Journal of agricultural, environmental and veterinary sciences
Issue II - Volume I - June 2017
ISSN: 2518-5780

المجلة العربية للعلوم و نشر الأبحاث
Arab Journal of Sciences & Research Publishing
AJSRP

The Effect of Floatable and Submerged Plants in Treating Drainage Waste Water in Egypt

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Abstract: The study compares the effect of floatable and submerged plants on waste water treatment water samples were collected before and after the presence of the studied plants; floating and submerged one. Anatomical studied of some aquatic plant illustrated pollution parts. Germination experiments were carried out on some crops. El-khairy drain locate in El-Behaira governorate with length of 22.4 Km the study was considered in a reach of 8 Km. in water samples were collected seasonally and analyzed for Biological oxygen demand, Chemical oxygen demand, Nitrate, Cadmium, Lead, Cupper, Iron, ammonia, turbidity, total suspended solid and phosphate. All measured parameters were significantly decreased. compared the result of floating plants to that of submerged one illustrated that P-values of floating plants were more significant in Biological oxygen demand, Chemical oxygen demand, Nitrate, Cadmium, Lead, Cupper and Iron where submerged plants were more significant in removing ammonia, turbidity, total suspended solid and phosphate. The anatomical change illustrated heavy deposit of pollutant in plant cells. Germination experiment show significant increase in germination percent in corn, rice, sesame and wheat from low (60, 51.2, 37.5 and 68.33) detected on drain water to high (61, 77.5,45 and 80) in water after pass on aquatic plans.

Keywords: Floating, submerge, anatomical, germination percent, drainage water

1. Introduction

Phytoremediation is one of the biological waste water treatment methods, (Roongtanakiat et al., 2007). It is the concept of using plants based system and microbiological processes to eliminate contaminants in nature. The remediation techniques utilize specific planting arrangements, constructed wetland, bloating – plant systems and numerous other configurations (Cunningham et al., 1995). The removals of waste water constituents are active by different mechanisms like sedimentation, filtration, chemical precipitation, adsorption, microbial interactions and uptake of vegetation (Hammer, 1989).

The principles of Phytoremediation systems are to clean up contaminated water. Which include identification and implementation of efficient aquatic plant; uptake of dissolved nutrients and metals by the growing plants; and harvest and beneficial use of the plant biomass produced from the remediation system. (LU, 2009),The most important factor in implementing phytoremediation is the selection of an appropriate plant, (Stefani et al., 2011), which should have high uptake of both organic and inorganic pollutants, grow well in polluted water and easily controlled in quantitatively propagated dispersion, (Roongtanakiat et al., 2007).The uptake and accumulation of pollutants vary from plant to plant and also from specie to specie within a genus (Singh et al., 2003).Many researchers have used different plant species like Water Hyacinth, Water lettuce, Duckweed vetiver grass and Common Reed. They have used these species for different types of contaminated waters, effluents etc. This new approach is based on natural processes for the removal of different aquatic macrophytes such as floating, submerged and emergent aquatic plants (Peterson and Teal, 1996), microorganisms (Perkins and Hunter, 2000),algae, substrates and water they have the ability to remove organic and inorganic matter, nutrients, pathogens, heavy metals and other pollutants from wastewater (Naranjo, 1993) in a completely natural way (House et al., 1999;).In last few years a great interest has been shown for research of aquatic saprophytes as good candidates for pollutant removal or even as bio indicators for heavy metals in aquatic ecosystems. It take up large amounts of inorganic nutrients (especially N and P) and heavy metals (such as Cd, Cu, Hg and Zn) as a consequence of the growth requirements and decrease the concentration of algal cells through the light shading by the leaf canopy, and possibly, adherence to gelatinous biomass which grows on the roots Free- floating plants have most of their photosynthetic parts above the surface of the water and their root below it. Typical plant species that have been used in the large scale applications are water hyacinth and duckweed species (Lemna, Spirodela, and Wolffiela) Kadlec, R. H., Knight, R. (1996). Free floating plants can be used as raw sewage as well as for primary or secondary treated effluents Vymazal, J., Brix, H.,Cooper, P. F., Haberl, R., Perfler, R. and Laber, J. (1998). The use of temperate climates of CWs with water hyacinth, one of the most productive plants in the world, is limited, because hyacinth needs high temperature for its growth. The major disadvantage of duckweed compared to water hyacinth is their shallow root system and sensitivity towards wind, however, major advantage is their lower sensitivity towards colder climates U.S. EPA (1998) Nevertheless treating wetland with duckweed in temperate climate is still been used. However, in winter they only work on anaerobic or facultative lagoons, floating leaved macrophytes includes plant species that are rooted in the substrate, and their leaf floated on the surface. *Water lily*, *yellow pond lily* and *lotus* are the typical representative of this group Water primrose is a perennial plant that stands erect along the shoreline but also forms long runners (up to 16 feet) that creep across wet soil or float out across the water surface. The photosynthetic tissue of submerged aquatic plant is entirely submerged. According to Gumbricht, T. (1993), sea moss (*Cladophora sp), green weed (Enteromorpha sp)*, pond weed (*Potomogeton sp), hornwort (Ceratophyllum sp), giant duck weed (Myriophyllum sp), Elodea canadensis and Egeria muttalli, sea lettuce (Ulva lacytuca) and* polishing effluent or eutrophied natural waste. Summing of different removal functions This metal has been found to vary with plant species (Abo Rady, 1980and Low et al., 1984), with different parts of plant (Dinka, 1986 and Nir et al1990), and with the kind of metal and its concentration in growth media (Lee et al., 1981), the use of submerged macrophytes for waste water treatment is still in the experimental stage. The development of epiphytic communities on the leaves of vascular plants may reduce photosynthesis in submerged macrophytes. Because of the shading of submerged macrophytes by algae and their sensitivity towards anaerobic condition, they have found their widest use in tertiary treatment step, The present study was conducted to evaluate the level of various pollutants in El-khairy drain in presence of aquatic plants grown in the drain, one of the first sized drain in Egypt that is heavily polluted with sewage, and domestic to study the effect of floating and submerged plants on concentration of pollutant in the drain and compare efficiency of removal for both and illustrate the anatomical change in some plants and on the germination percent of some crops seeds

2. Materials and Methods

El -Khairy drain is located in El- Behaira governorate crossing the agricultural road of Cairo – Alexandria. The drain is considered an agricultural drain. To achieve the objectives of that study, El- Khairy drain was selected to be studied. The drain is exposed to domestic, agricultural and industrial pollution also treated effluents drain receiving from Damanhour station about150,000 (m3/day) discharge to El-Khairy its water is considered as drainage water that can be used in irrigation where Polluted of waterways resulting from direct discharge of untreated waste water effluents, leading to the spread of diseases, bad odors, and the deteriorated quality of irrigation water, in addition to the negative impacts on potable water stations.

2.1Sampling collection:

In this study El- Khairy drain was studied in four sites: First location: in 0.5 km drain., Second location in 0 .5 km in presence of aquatic plants by length of 3m submerged plants, third location at floating plants three-meter length, fourth location in 1 km after aquatic plant.

2.2- physical and chemical analyses

of all water samples were carried out according to the Standard Methods for the examination of water and waste water (APHA., 1995), Ec ,pH, turbidity, BOD, COD, TSS, NH4, NO3, and Heavy metal(Fe, Cu, pb , and Cd) by using the Atomic Absorption spectrophotometer Model THERMO ICE 3000 series' AAS with hollow cathode lamp for each element being measured .This is followed according to Ediger ,(1973). All statistical analyses were done with SPSS 15.0 (SPSS, Chicago, USA). Independent Paired t-tests were used to evaluate the significance of differences between floatable and submerged plants.

3. Results and Discussion:

3.1 Seasonal variation of pollutants at different sites on El-Khairy drain in aquatic plants found

Water samples took before water plants position, at floating, at submerged plant and after aquatic plants and analyzed for different pollutants results are represented in form of maximum and mean a confidence level of 5% was adopted to evaluate the significance compare result at each site with test

Table (1-1) Seasonal variation of pollutants at different sites on El-khairy drain in aquatic plants found

Parameter		Sample site Before plants	At submerged plants	At floating plants	After plants	Tot al	Nearest canal	p
Temperature C°	Max	30.00	30.00	30.00	30.00	30.	30.00	1.0
	Min	18.00	18.00	18.00	18.00	18.	18.00	
	mean	23.75	23.75	24.00	24.00	23.	23.75	
	P*	0.89						
PH	Max	7.70	7.30	7.10	7.60	7.7	7.40	0.0
	Min	7.50	7.20	7.02	7.20	7.0	7.30	
	LSD	0.00	0.16	0.04	0.28	0.7	0.05	
	P*	0.54						
Turbidity NTU	Max	23.20	13.50	14.00	15.60	23.	7.50	0.0
	Min	15.60	8.60	10.70	11.30	8.6	7.00	
	LSD	0.00	0.04	0.01	0.00	3.9	0.22	
	P*		0.04					
Electrical conductivity	Max	1.70	1.40	1.48	1.38	1.7	0.59	0.0
	Min	1.20	1.20	1.25	1.30	1.2	0.25	
	Mean	1.45	1.30	1.37	1.35	1.3	0.39	
	LSD	0.00	0.00	0.00	0.00			
	P*	0.66						
Total suspended solid mg/L	Max	79.50	28.60	48.60	38.50	79.	23.50	0.0
	Min	70.60	25.00	36.00	35.40	25.	16.50	
	Mean	75.08	26.90	42.65	36.68	45.	20.25	
	LSD	0.00	0.04	0.00	0.00			
Biological	P*		0.002					
oxygen	Max	80.00	50.00	45.00	30.00	80.	14.00	
Demond mg/L	Min	70.00	45.00	31.00	30.00	30.	2.00	0.0
	mean	76.50	46.50	38.75	30.00	47.	6.50	
	P*		0.048					

Temperature variations go along with the normal climatic fluctuation. Table (1-1). Temperature values at different plant sites showed no significant. pH is a measure of the acid balance of solution pH values at different plant site showed significant at ($p <0.05$) compare values to control were showed slightly change to acidic EC values at different plant site showed significant at ($p <0.05$) compare result to control (LSD) show significant at all sites the drain water was more saline than the nearest canal. Total suspended solid max value was in summer before plants and min value was in winter after plants (79.55, 25) mg/L respectively. TSS values at different plant site showed significant at ($p <0.05$) compare of mean difference of water affected with floating and submerged plant in the drain (Paired-T test) showed significant at ($p <0.05$). The mean value of floating is less than that of submerged plants that mean the floating is more effective in purification process with significant 0.02 Compare the values to nearest canal show decrease value after plants each season than the drain water. Biological oxygen demand Were the max value in summer before plants and min value was after plants (80,30) mg/L respectively. BOD values at different plant site showed significant at ($p < 0.05$) source of difference mainly between floating and submerged plants. The compare of mean difference of water affected with float and submerged plant in the drain (paired -T test) showed significant at ($p < 0.05$). that mean the mean value of floating is less than that of submerged plants that the floating is more effective in purification process with significant 0.024 Compare the values to nearest canal show decrease value after plants each season than the drain water increase than the nearest canal . turbidity values at different plant site showed significant at($p < 0.05$) there were decrease in turbidity at submerged site than at floating one due to plant found paired -T test ($p^* < 0.055$)show significant .compare effect at both site with control (LSD)show significant Ammonia The max value was in summer before plants and min value was in winter after plants (12.4,3)mg/L respectively . ammonia values at different plant site showed significant at($p < 0.05$) for each value within plant site that value of submerged is less than that of floating plants that mean the submerged plant is more significant($p < 0.001$) in the purification process than the floating plant . removal pathway of nitrates in wetlands is more effective in purification process with significant (A.M.K. Van de Moortel,2008) chemical oxygen demand table(1-2)Were the max value in summer before plants and min value was after plants (146,40)mg/L respectively . COD values at different plant site showed significant at ($p < 0.05$) compare of mean difference (paired -T test) showed significant at ($p^* < 0.05$). The floating were more effective in purification process with significant 0.013 Compare the values to nearest canal (LSD) show significant drain water increase than the nearest canal .All results show decrease value after plants each season than the water before plants. The seasonal variation of nitrate were .Were the max values were in summer before plants and min value was in spring after plants at submerged plant (40.2,7.2)mg/L showed significant at($p < 0.05$)using ANOVA test for each value within plant site that mean the results (paired-T test)showed significant at ($p^* < 0.05$). The floating plant is more significant in the purification process. phosphate The max value was in summer before plants and min value was in summer after plants (4.7.2,2.8)mg/L respectively ANOVA test show significant at ($p < 0.05$)compare result to control(LSD)show significant .main effect resulting from floating and submerged plants in the drain (paired -T test)showed no significant at ($p^* < 0.05$)The mean value of floating relatively equal that of submerged one(2.89-3.02)that both have same effect on purification process Seasonal variation in Heavy metals(Iron, Cupper, Cadmium ,Lead)all show max in summer before plants where min after plants except min of lead record at floating plants . Compare means using ANOVA test show significant and compare results to control (LSD)shows significant and compare mean of submerged and floating results (paired -T test)to determine more effective purification one this comparison shows the floating is more effective in purification process .water analysis of heavy metal represent that floating plants more effective in absorb and accumulate heavy metal Generally the submerged plants show less accumulation of heavy metals. Same results were recorded in present study. The

Table (1-2) Seasonal variation of pollutants at different sites on El-khairy drain in aquatic plants found

		Sample site						
		Before plants	At submerged plants	At floating plants	After plants	Total	Nearest canal	P
Chemical oxygen demand (COD) mg/L	Max	146.00	77.00	62.00	70.00	146.	47.00	0.0
	Min	97.00	57.00	40.00	50.00	40.0	12.00	
	mean	118.50	68.00	49.00	55.25	72.6	28.25	
	LSD	0.00	0.01	0.01	0.03			
	P*	0.036						
Ammonia mg/L	Max	12.40	5.00	8.50	6.00	12.4	0.51	0.0
	Min	6.60	3.00	4.20	3.00	3.00	0.33	
	mean	9.13	3.88	6.45	4.25	5.93	0.42	
	LSD	0.00	0.00	0.00	1.50	2.71	0.07	
	P*	0.046						
Nitrate mg/L	Max	40.20	33.40	31.50	30.10	40.2	2.70	0.0
	Min	11.60	8.50	8.50	7.20	7.20	1.40	
	mean	19.55	15.35	15.03	13.83	15.9	2.19	
	LSD	13.80	12.05	11.01	10.89	10.9	0.56	
	P*	0.03						
Phosphate mg/L	Max	4.70	3.57	3.66	3.40	4.70	0.30	0.0
	Min	4.09	2.89	3.02	2.80	2.80	0.10	
	mean	4.32	3.20	3.35	3.05	3.48	0.16	
	LSD	0.0000	0.0000	0.0010	0.002	0.57	0.09	
	P*	0.5						
	Max	0.80	0.56	0.33	0.29	0.80	0.06	
Fe mg/L	Min	0.53	0.42	0.23	0.20	0.20	0.00	
	mean	0.69	0.50	0.27	0.26	0.43	0.04	0.0
	LSD	0.04	0.04	0.04	0.04			
	P*	0.02						
	Max	1.22	0.20	0.11	0.06	1.22	0.30	
	Min	0.92	0.13	0.06	0.04	0.04	0.30	0.0
Cu mg/L	mean	1.14	0.17	0.08	0.05	0.36	0.30	
	LSD	0.00	0.01	0.01	0.00		0.00	
	P*	0.005						
	Max	0.16	0.09	0.06	0.06	0.16	0.01	
Pb mg/L	Min	0.08	0.06	0.02	0.04	0.02	0.01	0.0
	mean	0.13	0.08	0.04	0.05	0.07	0.01	
	LSD	0.00	0.00	0.02	0.01	0.04	0.00	
	P*	0.01						
Cd mg/L	Max	0.44	0.32	0.19	0.18	0.44	0.01	
	Min	0.22	0.20	0.14	0.13	0.13	0.01	
	mean	0.34	0.28	0.16	0.16	0.24	0.01	0.0

	LSD	0.00	0.00	0.01	0.01			
	P*	0.01						

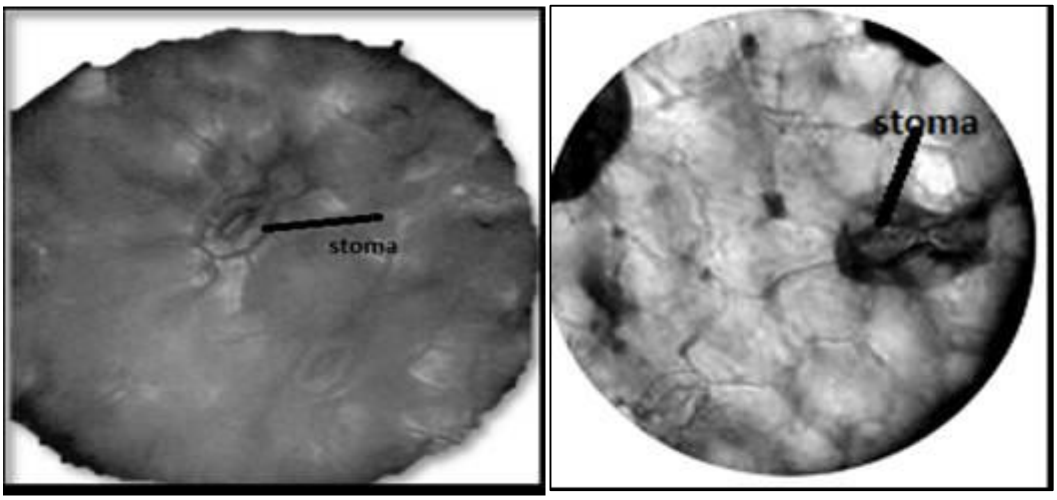
P Anova test p* Paired -T test LSD least significant deference

submerged species C. demersum showed least accumulation of heavy metals **Lovett-Doust, 1994**

The anatomical change of some aquatic plants

Plants that use in phytoremediation process they have developed a range of resistance mechanisms, which enable them to avoid and/or tolerate stress factors and survive even in highly contaminated soils and waters (Levitt 1980). Defense strategies can be divided into avoidance and tolerance types. Avoidance includes all mechanisms, which protect the plant cell from Trace metals entering the protoplast. Tolerance concerns those mechanisms that enable the plant to: (1) neutralize toxic metals inside the cell, (2) remove them from the protoplasts (e.g., to the apoplast) and (3) neutralize their toxic effects (Levitt J., 1980). Thus, outside the protoplast Trace metals are: accumulated by mycorrhizal fungi Levitt J 2002, chelated within the rhizosphere, bound by the CELL WALL compounds and blocked in their migration by the callose layer. Inside the cell, Trace metals are, e.g., chelated by metallothioneins, phytochelatins, organic acids and other compounds, and sequestered within the vacuole (V). One of the main strategies of plant cells for coping with Trace metals is to remove them from the cytoplasm by sequestration in extra cytoplasmic compartments such as the cell wall and the V. It protects the most sensitive sites within the protoplast from TM's toxicity (Vollenweider, 2006) tolerant to increase pollutants concentration in many self-defense action this was illustrated in the following

Morphological change in duckweed



A B

a-plants Magnified view (100x) of the upper surface of Lemna gibba showing a pore slit (stoma) in a control plant from canal ,b plant from polluted drain with stoma and polluted cells

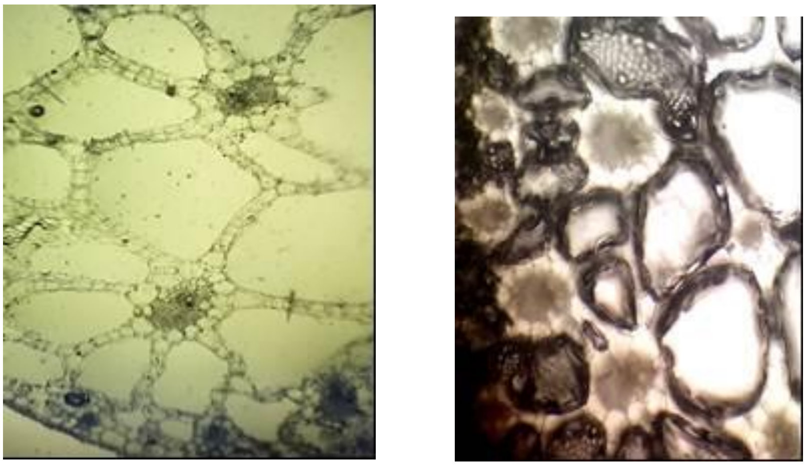
Aerenchyma tissue in the duckweed L (100x). The large intercellular spaces are surrounded by layers of choroplast-bearing parenchyma cells. The air-filled spaces provide buoyancy for the duckweeds, keeping them afloat on the water surface. Although enlarged air spaces may provide a competitive advantage for increased buoyancy, some species have greatly reduced air spaces and float below the water surface(Armstrong,2011).in control plant cells show no pollutants deposit in cell wall where in the polluted plant pollution deposits in the stoma cell wall and parenchyma cell wall

The anatomical change in root cells of water hyacinth

A B

Control cell show less deposit where no clear streams but cells appear in order and no destruction is noticed where in polluted root. Airenchyma cell have all the deposit of the pollutants that case destruction to some cells where the great deposit in the lateral roots and then remove it out of plant body similating tissues and epidermis of the plants from polluted sites variable deposits of polifenolic compounds are observed. In the midveins, there were black deposits along the walls of xylem and phloem vessels as compared to their respective controls (Gostin, 2009)

Anatomical change in petiole of water hyacinth



A B

a-is the control plant from canal,b is the plant from the drain in 100x magnifiy

The control cell show clear cell wall with no filled deposit, where in the polluted plant from the drain cell wall is full of polluted deposit one can distinguish clearly between both that help to use this way as indicator to polluted water. The study was agree with(Gupta, 2005). The histological modifications which occurred may potentially be used as biological markers for air pollution presence. Pollution stress altered the structure of the leaves of the investigated species. Nevertheless, these species are quite resistant to pollutant actions and despite the observed modifications they continue to grow and reach maturity (flowering stage). Various authors underlined the reduction of plant growth, as a consequence of pollution stress

4. Germination experiments

Sesame germination percent

Sesame germination percentage affected with the increase of water pollution and decreases the final germination percentage fig 1. Germination percent was low in water before plants treatment higher in water after plants treatment than. The values were (37.5,45), P-value was significant between the germination percent in seed irrigated with canal water control ,germination percent in seed irrigated with water after plant treatment, germination percent in seed irrigated with water before plants

Wheat germination percent

Wheat germination percentage affected with the increase of water pollution and decreases the final germination percentage fig 2 . Germination percent was low in water before plants treatment higher in water after plants treatment than. The values were (68.33, 80). P-value was significant between the germination percent in seed irrigated with canal water control, germination percent in seed irrigated with water after plant treatment, germination percent in seed irrigated with water before plants

Corn germination percent

Corn germination percentage affected with the increase of water pollution and decreases the final germination percentage fig 3 . Germination percent was low in water before plants treatment higher in water after plants treatment than. The values were (60, 61.66). P-value was significant between the germination percent in seed irrigated with canal water control, germination percent in seed irrigated with water after plant treatment, germination percent in seed irrigated with water before plants

Rice germination percent

Rice germination percentage affected with the increase of water pollution and decreases the final germination percentage fig 4. Germination percent was low in water before plants treatment higher in water after plants treatment than. The values were (51.25,77.50). P-value was significant between the germination percent in seed irrigated with canal water control, germination percent in seed irrigated with water after plant treatment, germination percent in seed irrigated with water before plants

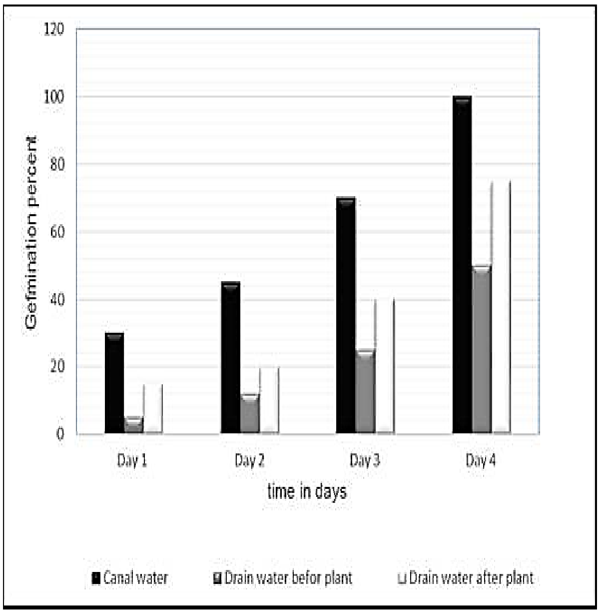


Fig. 1. Sesame germination percent

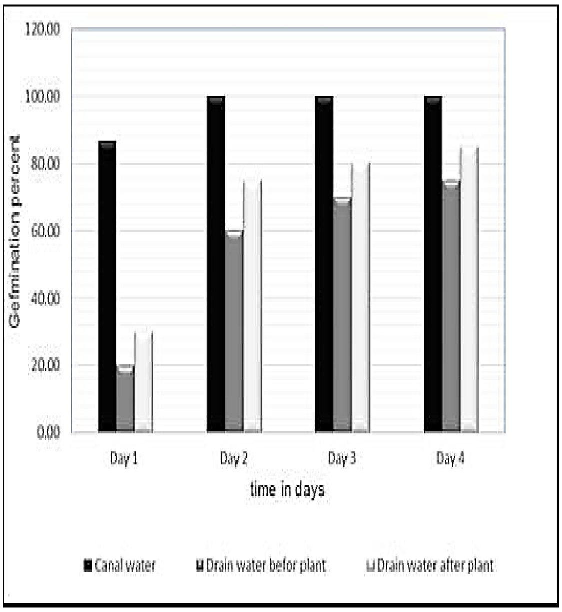


Fig. 2. Wheat germination percent

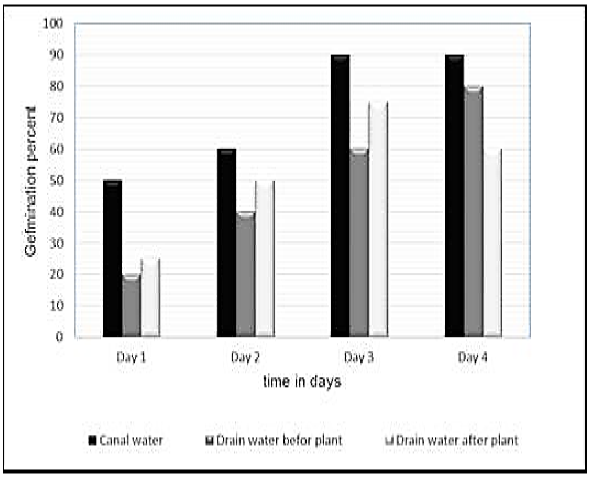


Fig. 3. corn germination percent

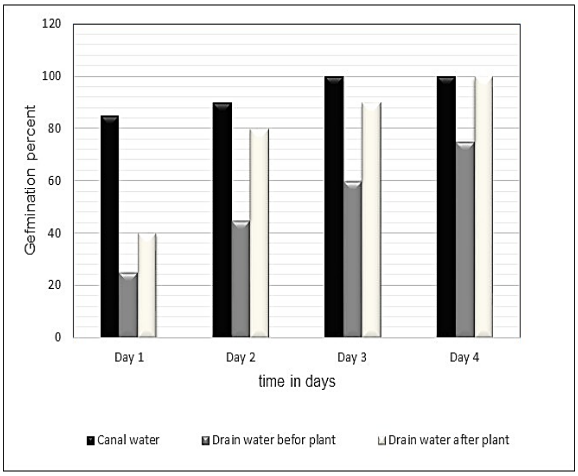


Fig. 4. rice germination percent

Seed germination was decreased by salinity levels > 6 dS m-1, while DM and grain yields were decreased by salinity levels of 12 dS m-1. Soliman *et al.* (1994),

5. Conclusion

Use of both floating and submerged plant were effective in decrease the concentration of contaminants. anatomical change in plants grew in polluted drain could be used as indicator for the contaminates specially by heavy metal. the germination experiment confirmed the purification of water after treated with aquatic plants

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تأثير النباتات الطافيه و المغمورة فى معالجة المياه الملوثة فى مصر

الملخص :

الدراسة تقارن تأثير النباتات الطافيه والمغمورة فى معالجة المياه الملوثة عينات المياه تم جمعها من قبل و بعد النباتات موضع الدراسه وهى النباتات الطافيه و النباتات المغمورة وتم عمل دراسه تشريحية للنباتات التى قامت بعملية التنقية و إجراء تجربه الإنبات لتقييم المياه بعد عمليه التنقية مصرف الخيرى بدمنهور بطول 22.5 كم الدراسه تمت فى مسافه قدرها 8 كم من المصرف وتم جمع عينات المياه موسميا وتحليلها لتقدير الأكسجين المستهلك بيولوجياوالأكسجين المستهلك كميائياوالنترات و الآمونيا و العكارة والأس الهيدروجينى و الملوحة و الفوسفوروالكادميوم والنحاس والرصاص و الحديد كل العناصر المقدرة انخفضت تركيزاتها وبمقارنه تأثير النباتات الطافيه و المغمورة إحصائيا كانت النباتات الطافيه أكثر قدره عن المغمورة فى العناصر الآتية لتقدير الأكسجين المستهلك بيولوجياوالأكسجين المستهلك كميائياوالنترات و والكادميوم والنحاس والرصاص و الحديد وكانت النباتات المغمورة الأكثر كفاءة فى تنقية الآمونيا و العكارة والمواد الصلبه وأوضحت التغيرات التشريحية وجود ترسيبات كثيفة للملوثات فى خلايا النباتات موضع الدراسة وكانت نسبه إنبات للذره و الارز و السمسم والغله من 60 و51.25 و37.5 و68.333 الى 61و77.5و45و80 بعد مرور الماء على النباتات المائية

الكلمات المفتاحيه :النباتات الطافيه و النباتات المغمورة والتشريح ونسبه الإنبات وتلوث المياه والمياه الملوثة