Chemistry Research Journal, 2019, 4(1):143-148

Available online www.chemrj.org

Research Article

ISSN: 2455-8990
CODEN(USA): CRJHA5

Effects of Water Pollution on Germination and Growth Parameters of *Amaranthus Spp* along Getsi River in Bompai Industrial Area Kano, Nigeria

Abubakar U. Zage[1], Aisha M. Ali[2], *Muhammad Ali[3]

[1]Department of Microbiology, Kano State University of Science and Technology Wudil, Kano
[2]Department of Crop Science, Kano State University of Science and Technology Wudil, Kano
[3]Department of Microbiology, Federal University Gusau
*Corresponding author: Muhammad Ali, Department of Microbiology, Federal University Gusau. Email: alimuhd4real@gmail.com

Abstract Industrial waste is one of the main sources of water and land pollution to the environments and the use of industrial wastewater/effluents in the process of irrigation of food crops especially leafy vegetables has increased in recent years due to shortage of clean water. The study was conducted to observe the effects of irrigation with polluted river water on germination and growth parameters of *Amaranthus spp* using 4 different plots along Getsi River in Bompai industrial area Kano, Nigeria. The physico-chemical properties of the polluted water (pH, electric conductivity, total dissolve solid (TDS), calcium, magnesium, sodium, potassium, nickel, cadmium, lead and zinc), germination rate and growth parameters (Plant height, shoot length, root length, no. of leaves per plant, total no. of plant per plot, moisture content, fresh and dry weight) of the plant were determined. The result indicated that the river water polluted with industrial sewage has higher pH, electric conductivity, and heavy metals concentration. The results also indicated that the seeds germination and the growth parameters of *Amaranthus* plants are affected by water pollution and proximity from the pollution source. There is no statistical difference on growth parameters of the *Amaranthus spp* on the 4 different plots used.

Keywords *Amaranthus spp*, germination, growth, industrial waste, pollution

1. Introduction

Industrial waste is a main source of pollution for all environments. It requires on-site treatment before discharging on land [1]. The problems of disposal of industrial waste whether solid, liquid or gas, all three types of wastes have the potential of ultimately polluting water. This polluted water, in addition to other effects, directly affects soil, not only in industrial areas but also in agriculture fields, as well as the beds of rivers, creating secondary source of pollution [2-3]. The use of industrial wastewater/effluents in the process of irrigation of food crops especially leafy and fruit vegetables has increased in recent years in urban and semi-urban areas due to shortage of clean water [4]. The use has also been promoted by urban farmers due to the belief that such industrial effluents contain high nutrients that can promote rapid vegetative growth of their crops, reduce or eliminate the cost of fertilization either in organic or inorganic form [5-6]. The use of industrial effluents could be a technical solution to reducing soil degradation through chemical pollution of soil [7] without considering the detrimental effects the chemical constituents of such effluents on the physiological processes, morphological and anatomical structures of such crops irrigated with the effluent [8-9].

In Nigeria, most of the urban farmers divert effluents (either known to be treated or untreated) to farmlands to irrigate their vegetable farms to meet up with the rising demand for fresh vegetables [7,10]. Reports have it that in Nigeria, vegetables are produced throughout the year e.g. Fatoba *et al.* [7] due to the availability of industrial effluent to irrigate. However, there should be cautious use of effluents for irrigation of crops that are tender and herbaceous like vegetables.

The reuse of wastewater, in particular for irrigation, is an increasingly common practice, encouraged by governments and official entities worldwide. Irrigation with wastewater may have implications at two different levels: alter the physic-chemical properties and microbiological content of the soil and/or introduce and contribute to the accumulation of chemical and biological contaminants in soil. The first may affect soil productivity and fertility; the second may pose serious risks to the human and environmental health. Kumar and Bhargava [11] cautioned on the deleterious effects of higher concentrations of effluent. Dutta and Bosgya [12] using paper mill and tannery effluent observed decreased chlorophyll content in *Lycopersicon esculentum*. Karunyal *et al.* [13], Somasheka and Siddaramaiah [14] (using soap and detergent effluent) reported the germination of *Pennissetum tyhoides*, *Pisum sativum* and rice seeds were suppressed at various high effluent concentrations. The previous studies mostly focused on the river water chemistry and physicochemical properties in the river water and some studies on seasonal and spatial distribution of heavy metals but, less detailed study on growth, yield and quality of different leafy vegetables has so far been conducted. The present study was conducted to observe effects of irrigation with polluted river water on germination and growth parameters of *Amaranthus spp* along Getsi River in Bompai industrial area Kano, Nigeria.

2. Materials and Methods

Study Sites

The study area was conducted at 4 different irrigation points (Ranji, Mayanka, Gidan kara and Jaba) along Getsi River in Bompai industrial area Kano, Nigeria, where untreated are produced from Bompai industrial area Kano. Kano state is located in the North-west Nigeria with coordinates 11^0 30' N 8^0 30' E. It shares borders with Kaduna state to the south- west, Bauchi state to the South-East, Jigawa state to the East, Katsina state to the West. It has a total area of 20,131km^2 (7,777sqm) and population of 11,058,300 (NPC, 2006).

Table 1: Name and location of different sampling site along Getsi River, Bompai Kano

S/N	Plots	Location	Distance from Industries (Meter)
1	A	Mayanka	500
2	B	Babbar gada	700
3	C	Kwana hudu	1500
4	D	Jaba	2000

Physico-chemical Properties of Water

The physico-chemical tests of water include determination of pH, electric conductivity, total dissolve solid (TDS), calcium, magnesium, sodium, potassium, nickel, cadmium, lead and zinc content using the methods of FAO (1993).

Germination percentage

The number of seeds germinated in each treatment was counted on 12th day after sowing and the germination percentage was calculated by using the following formula:

Germination % = No. of germinated seeds/ Total No. of seeds sown x 100

Measuring Plant Growth and Yield

A field experiment was conducted at irrigation area along Getsi River in Bompai industrial area Kano, Nigeria in order to evaluate the effect of industrial waste/sewage on growth of Amaranthus plants. In this study 4 different plots were used at different location within river Getsi including control with three replicates each. Observations on growth and yield of Amaranthus were taken randomly for five Amaranthus plants from each plot and every

treatment. Plant height (cm), shoot length (cm), root length (cm), no. of leaves per plant, total no. of plant per plot, moisture content, fresh and dry weight of plant were recorded and their mean values were calculated from the sample plants after harvesting. The plant was harvested after 35 days of sowing.

Statistical analysis

Mean of all the parameters were subjected to Analysis of Variance (ANOVA) and means separated by Duncan Multiple Range Test at $p<0.05$. All statistics were carried out with the use of Statistical Package for Social Sciences (SPSS) version 10.7

3. Results

Physico-chemical properties of the water

The physico-chemical properties of the polluted and water used for control is presented in Table 1. The result indicated that the river water polluted with industrial sewage has higher pH electric conductivity, and heavy metals than control water. The cadmium, nickel and lead level of the polluted water is higher than FAO safe limit.

Table 1: Physico-chemical properties of the polluted water and water used as control

Parameter	Polluted water	Control	FAO limit
pH	7.98	6.80	6.5-8.5
Elect. conductivity	55	40	50 - 60
TDS	575	450	0 – 2000
Calcium	51.0	46.5	0 – 20
Magnesium	35.0	40.0	0 – 50
Sodium	64.0	31.0	0 – 40
Potassium	40.0	16.0	0 – 20
Cadmium	0.052	0.01	0.01
Nickel	0.37	0.035	0.2
Lead	0.56	0.048	0.5
Zinc	1.95	0.27	2.0

Germination rate

The germination rate of *Amaranthus spp* irrigated with industrial sewage along River Getsi in Bompai industrial area is presented in Table 2. The control plants were irrigated with ground water and have germination rate of 94%. The result indicated that the seeds germination is affected by irrigation with polluted water and as well the proximity to the source of pollution. This lead to low germination rate in plot A when compared to B, C and D. Higher germination rate (86%) was found in plot D which is located 2000m from the pollution source.

Table 2: Germination rate of *Amaranthus spp* in the study area

Parameters	Plots				
	A	B	C	D	Control
No. of seeds sown	60	60	60	60	60
No. of germinated seeds	39	40	41	43	47
Germination rate (%)	78	80	82	86	94

Effect of Polluted River Water on Growth Parameters

The effect of polluted water on plant growth parameters such as total no. of plant per plot, plant height (cm), shoot length (cm), root length (cm), no. of leaves per plant, fresh and dry weight as well as moisture content of plant was presented in Table 3. The results indicated that the growth parameters of *Amaranthus* plants are affected by water pollution and proximity from the pollution source. The total no. of plants in the all plots varied from 39 to 41 (an average of 40.25). On the other hand, the number of plant in the control plot where normal water used for irrigation is 47. These observed results might be due to use of polluted river water for irrigation which contaminated with different heavy metals and chemicals. The plant height of the plants were ranging from 14.5 to 19.6 cm and the average height of the control plants was 22.1 cm. Root and shoot length of the plants decreased due to application of

polluted river water and proximity from the pollution source ranging from 14.9 to 16.1cm and 3.4 to 3.9 cm for shoot and root respectively. The average shoot and root length of in control treatment is 8.0 and 5.0 cm respectively. The average leaf number per plants ranged from 7.8 to 8.7. However, the average no. of leaf in control plants was 10. The average fresh and dry weights of the plants per plot were ranging from 9.40g to 10.1g and 1.03g to 1.09g, respectively with an average of 12.35g and 1.15 g for control experiment. The average percentage moisture content of the plants were as high as 89.5% in plot D samples, but higher moisture content was recorded in control with 90.6%.

Table 3: Effects of water pollution on growth and yield of Amaranthus spp

Growth parameters	**Plots**				
	A	**B**	**C**	**D**	**Control**
Total number of plants (n)	39	40	41	41	47
Plant height (cm)	17.5±0.8[a]	18.2±0.9[a]	18.3±0.8[a]	19.6±1.1[b]	22±1.0
Shoot length (cm)	14.9±0.6[a]	15.3±0.4[a]	15.9±0.9[b]	16.1±0.4[b]	18±0.9
Root length (cm)	3.4±0.2[a]	3.4±0.3[a]	3.6±0.2[a]	3.9±0.4[a]	5±0.3
Number of leaves (n)	7.8±0.6[a]	7.9±0.3[a]	8.6±0.5[a]	8.7±0.3[a]	10.2±0.6
Fresh weight (g)	9.4±0.7[a]	9.9±0.9[a]	10.2±0.4[a]	10.1±0.5[a]	12.35±1.0
Dry weight (g)	1.03±0.4[a]	1.05±0.3[a]	1.09±0.8[a]	1.06±0.7[a]	1.15±0.8
Moisture content (%)	89.1[a]	89.3[a]	89.3[a]	89.5[a]	90.6

Key: Numbers followed by the same letters in the same row are not significantly different according to Duncan's Multiple range at significant level of $p<0.05$. ± Standard Error, g = Gram, cm = Centimeter

4. Discussion

Industrial waste is one of the main sources of pollution for all environments. The problem of disposal of industrial waste is polluting water. This polluted water, in addition to other effects, directly affects soil, not only in industrial areas but also in agriculture fields, as well as the beds of rivers, creating secondary source of pollution [2-3]. The physico-chemical properties of the polluted and water used for control is this study indicated that the river water polluted with industrial sewage has higher pH electric conductivity, and heavy metals than control water. The cadmium, nickel and lead level of the polluted water is higher than FAO safe limit. Higher level of some heavy metals such as cadmium, nickel and lead in the river water is attributed untreated industrial waste flowing though river and this has negative effects on germination rate, physical growth and yield of irrigated plant using such water.

In this present investigation, some variation was observed on germination rate, physical growth and yield of irrigated plant in accordance to the type of water used and proximity to the pollution source. The finding of the present study showed that the seeds germination is affected by irrigation with polluted water and as well the proximity to the source of pollution. This implies that industrial effluents had negative impact on seed germination of the study plant. The finding of this study justifies the finding of Khan *et al.* [15] and Nagda *et al*. [16] which demonstrated that higher concentration of industrial effluent reduce seed germination rate. Similarly, this result was in conformity with that Islam *et al*., [17] on effect of Industrial effluents on germination of summer leafy vegetables which found that the industrial effluents significantly affects germination, root and shoot elongation of vegetable seeds. In the present study, the finding showed the highest seed germination in control plant. This implies that some compounds in polluted water may alleviate some part of negative impacts. Begum *et al.* [18] reported that the germination rate decreased with increasing the concentration of industrial effluents.

The effect of polluted water on plant growth parameters such as total no. of plant per plot, plant height, shoot length, root length, no. of leaves per plant, fresh and dry weight as well as moisture content of plant indicated that the growth parameters of *Amaranthus* plants are affected by water pollution and proximity from the pollution source. A considerable decreased in length was recorded in plant shoot and root, number of leaves, fresh and dry weight and moisture content. These growth parameters were found more improved in the control plants which were irrigated with normal ground water. This is attributed to the fact that the industrial effluents contained the high amounts of

heavy metals such lead, cadmium, copper and iron which exerted toxic effect on seedling plants leading to decreased shoot growth [17]. The proximity of the plants to the pollution source also play significant role in the growth and developments of the plants. The plants sample in plot A growth poorly when compared to the rest due to its nearness to the industrial area. This is due to the fact that the concentration of the polluted water reduces as it flows further along the river. These results show similarity with the results of Bazai and Achakazai [19] who suggested that plumule length is decreasing in higher concentration of polluted water.

This result also was in conformity with the finding of Panasker and Pawar [20] who studied the effect of textile mill effluent on growth of *Vigna unguiculata* and *Pisum sativum* seedlings and found that the polluted water at low concentration does not inhibit the seedling growth, but at higher concentration germination of seeds and seedlings growth will be affected. Other researcher also reported that waste water contain some essential organic compound which increase growth of crop [21-22].

In the polluted water, there is high value of pH and that of electric conductivity. This high pH of the industrial waste may be the reason for decreasing root and shoot length [23]. Moreover, heavy metals toxicity inhibiting the functions of essential enzymes [24]. Heavy metals are toxic for root growth because they accumulate on the root and retard cell elongation and cell division probably by blocking the hormonal system [25]. Several studies were conducted on the effects of industrial waste on germination rate and growth parameters of different types of plants. The findings of such studies indicated that the effect of high osmotic levels on seed germination and growth is due to toxicity of individual ions or due to osmotic inhibition of water absorption [26]. This previous findings supported the results of the present study that all growth parameters such shoot and root length number of leaver, dry and fresh weight are negatively affected by pollution caused by industrial waste as compared control. There is no statistical differences o the growth parameters of the *Amaranthus spp* on the 4 different plots used.

5. Conclusion

Based on the findings of this study, it may be concluded that irrigation by untreated industrial waste have effect on seed germination and growth of *Amaranthus spp*. These effects were mostly caused by accumulation of heavy metals. The proximity of plants to the pollution source also affects the growth of plant. It is important to treat industrial waste before discharging into water bodies.

References

[1]. Emongor, V., E. Nkegbe, B. Kealotswe, I. koorapetse, S. Sankwasa and S. Keikanetswe. (2005). Pollution Indicators in Gaborone industrial effluent. *Journal of Applied Sciences*, 5(1): 147-150.

[2]. Kisku, G.C., S.C. Barman and S.K. Bhrgava. (2000). Contamination of soil and plants with potentially toxic elements irrigated with mixed industrial effluent and its impact on the environment. *Water Air and soil Pollution*, 120 (1-2): 121-137.

[3]. Barman, S.C., S.K. Sahu, S.K. Bhargava and C. Chatterjee. (2000). Distribution of heavy metals in wheat, mustard and grown in field irrigated with industrial effluent. *Bulletin of Environmental and Contamination Toxicology*, 64: 489-496.

[4]. Arora, M., Kiran, B., Rani, S., Rani, A., Kaur, B., Mittal, S. (2008). Heavy metal accumulation in vegetables irrigated with water from different sources. *Food Chem* 111:811-815.

[5]. Swaminathan, K., Vaidhee-swaran, P. (1991). Effect of dyeing factory effluent on seed germination and seedling development of grountnut (*Arachis hypogea)*. *Environ Biol* 12(3):253-258.

[6]. Ahmed, R., A. Khalid, M. Arshad, Z.A. Zahir and M. Naveed. (2006). Effect of raw (un-composted) and composted organic material on growth and yield of maize (*Zea mays* L.). *Soil & Environment*, 25(2): 135-142.

[7]. Fatoba, P. O., Olorunmaiye, K. S., Adepoju, A. O. (2011). Effects of soaps and detergents wastes on seed germination, flowering and fruiting of tomato (*Lycopersicon esculentum*) and okra (*Abelmoschus esculentus*) plants. *Eco Env Cons* 17(1):7-11.

[8]. Wyszkowski, M. and Wyszkowska, J. (2003). Effect of soil contamination by copper on the content of macro elements in spring barley. *Polish J Nat Sci* 14:309-320

[9]. Kovacic, S. and Nikolic, T. (2005). Relations between *Betula pendula* Roth (Betulacae) leaf morphology and environmental factors in five regions of Croatia. *Acta Biol Cracoviensia* 47:7-13.

[10]. Uaboi-Egbenni, P. O., Okolie, P. N., Adejuyitan, O. E, Sobande, A. O, Akinyemi, O. (2009). Effect of industrial effluents on the growth and anatomical structures of *Abelmoschus esculentus*. *African J Biotechnol* 8(14): 3251-3260

[11]. Kumar, R. and Bhargava, A. K (1998). Effect of sugar mill effluent on the vegetative growth and yield of *Triticum aestivum* CV. U P2003. *Ad Plant Sci* 11(2):221-227.

[12]. Dutta, S. K. and Bosgya, C. L. (1997). Effect of paper mill effluent on germination of rice (*Oryza sativa.* L var Masun) and growth behaviour of its seedlings. *J Ind Pollut* 13(1):41-47.

[13]. Karunyal, S., Renuga, G., Paliwal, K. (1993). Effect of tannery effluent on seed germination, leaf area, biomass and mineral content of some plants. *Bioresourse Technol* 47:215-218.

[14]. Shomasheka, R. K. and Siddaaramaiah, K. (1997). Effect of soaps and detergents factory effluents on soils and crop plants. *J Ind Pollut* 9(2):77-84.

[15]. Khan M.G., Danlel G., Konjit M., Thomas A., Eyasu S.S. and Awoke G., (2011). Impact of textile waste water on seed germination and some physiological parameters in pea (*Pisum sativum* L.), Lentil (*Lens esculentum* L.) and gram (*Cicer arietinum* L.), *Asian J. Plant Sci*., 10, 269-273.

[16]. Nagada G.K., Diwan A.M. and Ghole V.S., (2006). Seed germination bioassays to assess toxicity of molasses fermentation based bulk drug industry effluent, *Eur. J. Environ. Agri. Food Chem.*, 5, 1598-1603.

[17]. Islam, M.M., Hossain, M.M., Mustafizur R., Naznin, A and Sirajum, M. (2015). Effect of Industrial Effluents on Germination of Summer Leafy Vegetables, *International Research Journal of Earth Sciences* 3(6), 16-23.

[18]. Begum S.A., Alam M.J., Rahman S.S. and Rahman M.M., (2010). Effect of industrial effluents on the germination and seedling growth of three leafy vegetables, *Bangladesh J. Sci. Ind. Res.*, 45 (2), 101-104.

[19]. Bazai Z.A., and Achakzai A.K.K., (2006). Effect of waste water from Quetta city on germination and seedling growth of Lettuce (*Lactuca sativa* L.), *J. Applied Sci.*, 6, 380–382.

[20]. Panasker D.B. and Pawar R.S., (2011). Effect of textile mill effluent on growth of *Vigna unguiculata* and *Pisum sativum* seedlings, *Ind. J. Sci. and Tech.*, 4, 266–272.

[21]. Lubello C.., Gori R, Paolo N.F. and Ferrini F., (2004) Municipal-treated waste water reuse for plant nurseries irrigation, *Water Res.*, 38, 2939–2947.

[22]. Nath K., Singh D., Shyam S. and Sharma Y.K., (2009) Phytotoxic effects of chromium and tannery effluent on growth and metabolism of *Phaseolus mungo* Roxb, *J. Environ. Bio.*, 30, 227–234.

[23]. Nawaz S., Ali S.M. and Yasmin A. (2006). Effect of Industrial effluents on seed germination and early growth of *Cicer arientum*, *J. Bio. Sci*., 6(1), 49-54.

[24]. Mayer A.M. and Poljakoff M.A., (1982). The germination of seeds, *Pergamon press*, London.

[25]. Mukharji S. and Mitra P., (1997). Growth and Metabolism of Growing Rice (*Oryza sativa*) seeds as influenced by toxic concentration of lead, *Z. Pflanzen physiol*, 81, 26-33.

[26]. Farid S., (2003). Heavy metal ion concentration in wheat plant (*Triticum aestivum*) irrigated with city effluent, *Pak. J. Sci. Ind. Res*., 46, 395-398.