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Seed Germination and Seedling Performance of Rice Grown in Municipal Wastewater

Umaru Mohamed Gassama*[1], Adam Bin Puteh[1], Jamilu Garba[2], Bashiru Kargbo[3]

[1]Department of Crop Science, Faculty of Agriculture, Universiti Putra Malaysia, UPM Serdang, Selangor D.E., Malaysia

[2]Department of Agricultural Education, Zamfara State College of Education, 1002 Maru, Nigeria

[3]Environmental Protection Agency-Sierra Leone

Corresponding author: medgassa1042@yahoo.com.my

ABSTRACT

The use of municipal wastewater for watering purposes is an essential way to utilize it nutrients. Laboratory experiment was conducted in a complete randomized design using sand medium with municipal wastewater and MR219 rice seed with the aim to assess the suitability of municipal wastewater (treated and untreated) at different concentrations (0, 2.5, 5, 10, 25, 50 and 100%) on seed germination and seedling performance. Significant ($p<0.05$) difference was observed between untreated and treated municipal wastewater for seedling length (SL), root volume (RV), seedling vigour index (SVI) and root:shoot ratio (R:S) while no different was observed between untreated and treated municipal wastewater for germination percentage (GP) and seedling phytotoxicity. The municipal wastewaters had stimulatory effect on the rice seeds at lower wastewater concentrations (<25%) while inhibitory effect was observed at higher wastewater concentrations (>50%). The concentrations of N, P, K, Ca, Mg, Zn, Fe, Cu and Mn were high in untreated municipal wastewater compare to treated municipal wastewater. Seeds imbibed with untreated municipal wastewater have high seed germination and seedling performance compare to treated municipal wastewater. Inhibitory effect on chlorophyll content was observed at >50% concentration of both untreated and treated municipal wastewater while promoting effects were observed at lower (<25%) concentration. Positive and significant correlation was indicated between parameters of rice seed germination and seedlings performance. Municipal wastewater of <50% concentration could be recommended as a good source of water and nutrients for rice seed germination without affecting seedling performance.

Keywords: Municipal wastewater, Seed germination, Seedling Performance, Oryza sativa, Nutrient uptake, Chlorophyll content

I. INTRODUCTION

Water is not only important in crop production but also an indispensable resource. The use of wastewater from industries and urban centers in agriculture has received considerable attention in recent years, and each type of effluent has specific characteristics, which may or may not be beneficial to crop-soil-animal subsystem (Padhan et al., 2011). The use of domestic wastewater for agricultural production is increasing, especially as domestic wastewaters are rich in plant nutrients and organic matters which are essential for plant growth and development as this practice may help reduce the pressure on fresh water for watering or irrigation (Dash, 2012). Agricultural use of domestic wastewater helps to preserve environmental quality and concurrently furthers other national goals such as providing sustainable agriculture while preserving scarce water sources (Chung et al., 2011). Plant growth, soil fertility and productivity can be enhanced with proper wastewater irrigation management system, which will increase levels of plant nutrients and soil organic matter essential for plant growth and development (Munir et al., 2007). Rajkishore and Vignesh (2012) recorded higher grain yields and increased soil nutrients at 50/75 times dilution of distillery effluent in irrigated rice. Looking into the context of wastewater, it can be a measured of both positive and negative resources. The positive aspect of using wastewater in agricultural activities is that it has nutrients which can be used for irrigation, thus benefits farming communities, societies and municipalities. The negative aspect of wastewater reuse is the damaging effect on humans, animals and ecological system that needs to be recognized and considered (Haussain et al., 2002). The macro and micro-nutrients in the sewage sludge assist as a good basis of plant nutrients and the organic constituents furnish helpful soil conditioning properties (Singh and Agrawal, 2008). The usage of municipal water with physical treatment could raise water resources for irrigation which may prove to be advantageous for agricultural production as the municipal water has been shown to high amounts of organic matter, nutrients and some heavy metals which are toxic to plants beyond a certain limit (Singh et al., 2012). As the demand of fresh water is increasing with increase in human population, it is therefore essential to determine the effect of wastewater on agricultural activities. In view of such perspectives, the present investigation was conducted to evaluate the response of rice seedlings on growth and development to different concentrations of untreated and treated municipal wastewater.

II. MATERIALS AND METHOD

Experimental Procedures

A popular rice variety, MR219 was planted on sand medium in the Seed Science Laboratory, Department of Crop Science, Faculty of Agriculture, Universiti Putra Malaysia. The rice seeds were watered with untreated (raw) and treated (processed) municipal wastewater obtained from wastewater plant treatment Indah Water Konsortium Berhard, Kuala Lumpur, Malaysia. Prior to use, the municipal wastewater samples were analyzed for their chemical and physicals content such as N, P, K Fe, Zn, Ca, Mg, Mn, Cu, Cd, Pb, NH_4, NO_3, Biological oxygen demand, Chemical oxygen demand, Total suspended solid, Oil and grease and pH using Standard procedure (APHA, 1998).

Seed preparation and imbibition treatment

Rice variety MR219 was sterilized with 70% of chlorox solution for fifteen minutes to remove microbes from the seeds. Double sterilized water was used to repeatedly wash the rice seeds. The rice seeds were then imbibed in different concentrations of untreated (raw) and treated (process) municipal wastewaters and distilled water for six hours before planting. One Hundred healthy treated rice seeds were put in plastic germination boxes of 2.5kg of sterilized sands and the sands were moisturized with 500 mL of different concentration of wastewater before planting the seeds. The experiment was conducted for a period of two weeks on a factorial design using the Completely Randomized Design (CRD) with three replicates. Two hundred milli-liters (200 mL) of different concentrations of wastewater and distilled water were used for watering. The germination test was conducted according to The International Seed Testing Association procedures (ISTA, 1999).

Procedure for nutrient analysis

Determination of nutrients was carried out using the modified method of Wolf (1982). The seedlings root and leaf samples were placed into envelop and then dried in the oven at 70ºC for 48 hours. The dried plant tissues were grinded and 0.25 g was used for the digestion. For the digestion process, the samples were transferred into clean digestion flasks and 5mL of concentrated H_2SO_4 was added to each flask for 2 hours. Thereafter, the flasks were heated for 45 minutes at 285ºC and 2ml of 50% (H_2O_2) was added to complete the process. The process was repeated several times until the samples became white and clear. The flasks were removed from digestion plate, cooled at room temperature and then diluted to make up to 100mL volume with distilled water. Then the macronutrients N, P and K were determined in the solution by using Auto-Analyzer (Lachat 8000 Series) while Ca, Mg and micronutrients Zn, Fe, Cu, Mn were determined in the solution by using Atomic Absorption Spectrometer (Perkin Elmer model 3110). Nutrients uptake by seedlings were determined as a function of the rice dry biomass production.

Chlorophyll Content

The chlorophyll content was measured according to the procedure described by Porra et al. (1989). The amount of 0.2 g of leaf was homogenized in 80% acetone for 2 minutes and then was centrifuged at 2500 rpm for 20 minutes and supernatant was extracted. About 3.5 mL of samples were pipetted into microfuge and the chlorophyll content was measured by using scanning spectrophotometer UV3101 PC. The samples were read at wavelength of 663 nm and 646 nm. The formulae of Lichtenthaler and Wellburn (1983) were used to calculate chlorophyll a and chlorophyll b contents.

Data Collection

Data was collected on the following parameters: germination percentage, seedling length, root volume, seedling vigour index, root:shoot ratio and seedling phytotoxicity.

Seedling Vigour Index (SVI) =Germination (%) x Seedling length (cm) according to the procedure of Abdul Baki and Anderson (1973).

Root: shoot ratio=Dry weight for root/Dry weight for shoot Seedling phytotoxicity = Root length of control-Root length of test/ Root length of control x 100 according to the procedure of Chou and Lin (1976).

Root volume was measured by using the root scanner and analysis machine (Analyzer WinMagRhizo, Epson Expression 1680).

Statistical Analysis

The SAS statistical software (9.2 versions) was used to analyze the data including analysis of variance (ANOVA). Treatments means were compared using least significance difference (LSD) at P<0.05.

III. RESULT AND DISCUSSION

Municipal wastewater characteristics

The analyses of both the chemical and physical characteristics of the untreated and treated municipal wastewaters are shown in Table 1. The municipal wastewater had differences in their characteristics. Municipal wastewater for both untreated and treated municipal wastewater was slightly acidic and alkaline in nature with pH range between 6.8 and 7.1. The characteristics of the wastewater used for watering showed that the presence of high amount of nutrients in untreated municipal wastewater than treated municipal wastewater (Table 1).

Table 1. Chemical and physical characteristics of Untreated and Treated Municipal Wastewater

Parameters	Untreated wastewater	Treated wastewater
Color	Dark black	Crystal clear
Electrical Conductivity (μS/cm)	8.6	6.70
Nitrogen (mg/L)	24.2	14.50
Phosphorous (mg/L)	2.99	0.33

Potassium (mg/L)	5.45	0.35
✚ Iron (mg/L)	2.11	0.14
✚ Zinc (mg/L)	1.06	0.27
✚ Calcium (mg/L)	20.65	13.51
✚ Magnesium (mg/L)	3.86	1.59
✚ Manganese (mg/L)	3.02	1.87
✚ Copper (mg/L)	3.25	1.32
✚ Cadmium (mg/L)	0.02	0.01
✚ Lead (mg/L)	nil	nil
*Biological Oxygen Demand (mg/L)	247	6.90
*Chemical Oxygen Demand (mg/L)	436	32.20
*Ammonium (mg/L)	30	22.00
*Nitrate (mg/L)	3.2	1.00
*Total suspended solid (mg/L)	280	8.80
*Oil and grease (mg/L)	3.5	1.50
*pH	6.8	7.10

Sources: Analytical Lab, Department of Crop Science, Universiti Putra Malaysia.

✚ Analytical Lab, Land Management, Faculty of Agriculture, Universiti Putra Malaysia.

* Indah Water Konsortium Berhad, wastewater treatment plant Kuala Lumpur, Malaysia.

Seed Germination

The different concentrations of untreated and treated municipal wastewater showed significantly different ($p<0.05$) on rice seed germination. Percentage germination increased with increase in concentration up to 25% and thereafter decreased gradually for both untreated and treated municipal wastewater (Table 2). Maximum germination percentage was recorded at 25% concentration with 93.3% and 90.5% germination for untreated and treated wastewater, respectively. Lower wastewater concentration had promoting effect on seed germination while higher wastewater had reducing effect.

Dash (2012) studied the impact of domestic wastewater on seed germination and physiological parameters of rice and wheat, and observed that at higher concentration, percentage germination of seeds was reduced. Similar result was also observed by Saravanamoorthy and Kumari (2007) in peanut. Furthermore, Singh et al., (2007) observed significant decrease in the percentage germination and seedling vigour of rice and wheat with an increase in spent wash concentration. The decrease may be due to the adverse effect of high toxicity of the wastewater at higher concentration (Ramana et al., 2002; Yousaf et al., 2010).

Table 2. Effect of different concentrations of treated and untreated municipal wastewater on percentage germination for MR219 rice seed

	Concentration (%)	Germination (%)	
		UTWW	TWW
MR219	0	83.6a	82.6ab
	2.5	84.3a	84.6a
	5	85.0a	85.6a
	10	87.3a	87.6a
	25	93.3a	90.5a
	50	74.0b	79.6b
	100	71.6b	76.3b

* Means with the same letters are not significantly different (P >0.05)
UTWW = Untreated wastewater
TWW = Treated wastewater

Seedling Performances

Seedling Length (cm)

Different concentrations of untreated and treated municipal wastewater on seedling length for variety MR219 was significantly different at $p<0.05$. Results indicated that seedling length increased with increase in concentration of untreated wastewater up to 10% concentration followed by decline. On the other hand, seedling length increased with increase in concentration of treated wastewater up to 25% and further increase in the wastewater concentration, decrease in seedling length was observed (Figure 1).

The seedling length under untreated municipal wastewater was 51.63cm as compared to treated municipal wastewater with 45.75cm (Fig: 2). Untreated municipal wastewater has high amount of nutrients than treated wastewater which enhance plant growth and development, thereby increase seedling plant height in untreated wastewater treatment.

Dash (2012) reported significant declined in seedling length of rice and wheat when seeds were treated with wastewater at higher concentration. Nawaz *et al.*, (2006) reported decreased seedling length of soybean with an increase in concentration of industry effluent. Dhanam (2009) observed that 100 % concentration of dairy effluent inhibited rice seedling growth and suggested that this may be due to osmotic pressure caused by high effluent dose.

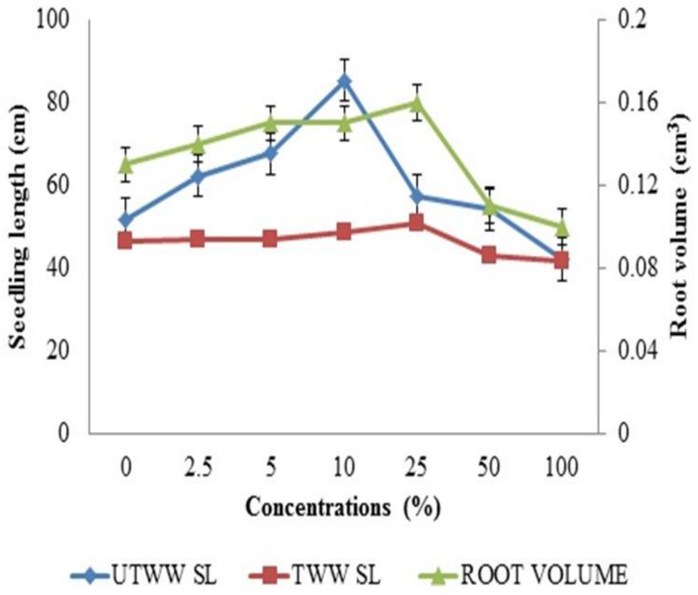


Figure 1. Effect of different concentrations municipal wastewaters on seedling length and root volume for MR219 rice variety

* UTWW SL = Untreated wastewater seedling length
*TWW SL = Treated wastewater seedling length
*Vertical bars on line represent SE (±)

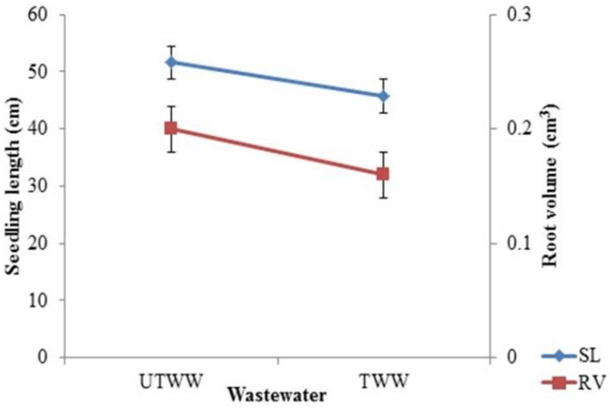


Figure 2. Effect of treated and untreated municipal wastewater on seedling length (SL) and root volume (RV) for MR219 rice seeds

* UTWW = Untreated wastewater seedling length

*TWW = Treated wastewater seedling length

*Vertical bars on line represent SE (±)

Root Volume (cm^3)

Different levels of wastewater concentrations differ significantly on root volume ($p<0.05$) of rice seedling (Figure 1). Results showed that root volume increased with increase in concentration till 25% for MR219 rice variety followed by a decline at >50%. The lowest root volume was recorded in 100% concentration. The result showed that lower concentration has stimulating effect on root volume while higher concentration has deleterious effect on root volume.

Maximum root volume 0.20 cm^3 was recorded when watered with untreated municipal wastewater compared to treated municipal wastewater 0.16 cm^3 (Fig: 2). The increase in root volume when watered with untreated wastewater might be due to the presence of high nutrients content. The result further indicated that untreated municipal wastewater had high potential organic nutrients which stimulate growth than the treated wastewater.

Rehman *et al.*, (2009) observed significant reduction in root volume of three vegetables crops when exposed to 100% concentration of textile effluent concentration while increased was observed at lower textile effluent concentration that supported the present study. Similar result was also observed by Kaliyamoorthy *et al.*, (2013) in rice.

Seedling Vigour Index

Seedling vigour index for MR219 rice was significantly influenced by different concentrations of municipal wastewater $p<0.05$ (Fig: 3). Results indicated that seedlings vigor increased with increasing concentration of wastewater until 5% concentration followed by a decline. However, seeds watered with 5% concentration of municipal wastewaters were the most vigorous seedlings with 4254 and seeds irrigated with 100% concentration of wastewater were the lowest seedling vigor index with 3703.

Seeds imbibed in untreated and treated municipal wastewater showed significant difference ($p<0.05$) in seedling vigour index (Fig: 4). Seeds imbibed with untreated wastewater recorded the highest SVI of 3761 while treated wastewater gave the lowest of 2642. The result further shows that untreated municipal wastewater contains nutrients that promote SVI than treated wastewater.

The concentration that gave the highest seedling vigor index for MR219 rice seeds are considered to be more vigorous (Abdul-Baki and Anderson, 1973). The direct use of the raw wastewater resulted in decreased benefits whereas diluted concentrations noticed higher seedlings quality parameters because of lesser toxicity and better utilization of plant nutrients by the seedlings (Manunatha, 2008).

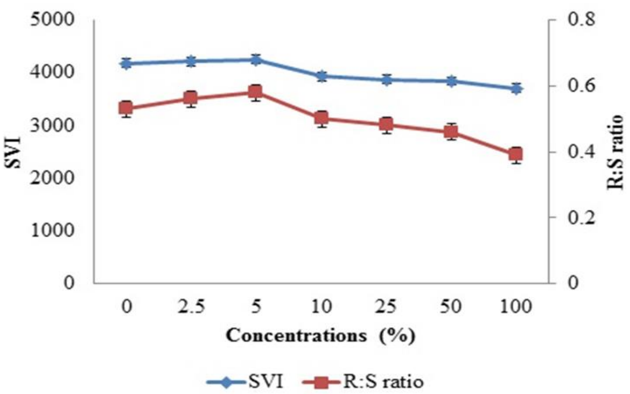


Figure 3. Effect of different concentrations municipal wastewaters on seedling vigour index (SVI) and root:shoot ratio for MR219 rice variety

* UTWW = Untreated wastewater seedling length

*TWW = Treated wastewater seedling length

*Vertical bars on line represent SE (±)

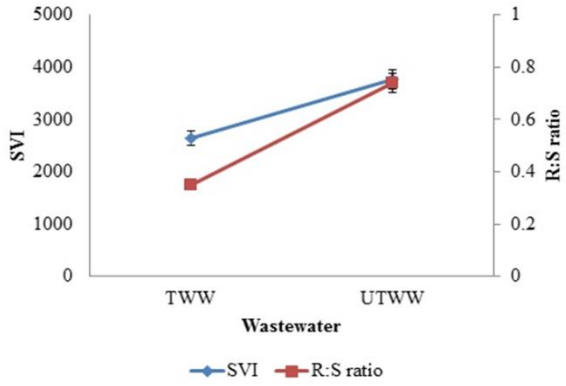


Figure 4. Effect of treated and untreated municipal wastewater on seedling vigour index (SVI) and root:shoot ratio for MR219 rice seeds

* UTWW = Untreated wastewater seedling length

*TWW = Treated wastewater seedling length

*Vertical bars on line represent SE (±)

Root: Shoot Ratio

Seeds imbibed with different concentration of municipal wastewater showed significantly different for root:shoot ratio ($p<0.05$). Seeds imbibed with distilled water (control) have normal root/shoot ratio for each seedlings and any change from this normal level either up or down would be an indication of a change in the overall health of the seedlings. Maximum root/shoot ratio was recorded at <5% concentration of wastewater. Furthermore, increasing the concentrations to >10% of the wastewaters reduced in the root:shoot ratio (Fig: 3). Increase in root/shoot ratio was observed at lower concentration of municipal wastewater while decreased in root:shoot ratio was observed at higher concentrations of the wastewaters.

When the wastewaters are diluted in different concentrations, the toxicity of the wastewaters constitution goes on weakening and at an optimum concentrations nutrients uptake takes place (Manunatha, 2008). The direct use of the raw wastewater resulted in decreased benefits whereas diluted concentrations noticed higher seed quality parameters because of lesser toxicity and better utilization of plant nutrients by the seedlings (Manunatha, 2008). An increase in root:shoot ratio is an indication of a healthier plant while decrease in root:shoot ratio is an indication of deterioration in the health of the crops. Untreated municipal wastewater gave better root/shoot ratio compare to treated municipal wastewater (Fig: 4). Untreated water gave a value of 0.74 while treated water gave a value of 0.35.

Seedling Phytotoxicity

Significant ($p<0.05$) difference on phytotoxicity of MR219 rice seedlings was observed when imbibed in different concentrations of treated and untreated municipal wastewater (Fig: 5). Lower wastewater concentrations (<25%) had lower phytotoxicity on the rice germination process that leads to better response of the rice seeds to the wastewater. However, further increase in the concentrations of the wastewater from 50%-100%, had higher phytotoxicity on the rice germination process that leads to retarded growth of rice seedlings (Fig: 5). Gassama *et al* (2015) recorded similar result on rice in previous studies when the seeds were imbibed in municipal wastewater that supported the present experimental result.

Higher concentration of wastewater effluent decreases activities of dehydrogenase (Murkumar and Chavan, 1987) and acid phosphatase (De Leo and Sacher, 1970) which are important enzymes during early germination process and also involved in mobilization of nutrient reserves (Flinn and Smith, 1967) that might have been happened in the present study. The low amount of oxygen in dissolved form due to high concentration of dissolved solids in the effluent reduces the energy supply through anaerobic respiration causing retardation of growth and development of seedling (Saxena et al., 1986). The enhancement of seed quality by the lower concentrations of the wastewater was due to the presence of nutrients especially N, P and K in the wastewater.

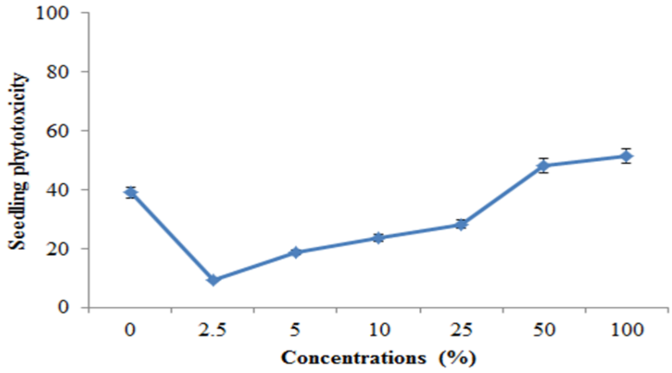


Figure 5. Effect of different concentrations municipal wastewaters on seedling phytotoxicity for MR219 rice variety

*Vertical bars on line represent error bars with percentage (±)

Chlorophyll Content in Seedlings

The chlorophyll content in the leaves of the seedlings derived from rice seedlings grown in different concentrations of municipal wastewater was significant at $p<0.05$ (Table 3). Chlorophyll a and b contents in seedlings increase at lower wastewater concentrations while decrease in chlorophyll a and b contents was observed at higher wastewater for both treated and untreated municipal wastewater (Table 3). Lower wastewater concentration (<25%) have promoting effect on chlorophyll a and b contents while higher wastewater concentration (50%-100%) have deleterious effect on chlorophyll a and b content.

Similar result has been reported in sorghum cultivars treated with textile mill wastewater (Garg and Kaushik, 2008). Pathrol and Bafna (2013) reported decreased in chlorophyll content in *Trigonella foenumgraecum* with decrease in the dilutions of the sewage water. Khan *et al*, (2011) suggested that higher concentration of wastewater are inhibitory to synthesis of chlorophyll molecules particularly chlorophyll *a*. In wheat, Liu D *et al* (2002) observed the decline in chlorophyll level when wheat seedlings were irrigated with sewage water. Similar result has been reported in rice cultivar imbibed with municipal wastewater (Gassama *et al.,* 2015). Chlorophyll a and b contents in the leaves of the seedlings decreased in response to wastewater imbibition. Reduction in chlorophyll content induced by wastewaters could be associated with higher concentration of heavy metals (Gadallah, 1995). Reduction in chlorophyll content stimulated by wastewater might be due to the formation of enzymes such as chlorophyllase which is responsible for chlorophyll degradation (Majumder et al., 1991, Rodriquez et al., 1987, Sabater and Rodriquez 1978), and also retardation of chlorophyll synthesis under the effect of heavy metals present in wastewaters or due to changes in the endogenous cytokinins in leaves (Cizkova, 1990) which are reported to be responsible for stimulation of chlorophyll synthesis (Banerji and Laloraya, 1967).

Table 3. Effect of different concentrations of untreated and treated municipal wastewater on chlorophyll (μg/ml) content on MR219 rice variety

Varieties	Concentrations of wastewater (%)	Chl a		Chl b	
		TWW	UTWW	TWW	UTWW
MR219	0	19.35b	21.47b	16.95b	11.68c
	2.5	20.84a	23.06b	18.61a	15.93c
	5	21.66a	25.85a	19.18a	17.87b
	10	22.04a	26.01a	19.37a	18.31b
	25	22.90a	27.55a	19.76a	28.27a
	50	14.17c	17.06c	14.80c	11.28c
	100	12.54c	15.66c	13.62c	8.49c

* Means within columns with common letters are not significantly (P>0.05) different
*TWW= Treated wastewater
*UTWW= Untreated wastewater

Correlation Analysis

A Positive and significant correlation was indicated between parameters of rice seed germination, seedlings performance and chlorophyll content (Table 4). Positive correlation indicated that when one variable is increasing the other variable has tendency to increase. Therefore, the increase in the one parameter showed an increase in the other parameter of the rice seeds germination and seedling performance.

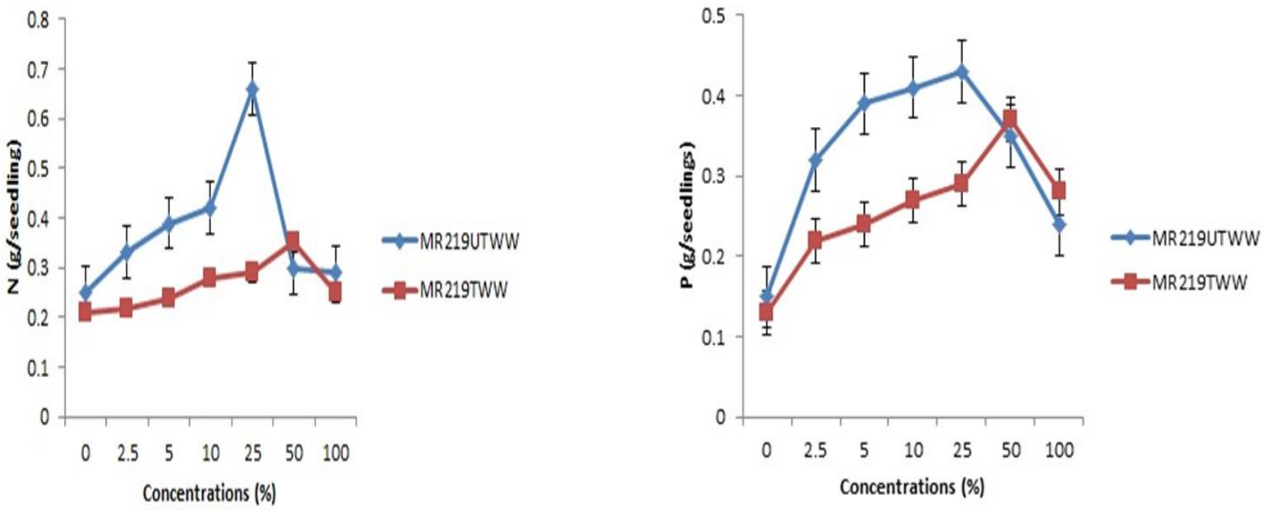
Table 4: The values of correlation between parameters of rice seedlings as affected by municipal wastewater

	Ger	Sl	Rv	Chla	Chlb
Ger	1				
Sl	0.591**	1			
Rv	0.428**	0.598**	1		
Chla	0.324*	0.230*	0.259*	1	
Chlb	0.437**	0.312*	0.332*	0.781**	1

Level of significance ** = p < 0.001, * = p < 0.01, NS = Not significant
*Ger=germination; Sl=seedling length; Rv=root volume; Chla=chlorophyll a; Chla=chlorophyll b

Nutrient uptake of rice seedlings

The concentration of N, P and K increased with increasing wastewater concentration up to 25% followed by a decline in untreated wastewater while in treated wastewater, N, P and K concentration of rice seedlings increased with increasing concentration up to 50% (Figure 6).



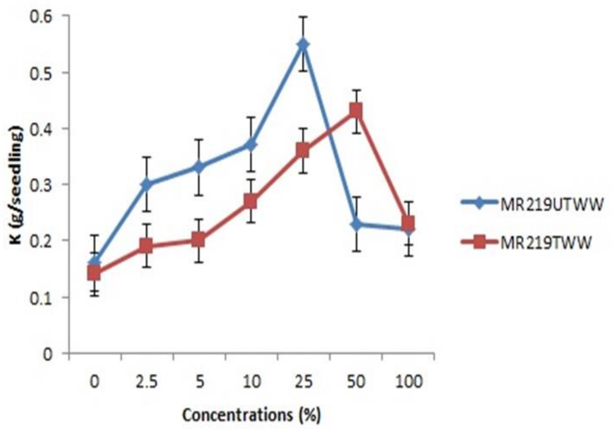
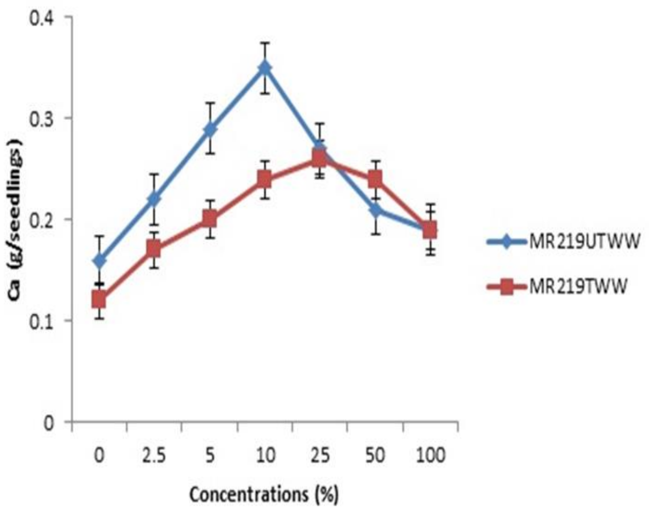


Figure 6. Nutrients uptake of rice seedlings in variety MR219 under different concentrations of municipal wastewater irrigation for Nitrogen, Phosphorous and Potassium. Vertical bars on line represent SE (±)
*UTWW= Untreated wastewater
*TWW= Treated wastewater

The concentration of Ca and Mg nutrients in seedlings increased with increasing wastewater concentration up to 10% concentration followed by decline in untreated wastewater while Ca and Mg nutrient increased with increasing concentration up to 25% concentration of treated wastewater was used for imbibition followed by a decline (Figure 7).



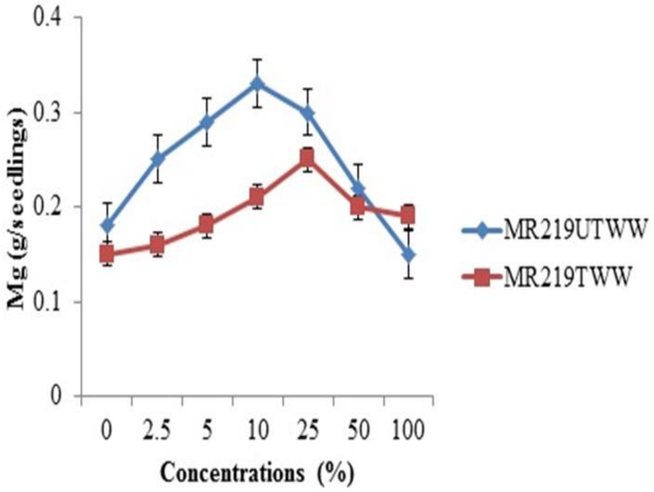


Figure 7. Nutrient uptake in rice seedlings in variety MR219 under different concentration of municipal wastewater irrigation for Calcium and Magnesium. Vertical bars on line represent SE (±)
*UTWW= Untreated wastewater
*TWW= Treated wastewater

Similar results were also observed in the case of Zn and Fe concentration in rice seedlings when imbibed with treated and untreated wastewater (Fig: 8).

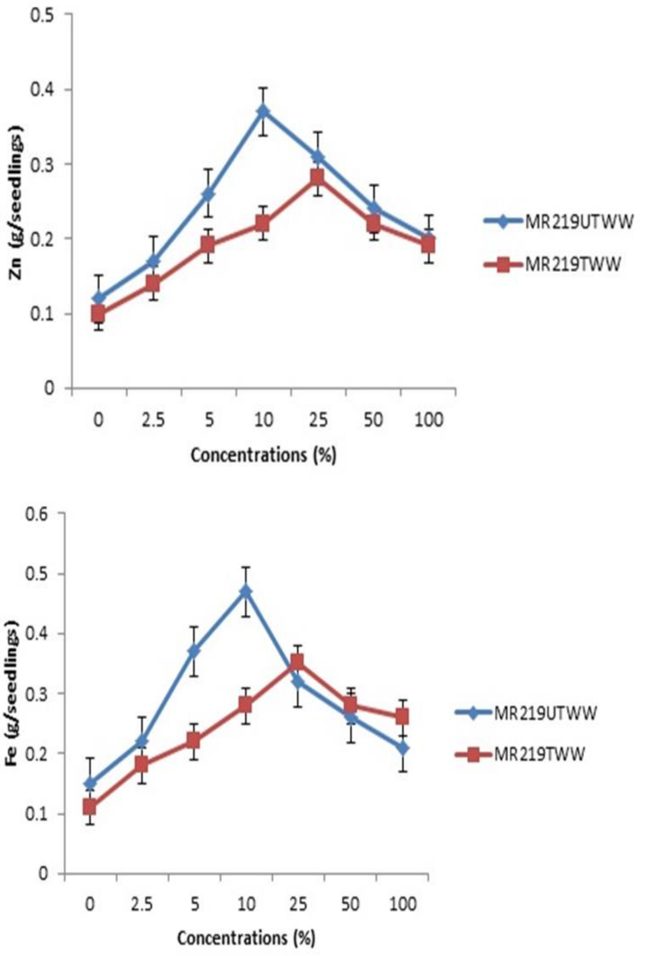


Fig 8: Nutrient uptake in rice seedlings in variety MR219 under different concentration of municipal wastewater irrigation for Zinc and Iron. Vertical bars on line represent SE (±)
*UTWW= Untreated wastewater
*TWW= Treated wastewater

The concentration of Cu and Mg increased with increasing concentration up to 25% concentration followed by a decline in untreated wastewater while in treated wastewater, Cu and Mg concentration of rice seedlings increased with increasing concentration up to 50% concentration followed by decline (Fig. 9).

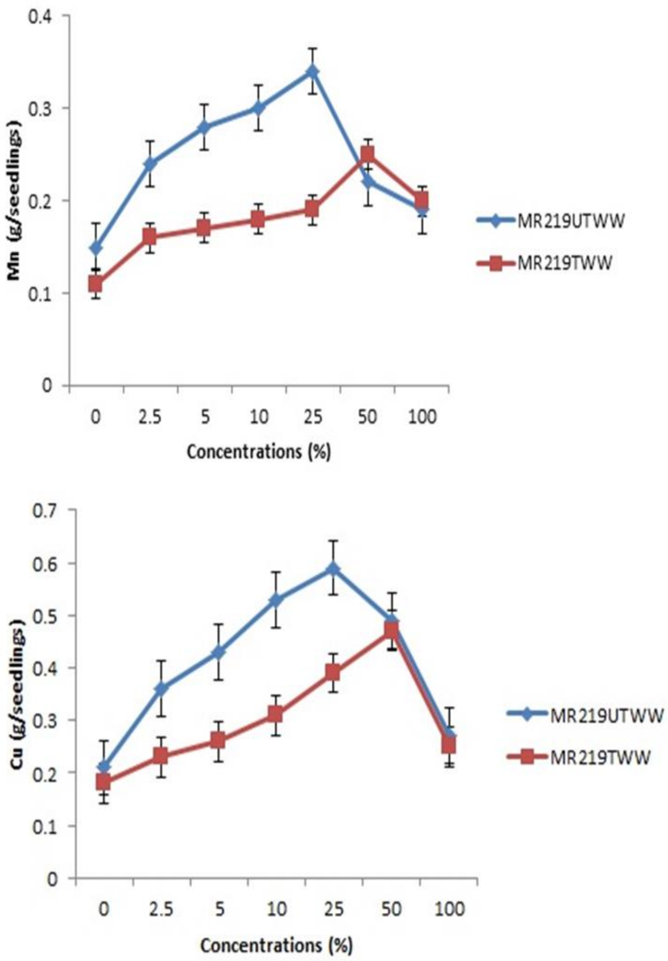


Fig 9: Nutrient uptake in rice seedlings in variety MR219 under different concentration of municipal wastewater irrigation for Cupper and manganese. Vertical bars on line represent SE (±)
*UTWW= Untreated wastewater
*TWW= Treated wastewater

These results above are consistent with the findings of Mojiri and Aziz (2011) who reported that imbibition with wastewater increased Fe, Mn and Zn in roots and leaves of Lepidium sativum. Arora et al., (2008) also observed the similar results that concentration of macro and micronutrients were higher in wastewater irrigated vegetables than in fresh water irrigated plants. The concentrations of the nutrients in the municipal wastewaters at lower concentrations were within the permissible limits for plant development and that which causes toxic effect on plant growth at higher concentrations (Varadarajan, 1992). Increase in the concentration of different minerals in the rice seedlings subjected to different municipal wastewater imbibition were different between untreated and treated wastewater. Untreated municipal wastewater was found to have more mineral nutrients content than treated wastewater. MR219 rice variety had more nutrient uptake when imbibed with untreated municipal wastewater compared to when imbibed with treated municipal wastewater. This might be due to the more nutrient in the untreated municipal wastewater application which might be influencing the physiological process that leads to increase in growth (Singh and Bhati, 2003). Furthermore, higher concentration of untreated wastewater inhibiting nutrients uptake might be due to abnormalities of cells in concentrated wastewater thereby lowering nutrient uptake (Abu and Ezeugwu, 2008). Khan and Sheikh (1976) reported a significant reduction of nutrients uptake under high effluents concentration that might be due to the level of toxicity and osmotic pressure causing lower water uptake. Similar phenomenon may have occurred in this study. Many crop scientists have reported that use of treated and untreated wastewater increased yield parameters of field crops to a certain concentration of wastewater and suggested that treated wastewater can be used for producing better quality crops with higher yields (El-Nahhal et al., 2013). In the present study, seeds imbibed with both treated and untreated wastewater at lower concentration increased nutrients up take which helps in rice plant growth and development.

IV. CONCLUSION

The use of wastewater in plant nourishment would be beneficial water resources for irrigation due to its nutrient contents. Municipal wastewater contains essential nutrients for plant growth and development. Seedlings imbibed with lower concentration of untreated municipal wastewater showed better seedling performance compare to treated municipal wastewater although untreated wastewater contains some hazardous toxic elements. Thus, municipal wastewaters can be used for irrigation purposes in agricultural practices after proper dilutions. It is also suggested that, treatment of municipal wastewaters is necessary to minimize the pollution effects before irrigating the crops. The promotion of seed and seedlings quality parameters at lower concentrations of the wastewater is due to the presence of optimum levels of plant nutrients in the wastewater.

V. ACKNOWLEDGEMENT

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