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Full Length Research Paper

Influence of untreated and bacterial-treated Yamuna water on the plant growth of *Zea mays* L.

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In present study an attempt has been made to study the pollution level of river Yamuna at Agra, by analyzing the physico-chemical parameters of untreated and bacterial-treated water and its effect on the growth of maize plant. Among different concentrations (25, 50, 75 and 100%) of treated water, the 100% concentration of treated water sample showed good effect on the plant growth over untreated sample and control.

Key words: Bioremediation, bacterial consortium, germination percentage, plant growth, *Zea mays*.

INTRODUCTION

River Yamuna is one of the most polluted rivers in the world. Industrial and domestic sewage contribute to the extent of 85% of the total pollution load. This water is unfit for drinking, swimming and fisheries (Shrivastava et al., 2001). Some factories have its own effluent treatment plant and oxidation pond. Effluent after treatment is discharged into the river. Some cultivators use the treated effluent for irrigation fields and grow vegetables and crop plant (Berman et al., 2001). Treatment methods for waste water which are being used in the industries are chemical coagulation, flocculation, sedimentation, floatation, filtration and other biological methods like activated sludge process, trickling filters, stabilization pond, anaerobic digestion and laggoning etc. This effluent treatment plants require high capital and operational cost (Bishnoi et al., 2006). Biological processes are more economical and eco-friendly than advance waste water treatment due to its low running and maintenance cost. It has been established that major contaminants in the waste water includes biodegradable organics, volatile organic compounds, toxic heavy metals, recalcitrant, suspended solids and nutrients (Metcaff and Eddy, 1991). Also, it is well known that the urban organic matter is easily biodegradable (Sharma et al., 2002). Thus the aim of environmental engineers and microbiologists should be to reduce the organic contents such treated water can be used in irrigation purpose.

In view of this, the present investigation was undertaken to evaluate the biodegradation of Yamuna river water after treatment with bacterial consortium and the potential effect of untreated and treated Yamuna river water on the growth of maize (*Zea mays* L.) was also studied.

MATERIALS AND METHODS

Collection and physico-chemical analysis of Yamuna water

The Yamuna water was collected in sterilized plastic container in a stretch of 1.5 km from Taj Mahal, Agra. Immediately after collection, the water sample was brought to the laboratory and stored at 4°C in a refrigerator until analyses of its physico-chemical properties and further use. The physico-chemical analysis was performed by standard procedure (APHA, 1998).

Isolation and identification of bacterial cultures

Total numbers of 10 water samples were randomly collected from different sources. The bacterial cultures were isolated by serial dilution agar plate technique (Aneja, 2001) and then these cultures were streaked on nutrient agar medium and stored at 4°C in refrigerator. The isolated bacterial cultures (*Rhodopseudomonas* palustrid MTCC- 8756, *Rhodobacter* sp., *Nitrobacter* sp., *Lactobacillus* sp., *Cellulo-monas* sp. and *Bacillus subtilis* MTCC-8114) were identified on the basis of Bergey's Manual of Systematic Bacteriolo-

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Table 1. Physico-chemical characteristics of Yamuna water.

Characteristics	ISI Standards of Irrigation	Untreated water sample	Treated water sample
Colour	Colourless	Light green	Colourless
pH	5.5 – 9.0	8.3	7.0
Turbidity (NTU)	-	60	20
Total Dissolved solid (TDS; mg/L)	2100	2256.0	1220.0
DO (mg/L)	-	10.5	9.6
BOD (mg/L)	30.0	35.0	10.6
COD (mg/L)	250	160.0	45.6
Organic carbon (mg/L)	-	54.0	16.2
Ammonical nitrogen (mg/L)	50	10.4	4.7

NTU = Nephelometric Turbidity Unit.

gy (Claus and Berkley, 1986). The bacterial cultures were deposited to Microbial Type Culture Collection (MTCC), Chandigarh, India.

In the experiment, the TSB broth was prepared for the inoculation of bacterial cultures. 5% of stock culture of bacterial consortium was used for the inoculation of sterilized water sample and this water sample was incubated at 37°C for 5 days of incubation. The different concentration (25, 50, 75 and 100%) of this treated water was used in the treatment process.

Effect of untreated and treated Yamuna water on the growth of maize plant

To study the effect of Yamuna water on plant growth, thirty pots (20 x 16 cm) were filled with equal amount of approximately 2.0 kg of garden lawn soil. Seeds were sterilized by 1% mercuric chloride solution for 2 – 3 min. After washing with distilled water, the seeds were soaked in different concentration of untreated and treated Yamuna water for 24 h. Then 10 seeds were sown in each pot. The pots were irrigated with different concentration of untreated and treated water. The pots were irrigated at a fix time interval through the study period. The pots which were irrigated by sterilized distilled water, served as control. The experiments were also run in triplicate. Pots were placed in field (Chandra et al., 2004).

Germination of seeds was recorded daily at fix time interval. After 45 days, three plants were thinned out from each set and washed thrice by sterilized distilled water. Root and shoot length were measured. Biomass of plant was determined by dry weight method (APHA, 1998). After harvesting the plant root, shoot and leaves were separated and dried at 65°C in hot air oven for 48 h. The difference of fresh weight and dry weight was recorded as biomass of plant. Leaf area and plant height were measured. The data were statistically analyzed (Elhance et al., 2002).

RESULTS AND DISCUSSION

Physico-chemical characteristics of untreated and treated Yamuna water

The physico-chemical characteristics of untreated and bacterial-treated Yamuna water are recorded in Table 1. The untreated water sample was light green in colour, slight alkaline (pH-8.3) in nature with high turbidity (60.0 NTU), TDS (2056 mg/L), DO (10.5 mg/L), BOD (30.0 mg/L), COD (160.0 mg/L), organic carbon (54.0 mg/L) and ammonical nitrogen (10.4 mg/L). The alkaline nature of Yamuna water may be due to presence of Ca and Mg ions in high concentrations. The TDS, BOD, COD and organic carbon were higher in the untreated water indicating the presence of high content of organic matter. After treatment with bacterial consortium, all the parameters were showed sharp reduction; colourless, neutral in nature (pH 7.0), lower turbidity (20.0 NTU), TDS (1220.0 mg/L) DO (9.6 mg/L), BOD (10.6 mg/L), COD (45.6 mg/L), organic carbon (16.2 mg/L) and nitrogen (4.7 mg/L). The results are agreed with the report of Ayyasamy et al. (2002) who observed the reduction in physico-chemical parameters of Sago factory effluent after degradation by aerobic microbial consortium.

Effect of untreated and treated Yamuna water on the growth of maize plant

The exposure of different concentration of untreated water on seed germination and other plant growth parameters are depicted in Table 2. The maximum seed germination and other plant growth parameters were recorded at 100% and minimum at 25% concentration as compared to control. In most cases, all the growth parameters were gradually increased with increasing the concentration of the treated water. All the growth parameters showed slightly higher growth at 100% concentration of untreated water over the control. This observation revealed that the untreated water significantly influenced the growth of plant. Similar results was observed by Ulamen et al. (2006) who studied the effect of pharmaceuticals effluent on the growth of maize and observed that 100% concentration of this effluent showed good results on the growth of maize plant. Robert et al. (2005) also reported similar results with brewery effluent. The effect of bacterial-treated Yamuna water on the growth of maize plant is presented in Table 3. It was observed that higher concentration of bacterial-treated water showed the most stimulatory effect on plant growth. The maximum plant growth was found at 100% and minimum at

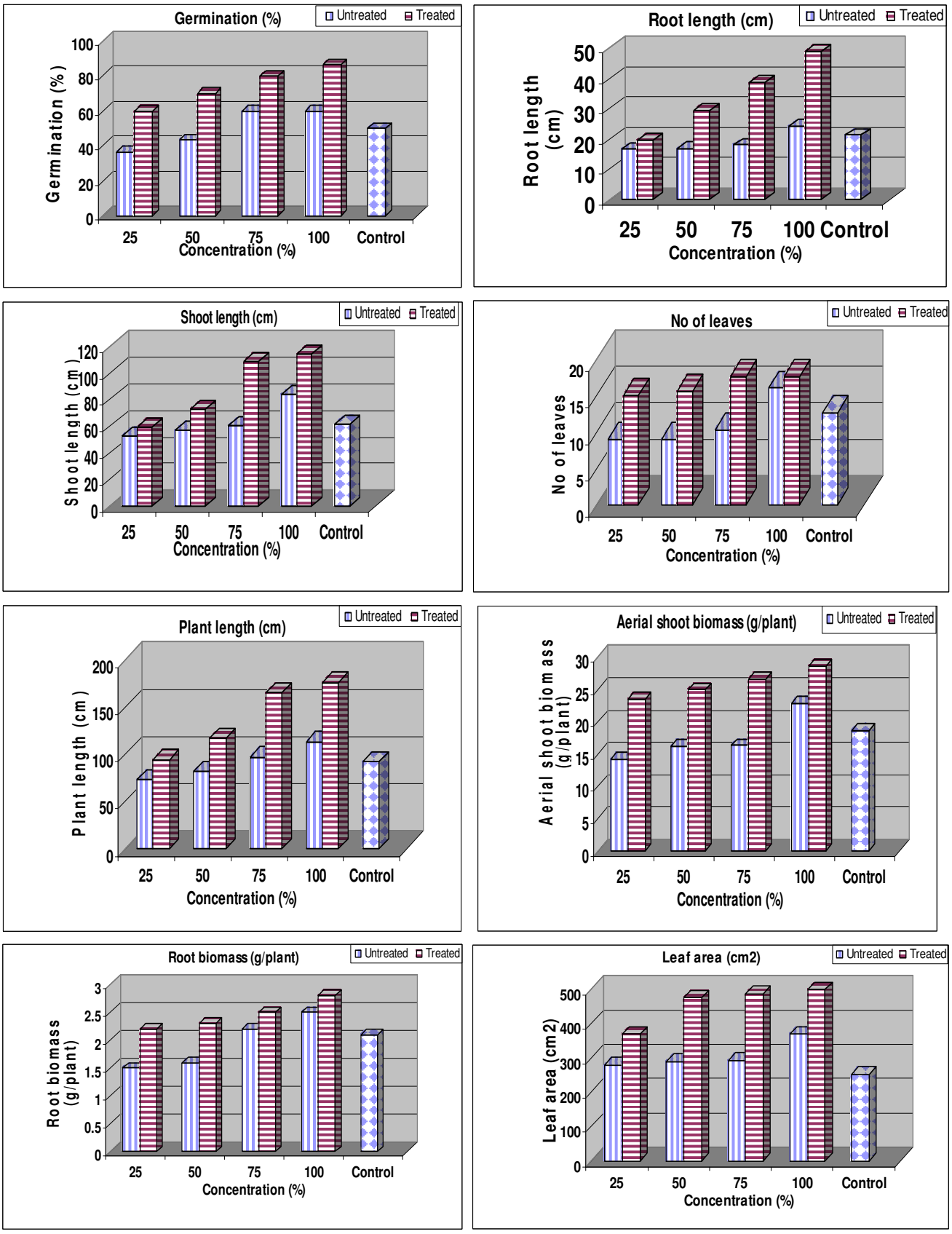

Figure 1. Effect of different concentrations of untreated and treated Yamuna river water on the growth of *Zea mays* L.

Table 2. Effect of different concentration of untreated Yamuna water on the growth of *Zea mays* L.

Concentration (%)	Germination (%)	Root length (cm)	Shoot length (cm)	No. of leaves	Plant length (cm)	Aerial shoot biomass (g/plant)	Root biomass (g/plant)	Leaf area (cm^2)
25	36.6	16.6	52.0	9.0	73.3	14.2	1.56	278.3
50	43.3	17.00	57.0	9.0	82.0	16.2	1.65	288.3
75	60.0	18.00	60.6	10.3	97.0	16.36	2.22	293.8
100	60.0	24.3	83.3	16.0	113.0	22.8	2.50	369.3
Control	50.0	21.3	61.0	12.6	92.2	18.72	2.12	250.66
CD at 5%	15.7	3.04	2.62	1.73	3.98	3.16	0.20	20.7
F-value	4.41*	12.32*	211.05*	23.56*	152.7*	11.60*	43.64*	47.94*

All the values are the mean of triplicate; * = Significant.

Table 3. Effect of different concentration of treated Yamuna water on the growth of *Zea mays* L.

Concentration (%)	Germination (%)	Root length (cm)	Shoot length (cm)	No. of leaves	Plant length (cm)	Aerial shoot biomass (g/plant)	Root biomass (g/plant)	Leaf area (cm^2)
25	60.0	19.6	58.6	15.0	94.0	23.5	2.23	370.0
50	70.0	29.66	72.0	15.6	117.6	25.0	2.37	475.3
75	80.0	38.66	108.0	17.6	165.0	26.6	2.57	486.6
100	86.6	49.0	114.0	17.6	176.3	28.6	2.86	499.0
Control	50.0	21.3	61.0	12.6	92.2	18.72	2.12	250.66
CD at 5%	15.76	4.87	9.8	1.34	5.24	1.41	0.37	5.99
F-value	9.16*	66.05*	75.47*	25.80*	596.34*	72.90*	6.35*	3287.31*

All the values are the mean of triplicate; * = Significant.

25% concentration over control (Figure 1). In most cases also, all the growth parameters were gradually increased with increasing the concentration of the treated water.

Conclusion

The experimental findings suggest that the maximum germination and all the plant growth parameters can be achieved with 100% concentration of bacterial-treated water sample. The observation revealed that the inoculation of the bacterial consortium in water may release the nutrients through biodegradation of the organic /inorganic matter of water sources, which promote the plant growth. Some studies have shown that the inoculation of agro-ecosystem with effective micro-organism cultures can improve the soil fertility and crop quality (Hussain et al., 1999; Khaliq et al., 2006). Therefore distinct benefits may be achieved with the application of bacterial consortium to yield high crop productivity. However, more intensive and systematic studies are required to provide a better understanding of the usefulness of bacterial consortium and waste water resources in crop production.

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