.29	49.6 ± 0.66
		100%	6.3 ± 0.15	22.5 ± 0.15	31.9 ± 0.20	42.3 ± 0.02

Fresh weight and dry weight

Fresh weight and dry weight of *Abelmoschus esculentus* L.treated with mineral water effluent treatment as shown in (Table 3). Fresh and dry weight of *Abelmoschus esculentus* crop was recorded maximum in 80% concentration of effluent The highest fresh weight value was 26.3 and dry weight value was 17.1 as compared to those in the other treatments was due to the beneficial effect of wastewater. Application of effluent produced a strong nutrient effect influencing growth and productivity of the seedlings. Greater biomass in the seedlings of effluent treatment than in the tap water irrigated crops (control) could be due to increased concentration of the available PO4- -P and K in the effluent (Gholami and S. Srikantaswamy,2009).

Table 3.Fresh weight and dry weight of *Abelmoschus esculentus* L.treated with mineral water effluent

Sl.No	Parameters	Effluent concentration	10 days	20 days	30 days	40 days
1	Fresh weight(g)	Control	0.89 ± 0.16	3.56 ± 0.16	14.5 ± 0.20	43.5± 0.15
		20%	0.91 ± 0.12	3.64 ± 0.12	15.1 ± 0.20	45 ±0.15
		40%	0.93 ± 0.29	3.65 ±0.32	15.3 ± 0.12	50.3 ± 0.05
		60%	0.99 ± 0.29	3.96 ± 0.15	15.6 ± 0.04	52.2 ± 0.12
		80%	1.2 ± 0.08	4.8 ± 0.99	16.5 ± 0.02	55.8 ± 0.02
		100%	0.92 ±0.08	3.63 ±0.09	14.3 ± 0.66	42.3 ± 0.18
2	Dry weight (g)	Control	0.17 ± 0.37	0.68 ± 0.16	2.72 ± 0.32	10.8 ± 0.15
		20%	0.19 ± 0.05	0.76 ± 0.32	3.04 ± 0.99	12.8 ± 0.09
		40%	0.20 ± 0.12	0.82 ± 0.16	3.28 ± 0.15	13.2 ± 0.04
		60%	0.25 ± 0.20	0.98 ± 0.08	3.92 ± 0.29	15.7 ± 0.11
		80%	0.29 ± 0.32	1.1 ± 0.29	4.3 ± 0.66	17.1 ± 0.16
		100%	0.18 ± 0.16	0.63 ± 30	3.71 ± 0.02	10.5 ± 0.29

Yield

The number of pods per plant with different concentrations of effluent are presented in Figure 4. It was increased as the applied concentration until 80% after which the number of pods started to decrease however it was still higher than control. The maximum and minimum number of pods 20 was recorded in 80% and control 9 pods respectively. In 80% concentration numbers of fruit were high. In 80% concentration the average fruit weight was 1.800 kg ± 0.43 gm. Vijayakumari (2005) reported the impact of textile dyeing industry effluent on the growth parameters of *Eleusine coracana*. Similar observation, increased height, growth and yield of pulse crops, irrigated with distillery spent wash effluent were reported by Chandraju,2008.

Table 4. Effects of mineral water effluent treated with *Abelmoschus esculentus* L. yield

Effluent concentration	Yield (kg)
Control	0.500
20%	0.800
40%	1.100
60%	1.500
80%	1.800
100%	0.750

Conclusion

The results of present study revealed that the physicochemical characteristics of industrial effluent to be reach a source of essential plant nutrients like N, P, K, Mg and Ca. *Abelmoschus esculentus* irrigated with mineral water industrial effluent gave a better biomass and yield over the control groups irrigated with tapwater. Maximum growth is found in 80% concentration of effluent and minimum growth in control. It was concluded that, irrigation of *Abelmoschus esculentus* with the packaged drinking water factory effluent could fulfill the fertilizer requirements of crop and can increase crop yield and may lead to an economic advantage over regular water irrigation.

References

APHA. Standard methods for the examination of water and waste water 21st Ed. Washington, D.C; 2005.

B. Shomar, M. Darwish, and C. Rowell. "What does integrated water resources management from local to global perspective mean? Qatar as a case study, the very rich country with no water," Water resources management, vol. 28, no.10, pp. 2781-2791, 2014.

D .B. Panasker and R.S. Pawar " Effect of textile mill effluent on growth of Vigna unguiculata and Pisum sativum seedlings," Indian Journal of Science and Technology, vol. 4, pp. 266 –272, 2011.

D. Rahmato. "Water resource development in Ethiopia," Issues of sustainability and participation. Forum for social studies Addis Ababa, Ethiopia. 1999

Dhanam S. Effect of Dairy Effluent on Seed Germination, Seedling Growth and Biochemical Parameter in Paddy. Botany Research International 2009; 2(2):61-63.

G. K. Nagda, A.M. Diwan and V.S. Ghole. "Seed germination bioassays to assess toxicity of molasses fermentation based bulk drug industry effluent," Electronic Journal of Environmental, Agricultural and Food Chemistry, vol. 5, pp.1598–1603, 2006

Jagatheesan, V. Shu,L. Visvanathan,C.(2011), "Aquaculture effluent : Impacts and remedies for protecting the environment and human health". Encyclopedia of environmental health, Elsevier,pp. 123 -135.

N.A. Khan, L. Gupta, S. Javid, S. Singh, M. Khan, and A. Inam. "Effects of sewage waste water on morphophysiology and yield of Spinacia and Trigonella," Indian journal of plant physiology, vol. 8, no.1, pp. 74-78, 2003

P. K. Goel and S. M.Kulkarni. "Effects of Sugar Factory Waste on Germination of Gram Seed (Ciceraeritinum L," International Journal of Environment and Pollution, vol. 1, no.1, pp.35-53, 1994

P. Thamizhiniyan, P.V. Sivakumar, M. Lenin, and M. Sivaraman. "Sugar mill effluent toxicity in crop plants," Journal of Phytology, vol .1, no.2, pp. 68–74, 2009.

S. Chandraju, H.C. Basavaraju, and C.C. Kumar. "Investigation of impact of irrigation of distillery spentwash on the nutrients of pulses," Asian Journal of Chemistry, vol. 20, no.8, p. 6342, 2008.

S. Gholami and S. Srikantaswamy .“Analysis of agricultural impact on the Cauvery river water around KRS dam,” World Appl Sci J, vol. 6, no.8, pp. 1157-1169, 2009.

Sasikala T and Poongodi N (2013). Impact of dye effluent on seed germination of black gram (VignamungoI hepper), Indian journal of applied research, 3(8): 2249-555x.

Z. Huma, N. Shahida, R. Abdur, U. Asad and K. Inayat. “Effects of domestic and industrial waste water on,” Current Opinion in Agriculture, Vol. 1, no.1, pp. 27–30, 2012