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QUALITY MEASUREMENTS OF VARIOUS TYPES OF WASTEWATERS AND THEIR IMPACTS ON PLANT GROWTH

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Abstract

Wastewater is a rich source of essential nutrients for growth of plants. But accumulation of heavy metals restrict the uptake of nutrients that leads to the deficiency of nutrients in plant body and ultimately reduce its growth. In present study, different types of wastewaters from the Malir (Domestic and Industrial wastewater) and Lyari river were collected and analyzed to evaluate their quality. The effect of wastewater assessed on germination and growth parameters of *Abelmoschus esculentus* (Okra) and *Phaseolus vulgaris* (Common Beans). It was evaluated that pH and dissolved oxygen were detected to be under permissible limit of World Health Organization water-quality-standards in DWW (Domestic wastewater) and LWW (Lyari wastewater). Higher amounts of essential nutrients such as Ca, K and Mg were perceived in DWW. Consequently DWW and LWW significantly improved the germination (%) and growth of *A. esculentus* and *P. vulgaris*. IWW (industrial wastewater) and mix wastewater (combination of DWW and IWW) reduced germination (%) as well as growth of crops. Higher amount of as and Cd were detected in IWW. Thus, it might be due to their increased concentrations that effected plant growth. However, plant growth depends on quality of applied water as well as variety of crop that tolerate their characteristics.

Key words: Quality of wastewaters, Common Beans, Okra, Germination %, Plant growth.

Introduction

Various countries of the world utilize treated wastewater to irrigate the crop (Pedrero *et al.*, 2010; Barbagallo *et al.*, 2014; La Bella *et al.*, 2016). More than 20 million hectares of the land all over the world is irrigated with wastewater (Abaidoo *et al.*, 2010). Since farmers are compulsive to utilize wastewater in those regions where fresh water is less available to irrigate agriculture land. According to WHO (2006) and Hamilton *et al.*, (2006) approximately 10% of the world's population consumes crops irrigated with wastewater.

Domestic and industrial wastewater are either disposed-off or utilized for the irrigation of agriculture land which build opportunities and problems as well. The composition of domestic and industrial water varies from each other (Mitra & Gupta, 1999; Antil, 2012) such as large amount of organic matter present in domestic water whereas industrial water contains toxic materials. Thus, Wastewater from domestic and municipal resources creates opportunities for farmers to utilize for crop irrigation as it contains organic matter and rich in macro and micronutrients (Feigin *et al.*, 1991; Pescod, 1992; Gupta *et al.*, 1998; Brar *et al.*, 2000). In consequence, Wastewater has both advantages and disadvantages for irrigation. Advantages like it improves the yield, recycles the organic matter/nutrients, decreases the fertilizer amount/cost, evades the pollution from the surface of water bodies, enhance the economic efficiency and preserves the freshwater sources (Khaleel *et al.*, 2013). Whereas, it has also some disadvantages like storage capacity, careful planning, diseases caused by pathogens, availability of toxic material that pollute the ground water (Peña *et al.*, 2014). Hence, nature of the wastewater is subjected by its source from where it is produced.

Pakistan is a developing country which produces a large extent of untreated wastewaters from industries as well as domestics. Due to the scarcity of fresh water, farmers are compulsive to utilize wastewater for irrigation land. On the other hand, wastewater is a rich source of organic matters and essential nutrients of plant growth (Khadhar *et al.*, 2010; Haddaoui *et al.*, 2016). Thus, it is not only alternate of fresh water but also replace the harmful chemical fertilizers of plants. However, sustained and continued utilization of wastewater become toxic to plant growth as well as soil nature (Adriano, 1986; Ghafoor *et al.*, 2004; Qadir & Oster, 2004) as it contains heavy metals and other harmful chemicals.

Plant body performs various metabolic processes such as germination, photosynthesis, respiration, plant-water relation and mineral uptake etc. For the enactment of these activities, macro and micro-nutrients are vital for the body of plant. Macro-nutrients like Potassium, Calcium, Magnesium etc. are essential for growth of plant on large scale. Whereas, micro-nutrients are needed for plant in little amount. However, large amount of these elements in irrigation water act as toxic metals for plant body such as Iron, Zinc, Copper, Cadmium etc. Heavy metals in wastewater induces abiotic stress on plant growth and decrease leaf expansion that leads to the minimum performance of photosynthesis (Shah *et al.*, 2013; Divyapriya *et al.*, 2014). Due to high amount of other harmful chemical in irrigation water, plant germination, growth, root elongation and other developmental phases are adversely affected (Salem *et al.*, 2015, Pan & Chu, 2016).

The main purpose of this study is to evaluate the quality of wastewater collected from Malir and Lyari rivers (wastewater channels) and theirs effects on germination and plant growth.

Materials and Methods

Rivers of Malir and Lyari are the major reservoirs of wastewater in the city of Karachi, Pakistan. They contain discharged wastewater of nearby various industries, factories, domestics etc. The sites were selected where crops were growing by utilizing wastewater of these rivers for irrigation.

Wastewater samples from the Malir river (Domestic and Industrial wastewater) located at Quaidabad and Lyari river nearby Gulshan Chowrangi, Karachi (Fig. 1) were collected for determining its quality and effect on seed germination and plant growth. Physiochemical analysis (like Electric Conductivity, pH, Total Dissolved Solids, salinity and Oxidation Reduction Potential) of water samples was carried out by using Hanna Multi parameter meter model HI9828. While, alkalinity, Total Suspended Solids (TSS), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were analyzed through standard methods (Anon., 1998). The measurements of essential nutrients (Ca, K and Mg) and metals like As, Cd, Cu, Fe, Ni, Pb and Zn were recorded by Flame Atomic Absorption Spectrophotometer (FAAS) PE-AAnalyst 700. Using appropriate drift blanks the amount of metals were determined and external calibration was used for quantitative analysis of metals.

Petriplate experiment was designed to determine the effect of various wastewaters such as domestic wastewater (DWW), industrial wastewater (IWW), wastewater of Lyari river (LWW) and mix wastewater of DWW and IWW from Malir river on germination of seeds of different crops e.g. *Abelmoschus esculentus* and *Phaseolus vulgaris*. Surface sterilized seeds were placed on double layered filter paper laying in petriplates (9 cm) and moistened by 2 mL of respective wastewater. Each treatment were replicated with three plates. With the comparison of wastewater treatments, distilled water were used as control. Number of seeds were examine to germinate on daily basis at average temperature of day time 30°C and night 27°C. After 10 days, germination percentage (%) were calculated by following formula (Anon., 1999):

$$\text{Germination \%} = \frac{\text{No. of seeds germinated}}{\text{Total no. of seeds}} \times 100$$

Length of root, shoot and fresh biomass of seedlings were measured after 10 days of germination. While, dry biomass were recorded after oven drying of seedlings at 60°C.

Dependency of all quality-parameters of wastewaters with each other was determined through Pearson correlation coefficient and statistics on germination percentage and growth parameters of both crops were carried out through analysis of variance (ANOVA) by SPSS 20.

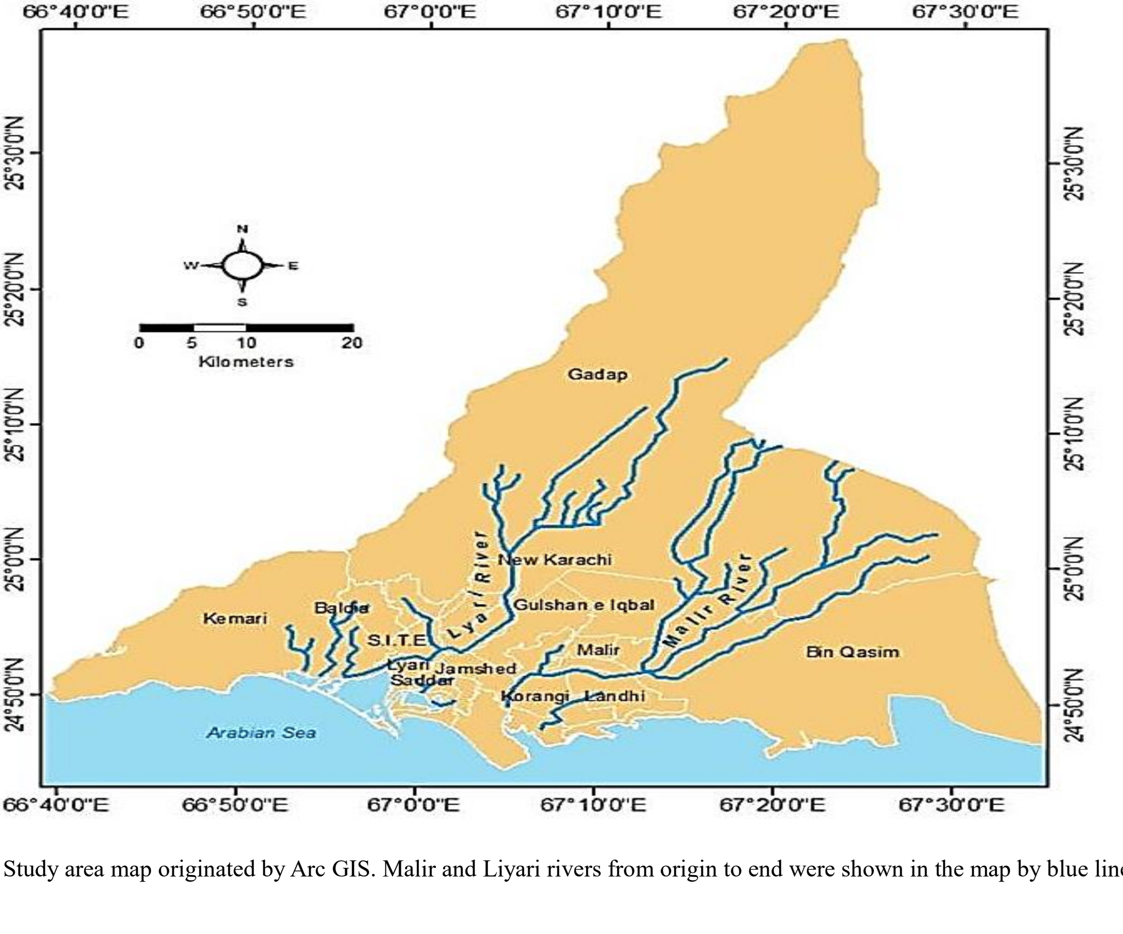


Fig. 1. Study area map originated by Arc GIS. Malir and Liyari rivers from origin to end were shown in the map by blue lines.

Results

The measures of all physio-chemical parameters with permissible limit of WHO water quality standards have been shown in Fig. 2. The highest amounts of EC, TSS, alkalinity and BOD, COD were found in all types of wastewaters then acceptable limits of WHO standards (Figs. 2 and 3). pH of DWW and LWW had been detected permissible in limit (8.0) whereas IWW was much higher in pH value than WHO standard value (10.2). IWW had higher rate of ORP (310.6 mV) and salinity (3.92 %) then DWW and LWW while DO in all the wastewater samples was very lower than the permissible limit of WHO standard (9.2 mg/L). TDS was found limited only in DWW (940 mg/L) as compared to other wastewaters as shown in Fig. 2.

Amount of potassium was found higher in DWW (18.07 mg/L) and IWW (18.02 mg/L) as compared to the LWW (5.295 mg/L) whereas lowest amount of magnesium have been detected in IWW (5.631 mg/L) and LWW (5.046 mg/L). Highest rate of calcium was present in DWW (67.53 mg/L) than LWW (17.77 mg/L), while IWW had lesser quantity of calcium (8.567 mg/L).

With the comparison of WHO water quality standards, heavy metals like copper, nickel and zinc were found lower than the permissible limits in all types of wastewater samples (Table 2). Whereas, Fe and Pb found below the detection limit. Arsenic was greater in IWW (0.422 mg/L) than the WHO standard value (0.01 mg/L) but with the comparison of NEQS As was under the limit, while LWW had the amount of As less than the detection limit. In case of cadmium, higher amount have been detected in IWW (0.004 mg/L) as compared to DWW (0.003 mg/L) and LWW (0.002 mg/L) that had permissible limit of cadmium.

The pearson correlation among physiochemical measures, essential nutrients and heavy metals in all forms of wastewaters have been shown in (Table 3). on their significance level. Among all variables, significant correlation of pH was found with ORP (r = 1.000, $p<0.05$) and alkalinity (r = 0.998, $p<0.05$). EC was highly significant with TDS (r = 1.000, $p<0.01$) whereas correlation of salinity found significant to the TSS (r = 0.997, $p<0.05$). ORP and alkalinity observed to be significant at r = 0.999, $p<0.05$. COD was negatively correlated with Mg (r = -0.999, $p<0.05$), although, correlation of K was negative with Cu and Zn (r = -1.000, $p<0.01$). However, highly significant correlation of Cu and Zn was perceived at r = 1.000, $p<0.01$.

The present study showed significant effects of wastewaters on seed germination of *A. esculentus* (F = 3.769, $p<0.040$) as well as *P. vulgaris* (F = 5.700, $p<0.012$). It is evaluated that DWW and LWW significantly induced the germination of both crops as it is shown in table 4. Whereas application of IWW decreased the germination percentage of *A. esculentus* (26.67 ± 6.66%) and *P. vulgaris* (66.67 ± 0.882%). Mix water found to be similar as control on *A. esculentus* (53.33 ± 17.63%) however it declined the germination of *P. vulgaris* (66.67 ± 6.66 %) than control (73.33 ± 6.66%).

All types of wastewaters significantly influenced on the length of root (F = 12.833, $p<0.001$) and shoot (F = 10.002, $p<0.003$) in *A. esculentus* as well as on the root (F = 5.394, $p<0.017$) and shoot length (F = 10.865, $p<0.002$) of *P. vulgaris*. With the comparison of control (tap water), the application of DWW and LWW remarkably increased the root and shoot length of *A. esculentus* and *P. vulgaris* as shown in table 4. Whereas, IWW severely reduced the length of plant of both crops. Mix water did not show any effect on the root length of *A. esculentus* (3.708 ± 0.542 cm), however, it enhanced the length of shoot (4.813 ± 0.688 cm). Although, root and shoot length of *P. vulgaris* became negatively affected by Mix water (Table 4).

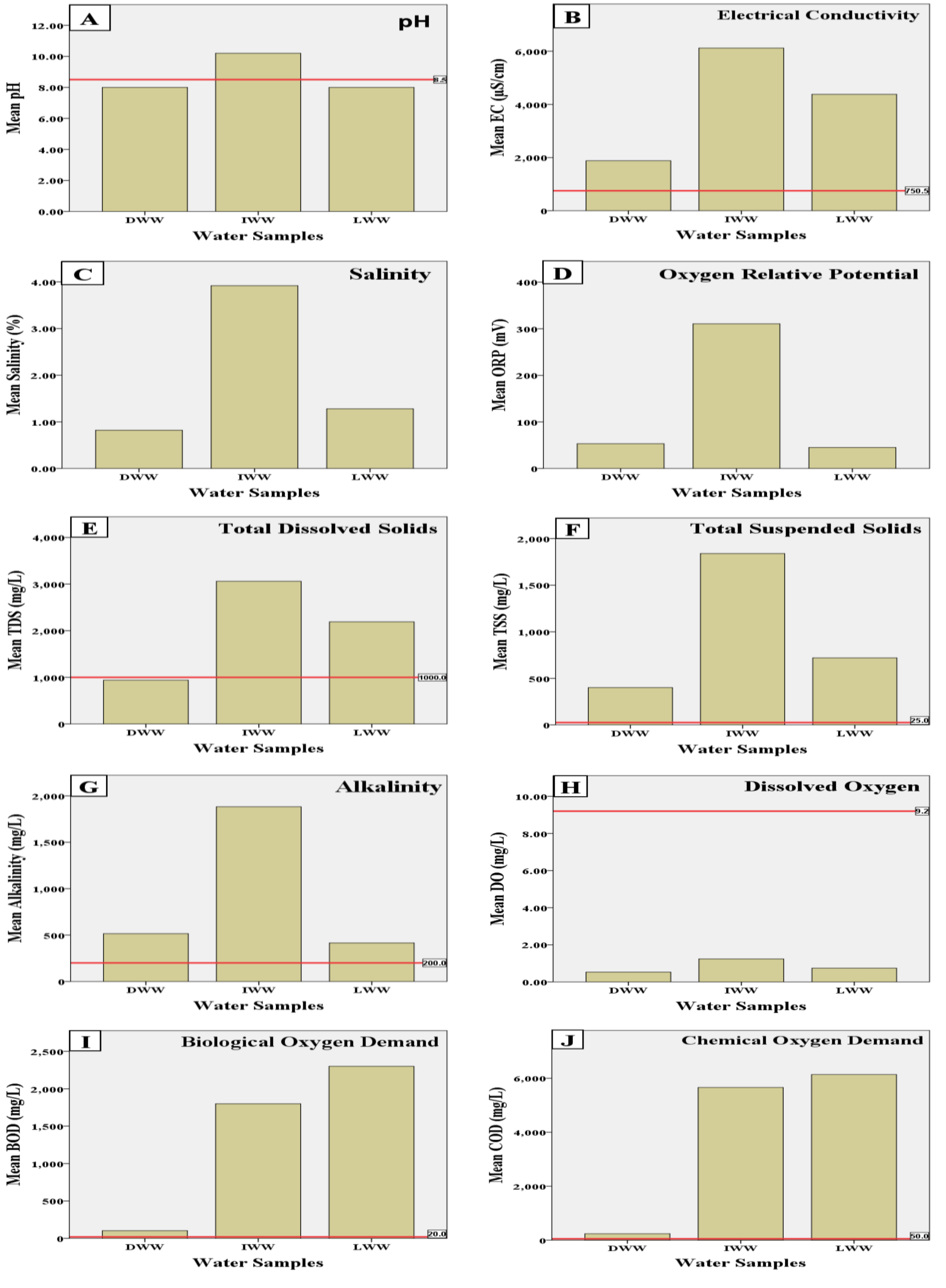
Wastewaters considerably impacted on the root fresh (F = 5.632, $p<0.019$) and dry biomass (F = 6.638, $p<0.012$) of *A. esculentus* moreover fresh (F = 9.555, $p<0.003$) and dry biomass (F = 4.240, $p<0.034$) of roots of *P. vulgaris*. Wastewaters like DWW, IWW and Mix water adversely affected the fresh and dry biomass of roots of *A. esculentus* as compared to control (Table 4). Whereas, LWW improved the fresh biomass of *A. esculentus* to 0.052 ± 0.009 g but dry biomass retained as control (0.004 ± 0.000 g). On the other hand, fresh biomass of roots of *P. vulgaris* increased with the application of DWW (0.201 ± 0.011 g) and LWW (0.215 ± 0.034 g) as compared to the control (0.119 ± 0.022 g). However, dry biomass of roots were increased only by DWW (0.026 ± 0.005 g), while LWW was not showed any effect on dry biomass of *P. vulgaris* (0.020 ± 0.002 g). Shoot fresh biomass of both crops *A. esculentus* (F = 39.658, $p<0.000$) and *P. vulgaris* (F = 3.935, $p<0.041$) were significantly increased by DWW and LWW as shown in table 4, but IWW and Mix water considerably reduced the fresh biomass of shoot of both plants. Although, dry biomass of shoots in *A. esculentus* (F = 9.587, $p<0.004$) and *P. vulgaris* (F = 4.194, $p<0.035$) were noticeably decreased by all types of wastewaters. However, with the comparison of control (0.264 ± 0.016 g), dry biomass of shoot in *P. vulgaris* was slightly increased by applying mix water (0.276 ± 0.022 g).

Discussion

The physiochemical parameters of wastewaters from different sites i.e., Malir and Lyari river along with the comparison of WHO standards of water quality have been shown in Fig. 2. The swift population and instant development of industries are responsible in spreading pollution to the water bodies through direct loading of waste discharges to the water channels. These discharges from homes, industries, pharmaceutical companies alter the nature of water bodies in which they are fraternizing. The results of physiochemical analysis, presence of heavy metals and essential nutrients for the quality of the nature of these wastewaters have been given in Fig. 2, (Tables 1 & 2).

Table 1. Concentrations of essential nutrients in various types of wastewaters.

Essential nutrients	Units	Domestic water	Industrial water	Lyari water
K	mg/L	18.07	18.02	5.295
Mg	mg/L	19.62	5.631	5.046
Ca	mg/L	67.53	8.567	17.77



Key note: ▬ = WHO Limit of water quality standard.
Fig. 2. pH (A), electrical conductivity (B), salinity (C), ORP (D), total dissolved solids (E), total suspended solids (F), alkalinity (G), dissolved oxygen (H), biological oxygen demand and (I) chemical oxygen demand (J) have been shown in wastewater samples with the comparison of tap water as control.

Fig. 3. Effect of different types of wastewater on length of *A. esculentus* (A) and *P. vulgaris* (B) seedlings.

Table 2. Concentrations of heavy metals in wastewater with the comparison of water quality standards of WHO and NEQS.

Heavy metals	Units	Domestic water	Industrial water	Lyari water	Drinking water quality standards (WHO)	Water quality standards (NEQS)
Fe	mg/L	BDL	BDL	BDL	0.30	2.0
Cu	mg/L	0.003	0.003	0.012	2.00	1.0
Pb	mg/L	BDL	BDL	BDL	0.01	0.5
Zn	mg/L	BDL	BDL	0.103	3.00	5.0
As	mg/L	0.287	0.422	BDL	0.01	1.0
Ni	mg/L	0.003	0.016	BDL	0.07	1.0
Cd	mg/L	0.003	0.004	0.002	0.003	0.1

Key note: BDL = Below the detection limit

Through the results of this study is revealed that physiochemical parameters of all wastewater samples were found relatively higher than the permissible limit of water quality standards. pH of IWW was alkaline in nature which is comparatively higher than quality standards of Anon., (2000) and WHO (2006). While DWW and LWW had permissible level of pH. It is the chief parameter for examining the quality of water and valuable contrivance for exploration of water characteristics. The increased level of pH influences the other physiochemical properties of water bodies (Gupta *et al.*, 1992, Gowrisankar *et al.*, 1997) that adversely alter the nature of water. Other parameters like alkalinity, total suspended solids, BOD and COD have been found greater than permissible limits of standard water quality in all water samples. The higher amount of BOD shows the enormous amount of dissolved oxygen required by aerobic microorganisms to decompose organic material present in wastewater. Greater concentration of organic substances needs higher amount of oxygen to break down that leads to heighten the amount of BOD. Whereas, extent of COD indicates the amount of oxygen utilized for chemical oxidation of the organic impurities into the inorganic matters. According to Islam (2014), the quantity of COD is based on the breakdown of organic substances in wastewater without the contribution of microorganisms. Although, acceptable amount of TDS was detected only in DWW according to the WHO limits. Das *et al.*, (2010) also reported the higher concentration of TDS in wastewater. It is due to the existence of dissolved inorganic and organic impurities which leads to the higher concentration of TDS in wastewaters.

The heavy metals are commonly present in wastewaters (Ping *et al.*, 2011) which includes iron, copper, lead, zinc, arsenic, nickel, cadmium etc. The higher amount of these metals causes environmental problems when release into water channels. The small amount of heavy metals is also present in water bodies naturally by means of airborne dust, weathering and erosion of bed rock material, vegetation, forest conflagration and ore deposits (Fernandez-Leborans & Herrero, 2000; Ogoyi *et al.*, 2011). But their higher accumulation is due to the direct or indirect activities of human such as increased urbanization, expanded industrialization, traffic pollution etc. Due to their non-degradable property, they accumulate in the environment (Sharma *et al.*, 2007) which results in the destruction of ecosystem. In the present study, heavy metals like iron, copper, zinc and nickel were found under the permissible limit of WHO and NEQS. Whereas, arsenic and cadmium were found to be higher than quality standards of water. Increased amount of cadmium was detected in IWW while DWW and IWW were found to be save in quantity of cadmium. Jan *et al.*, (2010) reported greater concentration of cadmium in wastewater which was used to irrigate the agriculture land in Peshawar, Pakistan. Farooqi *et al.*, (2009) found adverse effects of cadmium on the seedling growth of *Albizia lebbeck* (L.) Benth. According to Gardea-Torresdey *et al.*, (2005), higher concentration of cadmium negatively influence on the germination of seed and lipid content in plant body.

Table 3. Pearson correlation of physiochemical measures, essential nutrient and heavy metals among all forms of wastewaters.

	pH	EC	Salin	ORP	Alkal	TDS	TSS	DO	BOD	COD	K	Mg	Ca	Fe	Cu	Pb	Zn	As	Ni	Cd
pH	1																			
EC	0.810	1																		
Salin	0.991	0.883	1																	
ORP	**1.000****	0.794	0.986	1																
Alkal	**0.998***	0.773	0.980	**0.999***	1															
TDS	0.810	**1.000****	0.883	0.794	0.773	1														
TSS	0.977	0.916	**0.997***	0.971	0.963	0.916	1													
DO	0.958	0.945	0.988	0.950	0.938	0.945	0.997	1												
BOD	0.300	0.803	0.428	0.274	0.241	0.803	0.495	0.562	1											
COD	0.435	0.881	0.555	0.411	0.380	0.881	0.616	0.676	0.989	1										
K	0.497	-0.106	0.373	0.520	0.549	-0.106	0.302	0.226	-0.679	-0.565	1									
Mg	-0.469	-0.898	-0.586	-0.445	-0.414	-0.898	-0.645	-0.703	-0.983	**-0.999***	0.533	1								
Ca	-0.620	-0.962	-0.722	-0.599	-0.571	-0.962	-0.772	-0.820	-0.934	-0.976	0.372	0.984	1							
Fe	0.821	0.330	0.735	0.836	0.854	0.330	0.682	0.622	-0.298	-0.157	0.904	0.119	-0.061	1						
Cu	-0.500	0.103	-0.376	-0.523	-0.552	0.103	-0.305	-0.230	0.676	0.562	**-1.000****	-0.530	-0.369	-0.905	1					
Pb	0.235	-0.379	0.099	0.261	0.294	-0.379	0.024	-0.054	-0.857	-0.773	0.960	0.748	0.616	0.748	-0.959	1				
Zn	-0.493	0.111	-0.369	-0.516	-0.545	0.111	-0.298	-0.222	0.682	0.568	**-1.000****	-0.537	-0.376	-0.902	**1.000****	-0.962	1			
As	0.661	0.095	0.552	0.681	0.706	0.095	0.487	0.417	-0.517	-0.388	0.980	0.353	0.178	0.971	-0.980	0.885	-0.979	1		
Ni	0.974	0.657	0.934	0.980	0.986	0.657	0.905	0.868	0.078	0.221	0.680	-0.258	-0.428	0.928	-0.682	0.448	-0.676	0.813	1	
Cd	0.866	0.408	0.789	0.879	0.895	0.408	0.741	0.685	-0.217	-0.073	0.864	0.035	-0.145	0.996	-0.866	0.690	-0.862	0.948	0.956	1

Key note: *. Correlation is significant at the 0.05 level (2-tailed); **. Correlation is significant at the 0.01 level (2-tailed)

Table 4. Seed germination with length and fresh/dry biomass of *A. esculentus* and *P. vulgaris* under the applications of various wastewaters as compared to tap water (control).

Parameters	Control	DWW	IWW	LWW	Mix Water	F-value	Sig. (*P*)
A. esculentus							
Germination (%)	53.333 ± 6.667	73.333 ± 6.667	26.667 ± 6.667	80.000 ± 11.547	53.333 ± 17.638	3.769	0.040**
Root Length (cm)	3.672 ± 0.306	4.772 ± 0.705	0.850 ± 0.650	6.033 ± 0.260	3.708 ± 0.542	12.833	0.001***
Shoot Length (cm)	2.900 ± 0.351	6.250 ± 0.555	2.000 ± 1.000	7.167 ± 0.855	4.813 ± 0.688	10.002	0.003***
Root Fresh Biomass (g)	0.054 ± 0.008	0.038 ± 0.002	0.011 ± 0.004	0.052 ± 0.009	0.030 ± 0.004	5.632	0.019**
Root Dry Biomass (g)	0.004 ± 0.000	0.003 ± 0.000	0.001 ± 0.000	0.004 ± 0.000	0.003 ± 0.000	6.638	0.012**
Shoot Fresh Biomass (g)	0.206 ± 0.002	0.274 ± 0.007	0.156 ± 0.012	0.271 ± 0.009	0.201 ± 0.007	39.658	0.000***
Shoot Dry Biomass (g)	0.030 ± 0.000	0.019 ± 0.002	0.023 ± 0.000	0.022 ± 0.002	0.023 ± 0.001	9.587	0.004***
P. vulgaris							
Germination (%)	73.33 ± 6.66	93.33 ± 6.66	53.33 ± 6.66	86.67 ± 6.66	66.67 ± 6.66	5.700	0.012**
Root Length (cm)	11.250 ± 2.126	13.556 ± 2.819	4.139 ± 0.155	13.033 ± 0.291	7.250 ± 1.250	5.394	0.017**
Shoot Length (cm)	6.550 ± 1.333	8.778 ± 0.894	2.139 ± 0.320	10.817 ± 1.242	5.000 ± 1.000	10.865	0.002***
Root Fresh Biomass (g)	0.119± 0.022	0.201 ± 0.011	0.064 ± 0.007	0.215 ± 0.034	0.085 ± 0.027	9.555	0.003***
Root Dry Biomass (g)	0.020 ± 0.003	0.026 ± 0.005	0.012 ± 0.000	0.020 ± 0.002	0.011 ± 0.001	4.240	0.034**
Shoot Fresh Biomass (g)	1.073 ± 0.082	1.406 ± 0.068	0.858 ± 0.031	1.349 ± 0.215	0.984 ± 0.090	3.935	0.041**
Shoot Dry Biomass (g)	0.264 ± 0.016	0.255 ± 0.019	0.255 ± 0.010	0.171 ± 0.030	0.276 ± 0.022	4.194	0.035**

Key note: ± = Standard error of three replicates, Sig. (*P*) = Significance level: *p<0.05, **p<0.01 and ***p<0.001

In this study higher concentration of arsenic was detected in DWW and IWW but according to NEQS limit it was under the permissible limit. While in LWW, As perceived under the permissible limit of WHO and NEQS. According to Akhtar & Shoaib (2014), increased amount of arsenic reduce the seedling growth and biomass of *Triticum aestivum* L. when it accumulate in plant tissues. Some other prior studies in Pakistan also reported accumulation of heavy metals in plant body by irrigation of wastewater (Jan *et al.*, 2010; Khan *et al.*, 2010).

Certain elements are essential like zinc, copper, iron, nickel, manganese etc. in very little amount as they work for plant growth like mineral nutrients. But function of others such as lead and cadmium is unknown in plant body (Lasat, 2002). So, the unnecessary extents of elements become toxic for growth of plant (Prodgers & Inskeep, 1991).

Essential elements are the macro nutrients which are necessary for the plant growth. The body of plant uptakes these nutrients from soil through its roots. Plant growth faces problems when soil is deficient in having essential nutrients. In this study it is also revealed that wastewater contains sufficient amount of essential nutrients for plant growth such as potassium, magnesium and calcium. Correspondingly, various researchers have also been reported that wastewater comprises higher amounts of macro nutrients i.e. potassium, magnesium, calcium, nitrogen and phosphorus (Barton *et al.*, 2005; Fonseca *et al.*, 2007; Sophocleous *et al.*, 2009; Jaiswal & Elliott, 2011) as well as micro nutrients like zinc, iron, manganese, copper, nickel etc. (Pedrero & Alarcón, 2009; Xu *et al.*, 2010).

Among all types of wastewaters, DWW found to have higher quantities of K, Mg and Ca as compared with IWW and LWW. Moraetis *et al.*, (2011) found 50 times greater amount of K in wastewater of Oil Mill as compared to the ground water. According to Morgan *et al.*, (2008), after irrigation with wastewater citrus plant found to have increased amount of Mg in the body. Similar results were also reported by Pedrero & Alarcón (2009). In IWW, greater amount of K and Mg was present than LWW while Ca was found in order as DWW > LWW > IWW. Though, Pereira *et al.*, (2011) reported increased concentration of Ca in the soil extending to 90 cm in the depth.

Prior studies in various other countries like Egypt, Greece, Israel, Italy, Jordan, Spain and USA proved beneficial influences of wastewater in the field of agriculture for irrigation of crop as an alternative source of fresh water (Aucejo *et al.*, 1997; Omran *et al.*, 1988; Meli *et al.*, 2002; Graber *et al.*, 2006; Ammary, 2007; Morgan *et al.*, 2008; Kalavrouziotis *et al.*, 2009; Pedrero & Alarcón, 2009, Pedrero *et al.*, 2010). Although, few studies observed nutrient ailments in plants through continuous irrigation with wastewater (Fatta-Kassinos *et al.*, 2011). For evading these ailments, potential of nutrients in soil-water should be examine according to the requirement of plant growth.

Due to permissible limit of pH (WHO, 2006) and other nutrients availability, DWW and LWW significantly influence on the seed germination and plant length of both crops (*A. esculentus* and *P. vulgaris*) as shown in table 4. According to Bazai & Achakzai (2006), wastewater from Quetta city, Pakistan, enhanced the germination and growth of *Lactuca sativa* with its initial measures, but the higher concentration of wastewater considerably reduced the length of plumule as compared to control. In present study, it was also observed that IWW and mix water with higher concentrations of physiochemical measures and metals like As, Cd etc. negatively impact on seed germination and growth parameters of both crops. Similarly, Dash (2012) observed that DWW increased the germination of *Oryza sativa* and *Triticum aestivum* cultivars upto its 50% concentration but the seed germination found delayed in higher concentrations of wastewater. The higher rate of salinity in water causes toxicity of high osmotic pressure due to which seeds became unable to take water that leads to decrease in the germination percentage. Correspondingly, in present study, higher levels of salinity and other parameters in IWW reduced the germination percentage and growth parameters of both crops *A. esculentus* and *P. vulgaris*. Khan *et al.*, (2011) also reported that textile wastewater with increased concentrations ultimately decreased the germination of seeds. Same findings have been observed by Nagda *et al.*, (2006) with the application of industrial effluent on the seed germination. Though, according to Ungar (1978), germination of seeds depends on their ability to germinate under high osmotic pressure that varies with species and its variety. In such a manner, Tan *et al.*, (1979) also described by his findings that different varieties of crops showed diverse impacts on their germination and growth parameters by the applications of altered types of wastewaters.

Various researchers stated that wastes from industries and domestics contain varieties of heavy metals like Cu, Fe, Mn, Ni, Pb, Zn as well as essential nutrients for plants (Akbar *et al.*, 2007; Amin *et al.*, 2009; Umebese *et al.*, 2009). These nutrients in wastewaters are necessary for the growth of plants but the higher concentrations of heavy metals in water compete with nutrients to uptake by roots that eventually cause reduction in the growth of plant. Respectively, Cheng & Zhou (2002) found reduced length of roots in *T. aestivum* due to heavy metals and toxic chemicals. In this study, it also have been proved that IWW and mix water contained higher concentrations of physiochemical measures and heavy metals that adversely influence on growth of both crops. Anyhow, different varieties of plants showed altered response by different wastewaters (Rosa *et al.*, 1999).

Conclusion

In the present study, it is evaluated that DWW and LWW had adequate amount of essential nutrients and permissible limit of pH that significantly exhibited positive influence on the germination and growth parameters of *A. esculentus* and *P. vulgaris.* Whereas, IWW contained higher measures of physio-chemical parameters and metals that lead to the negative impact on both crops. Thus, it depends on the quality of wastewater which influence on the growth of plant as well as variety of crop that tolerate the properties of applied wastewater.

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