CAN EM BIOSTIMULANT REDUCE THE HAZARDS OF SANITARY WATER WHEN USED AT VARIOUS LEVELS FOR IRRIGATION OF NEEM (*AZADIRACHTA INDICA* L.) SEEDLINGS

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Abstract

An investigation was conducted under the full sun at the nursery of Hort. Res. Inst., ARC, Giza, Egypt during 2013 and 2014 seasons to examine the effect of blending irrigation water with primary treated sanitary water at the levels of 0, 25, 50, 75 and 100 %, alone or in the presence of the effective microorganisms (EM) biostimulant, which added with irrigation water at the rate of 3 ml/l on growth and chemical composition of 10-months-old Neem (*Azadirachta indica* L.) seedlings cultivated in 16-cm-diameter black polyethylene bags filled with about 3.5 kg of clay and sand mixture (1:1, v/v). The obtained results indicated that means of all vegetative and root growth parameters were significantly increased as a result of irrigation with sanitary water up to 75 % level where the level of 50% sanitary water treatment gave the highest means compared to those of the control and other levels of sanitary water in the two seasons. A pure sanitary water (100 % level) slightly reduced means of various growth traits to become less than those of control with non-significant differences among them in most instances of both seasons. Application of 3 ml/l of EM to any level of sanitary water caused additional improvement in all vegetative and root growth measurements, even with 100 % sanitary water treatment that recorded growth rates better than control ones with significant differences among them in most cases of the two seasons. However, the mastership in both seasons was for combining between 50 % sanitary water level and 3 ml/l EM treatment which gave the highest averages compared with the other individual and combined treatments. A similar trend to that of vegetative and root growth characters was also obtained in respect of chlorophyll a, b and carotenoids content in the leaves, as well as total soluble sugars content in the stem, leaves and roots. The contents of phosphorus and potassium in the stem, leaves and roots were inconsistent, with no specific trend as observed in other chemical constituents. The content of lead (Pb) and cadmium (Cd) in the different parts of plants showed a progressive increment with increasing sanitary water percent in ml irrigation water, but was greatly declined by applying of 3 ml of EM to the each liter of irrigation water regardless of its quality, indicating ability of such biostimulant in bioremediation of waste water.

Hence, it is recommended to apply EM biostimulant at the rate of 3 ml/l to primary treated sanitary water when used for irrigation of Neem nurselings to minimize the hazards of such water, especially when used at 75 or 100 % levels.

Keywords: Neem, *Azadirachta indica* L., Sanitary water, EM, Vegetative and root growth and chemical composition.

INTRODUCTION

Azadirachta indica L. (Syn. *Azadirachta indica* A. Juss., *Melia indica* (A. Juss) Brandis), Neem, or Indian Lilac, is a fast growing evergreen tree in the mahogany family (Meliaceae). It can reach a height of 15-20 m, sometimes to 30 m or more. It is grow well in tropical and sub-tropical regions (Huxley *et al.*, 1992). It is one of the very few shading trees that thrives in drought-prone areas for shade lining streets around temples, schools and any public buildings or in most people's back yards. It is of great importance for its anti-desertification properties and possibly as a good carbon dioxide sink. It can grow in many different types of soil, but it thrives best on well drained deep and sandy soils. It can tolerate high to very high temperatures, but does not tolerate temperature below 4 °C. It is not delicate about water quality and thrives on the meret trickle of water, whatever the quality (Portser, 2006).

Due to the scarcity of water resources and increasing demand for water, exploitation of sanitary water to irrigate ornamental and woody plants, which are not food chain crops may be the proper solution and economic way for its disposal in safe manner plus alleviate the water shortage problem. However, reuse of such water showed variable responses by various woody plant species. In this regard, Hassan *et al.*, (2003) found that growth of *Acasia saligna*, *Albizia lebbeck*, *Melia azedarach*, *Taxodium distichum* and *Tipuana speciosa* was considerably different in response to irrigation with sewage effluent for a period of 8 years, where *T. distichum* was the most suitable tree for irrigation timber plantations on the basis of wood production. A great variable was also found in uptaking of Cu, Cd, Mn, Pb, Ni and Zn elements due to tree species. Likewise, Shahin and El-Malt (2006) concluded that *Tipuana tipu* was the most suitable tree for arboriculture of the sandy soil irrigated for many years with sanitary water, followed by *Acacia nilotica* and then *Quercus suber*.

Utilization of *Melia azedarach* fruit based adsorbents for the removal of heavy metals showed that 100 mg of *Melia azedarach* adsorbent removed about 95 % of Cu ions, while 69-85 % of Ni ions were only removed (Kaur *et al.*, 2011). This observation was also demonstrated by the results of Pandey *et al.*, (2011), Pandey and Srivastava (2012) and Singh and Srivastava (2014) whom reported that vegetation filter system for pollutants removal from waste water using *Eucalyptus hybrid*, *Populus deltoides*, *Salix alba* and *Melia azedarach* timber species for treatment of domestic waste water and can be also helpful in fulfilling the wood requirement of villagers and local market.

A commercial Japanese product, EM is a biostimulant that contains more than 60 selected strains of "Effective Microorganisms", viz., photosynthetic bacteria, lactic acid bacteria, yeast, actinomycetes and various fungi that improve growth and health of plants (Primavesi, 1999). Furthermore, Janas (2009) stated that EM is characterized by a wide spectrum of activity and complex effect on plant living environment. Thus, it may be used as foliar treatments, or as-soil drench. Its effects including plant disease resistant, yield creating and protective were observed in many industrial, medicinal and ornamental plants. It is also creating humus and regulates basic relations in the soil. So, it is used in many countries, on a large scale in organic production of agricultural crops. This was emphasized by Kirithiga (2010) who mentioned that EM, a culture of coexisting beneficial microorganisms predominantly consisting of lactic acid bacteria, photosynthetic bacteria, yeast, fermenting fungi and actinomycetes usually enhances microbial turnover in soil and thus known increase soil macro-nutrients and increases plant growth and yield. Furthermore, Miyajima *et al.*, (2001) confirmed that the use of EM and EM bokashi suppressed generation of dioxins through increasing the activity of lignin-decomposing enzymes in soil and the population of soil microorganisms (including Pseudomonas) and diversifying the soil microflora. So., the EM can be used as an effective method for bioremediation of the soil environment. Quang (2001) added that EM is very effective in treating waste water discharge from hospitals and slaughtering, reducing stink, putrid smell and BOD, COD, TSS and coliform indices and other pathogenic microorganisms. EM is easy and convenient to use, safe and inexpensive.

The beneficial effects of EM biopreparations on trees were indicated by Khan *et al.*, (2006) on *Albizia procera,* Khan *et al.*, (2006) on *Albizia saman*, Khan *et al.*, (2011) on *Dalbergia sissoo,* Mohammed *et al.*, (2013) on *Coffea arabica* and Khan *et al.*, (2014) whom reported that 2 % EM solution gave the highest germination rate of *Acacia auriculiformis* seeds and the highest shoot and root lengths of the resulted seedlings. Both fresh and dry weights of shoots were maximum with the application of 2 % EM, while both fresh and dry weights of roots were maximum with 5 % EM solution. Although the highest vigour index, volume index and sturdiness were found, in 2 % EM, the highest quality index was found in 5 % EM solution. The contents of chlorophyll a, b and carotenids were maximum in 2 % EM solution.

The present work, however aims to explore the beneficial effects of fertigation with effective microorganisms (EM) on growth and quality of Neem seedlings irrigated with different strengths of sanitary water.

MATERIALS AND METHODS

The current work was performed under the full sun at the nursery of Hort. Res. Inst., ARC, Giza, Egypt throughout the two consecutive seasons of 2013 and 2014 to detect the effect of sanitary water blended with irrigation water at various levels in presence or absence of EM biostimulant on growth and chemical composition of Neem plants.

Thus, uniform 10-months-old seedlings of Neem (*Azadirachta indica* L.) of about 40 ± 2 cm height were transplanted on March, 15th for the two seasons in 16-cm-diameter black polyethylene bags (one seedling/bag) filled with about 3.5 kg of a mixture of clay and sand at equal volumes. The physical and chemical properties of the used mixture are shown in Table (1).

Table (1): The physical and chemical properties of clay and sand used in the two seasons.

Soil type	Particle size distribution (%):				S.P.	E.C	pH	Cations (meq/L)				Anions (Meq/L)		
	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{--}
Clay	7.46	16.75	34.90	40.89	41.67	2.18	8.33	16.93	9.33	20.44	0.37	3.82	1.46	41.79
Sand	18.72	71.28	4.66	5.34	21.80	1.58	8.14	2.65	2.48	21.87	0.78	3.85	13.00	10.93

The seedlings were irrigated immediately after culturing with 1500 ml of one the following water treatments.

1- Fresh water, referred to as control (EC = 0.42 dS/m).

2- Primary treated, sanitary water obtained from Zenein Waste Water Treatment Plant, Zenein, Giza governorate then blended with irrigation water at the levels of 25, 50, 75 and 100 % sanitary water. The chemical analysis and pathological characteristics in 3 samples of sanitary water used in both seasons were determined and illustrated in Tables (2) and (3), respectively.

Table (2): Chemical analysis of the three sanitary water samples.

Sample	E.C. (ds/m)	pH	Cations (meq/L)						Anions (Meq/L)				Heavy metals (ppm)			
			P^{3+}	Ca^{2+}	Mg^{2+}	NH_4^+	K^+	Na^+	HCO_3^-	NO_3^-	Cl^-	SO_4^{--}	Fe	Zn	Pb	Cd
1	1.28	7.80	2.55	1.50	3.68	19.61	6.84	0.81	6.28	1.96	5.17	21.58	0.91	0.46	0.078	0.012
2	1.12	7.50	2.30	2.15	1.96	15.68	7.33	0.67	5.74	2.33	5.46	16.56	0.84	0.63	0.09	0.009
3	1.20	7.60	2.43	1.65	2.80	17.10	6.40	0.75	6.11	1.7	5.33	17.99	0.87	0.51	0.083	0.011

Table (3): Detecting of pathogenic indicators, Salmonella & shigella and human parasites in the three samples of sanitary water used in both seasons.

Pathogenic indicators	Detection			Human parasites	Detection		
	1	2	3		1	2	3
Total coliform becteria	d	d	d	E. Histylotica Cyst.	d	D	d
Fecal coliform becteria	d	d	d	G. lamblea	d	D	nd
Salmonella & Shigella	d	nd	d	E. coli, Raund-and Hook worms	d	D	d

d = detected, and nd = non detected.

3- Each type (level) of sanitary water was amended with 3 ml/l of the commercial Japanese biostimulant that contains more than 60 strains of effective microorganisms (EM), viz., lactic acid bacteria, photosynthetic bacteria, yeasts, fermenting fungi and actinomycetes to form 4 combined (fertigation) treatments.

Through the course of this study, the Neem seedlings were irrigated once every 2 days with 750 ml/bag of the various water quality used and also, received the usual agricultural practices necessary for such plantation whenever needed.

The layout of the experiment in the two seasons was a completely randomized design (Das and Giri, 1986) with 3 replicates as each replicate contained 5 plants, i.e., 15 plants in each treatment.

At the end of each season (on 15^{th} of October), the following data were recorded: plant height (cm.), stem diameter at the base (cm.), number of branches and leaves/plant, root length (cm.), number of roots/plant as well as fresh and dry weights of stem, leaves and roots. In fresh leaf samples taken from the middle parts of the plants in the only second season, photosynthetic pigments content (chlorophyll a, b and carotenoids, mg/g f.w.) was measured according to the method of Moran (1982), while in dry samples of stem, leaves and roots, the percentages of total soluble sugars (Dubois *et al.*, 1966), nitrogen (Pregl, 1945), phosphorus (Luatanab and Olsen, 1965), potassium (Jackson, 1973), as well as the content of lead (Pb) and cadmium (Cd) in ppm (Jackson, 1973) were also determined.

Data were then tabulated and the morphological ones were statistically analyzed using SAS Institute program (1994) followed Duncan's Multiple Range Test (Duncan, 1955) to verify the significance between means of various treatments.

RESULTS AND DISCUSSION

Effect of sanitary water in the absence or presence of EM on:

A- Vegetative and root growth traits:

According to data presented in Tables (4, 5 and 6), it is clear that sanitary water up to 50-75 % blended level significantly increased means of the different vegetative and root growth parameters relative to control means in the two seasons, with the superiority of 50 % sanitary water level which gave the highest values compared to other levels in both seasons. However, 100 % sanitary water slightly reduced means of various growth parameters to be less than means of control, but without significant differences among them in most cases of the first and second seasons.

Improvement growth of plants irrigated with 25-75 % sanitary water may be ascribed to the direct role of this water in enhancing soil fertility by adding some nutrients and organic matter which in turn, improve soil physical and chemical properties (Kanekar *et al.*, 1993), meanwhile reduction of growth by 100 % sanitary water level may be ascribed to accumulation of some toxic and heavy metals that may induce chlorosis, leaf abscission and some physiological disorders (Gogate *et al.*, 1995) or may be due to contamination with some pathogens and parasites that cause infestation with some plant diseases, which consequently affect negatively growth and health of plants (Norman *et al.*, 2003). The abovenamed results are in accordance with those attained by Hassan *et al.*, (2003) on *Acacia saligna*, *Albizia lebbek*, *Melia azedarach, Taxodium distichum* and *Tipuana speciosa*, Shahin and El-Malt (2006) on *Tipuana tipu, Acacia nilotica* and *Quercus suber*, Kaur (2001) on *Melia azedarach* and Singh and Srivastava (2014) on *Eucalyptus hybrid*, *Populus deltoides, Salix alba* and *Melia azedarach*.

On the other hand, application of 3 ml/l of EM to sanitary water at any level (as fertigation treatments) markedly improved all vegetative and root growth characters, even with 100 % sanitary water treatment, which recorded growth averages better than those of control. The prevalence however was for 50 % sanitary water + 3 ml/l EM combined treatment, as it gave the highest values over the various individual or combined treatments in the two seasons. This may be attributed to lump the beneficial effects of both the medium level of sanitary water (50 %) and the biostimulant EM.

In this regard Janas, (2009) stated that, EM activated growth, induced plant disease resistance, creating humus and regulated basic relations in the soil. It has ability to break down organic matter, thereby providing plant nutrients and enhancing soil physical and chemical properties (Sangakkara and Marambe, 1999). Also, Bhasme *et al.*, (2006) noted that EM decomposed agricultural substrates faster than other biological decomposers. Miyajima *et al.*, (2001) indicated that EM bio-preparations prevented generation of dioxins through increasing the activity of lignin-decomposing enzymes in soil and diversifying the soil microflora. So, it can be used for bioremediation of the soil environment. Besides, Quang (2001) claimed that EM is very effective in treating waste water, reducing stink, putrid smell and BOD, COD, TSS and coliform indices and other pathogenic microorganisms. These findings are supported by those elicited by Khan *et al.*, (2006) on *Albizia procera*, Khan *et al.*, (2011) on *Dalbergia sissoo,* Mohammed *et al.*, (2013) on *Coffea Arabica* and Khan *et al.*, (2014) on *Acacia auriculiformis*.

Table (4): Effect of sanitary water at various percentages, alone or combining with EM biostimulant on vegetative growth parameters of *Azadirachta indica* L. plant during 2013 and 2014 seasons.

Treatments	Plant height (cm.)		Stem diameter (cm)		No. of branches/ plant		No. of leaves/ plant	
	2013	2014	2013	2014	2013	2014	2013	2014
Control	115.33g	119.00e	0.80cd	0.86c	1.33d	1.33d	28.00e	29.33e
25 % sanitary water (SW)	121.40ef	122.33de	0.83c	0.90c	1.40d	1.37d	33.56de	35.00d
50 % S.W.	151.40b	153.00b	1.02b	1.10ab	2.75b	3.00ab	42.33b	43.78b
75 % S.W.	124.33e	126.67d	0.95bc	1.03b	1.68c	1.76c	35.81d	37.29cd
100 % S.W.	112.78g	114.50f	0.78d	0.84c	1.00d	1.00d	28.00e	27.36e
25 % S.W. + 3 ml/l EM	120.67e-g	123.98de	0.85c	0.90c	1.46cd	1.50cd	35.00d	36.12d
50 % S.W. + 3 ml/l EM	156.10a	158.71a	1.21a	1.33a	4.00a	3.89a	52.33a	53.21a
75 % S.W. + 3 ml/l EM	146.21c	136.33c	1.30ab	1.16ab	2.91b	2.67b	41.67b	42.90b
100 % S.W. + 3 ml/l EM	138.00d	129.00cd	0.99bc	1.08ab	1.80c	1.63c	39.36c	40.67c

Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test at 5 % level.

Table (5): Effect of sanitary water at various percentages, with or without EM biostimulant on fresh and dry weights of *Azadirachta indica* L. stem and leaves during 2013 and 2014 seasons.

Treatments	Fresh weight (g)				Dry weight (g)			
	Stem		Leaves		Stem		Leaves	
	2013	2014	2013	2014	2013	2014	2013	2014
Control	22.00e	23.51e	21.90f	23.03f	6.29e	7.70e	5.64e	6.60e
25 % sanitary water (SW)	26.07d	28.82d	27.30e	31.00e	9.54d	10.00d	9.17d	9.46d
50 % S.W.	39.00b	41.08b	44.12bc	45.33bc	14.13b	14.89bc	16.50b	16.63bc
75 % S.W.	32.60c	33.73c	33.40d	34.92de	11.67cd	12.01c	10.15cd	10.71cd
100 % S.W.	20.86e	21.67e	22.78f	23.10f	6.30e	7.48e	6.67e	6.84e
25 % S.W. + 3 ml/l EM	28.93cd	31.70cd	37.26cd	38.21d	10.42d	11.05d	9.98d	10.00d
50 % S.W. + 3 ml/l EM	48.67a	51.42a	52.67a	53.11a	16.39a	17.56a	18.20a	20.17a
75 % S.W. + 3 ml/l EM	47.00ab	46.59ab	46.15b	47.80b	15.50ab	15.19b	17.11ab	17.89b
100 % S.W. + 3 ml/l EM	31.93c	30.47cd	41.90c	43.02c	12.27c	11.70cd	11.25c	11.71c

Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test at 5 % level.

Table (6): Effect of sanitary water at various percentages, alone or combining with EM biostimulant on root growth parameters of *Azadirachta indica* L. plant during 2013 and 2014 seasons.

Treatments	Root length (cm)		No. of main roots/plant		Roots fresh weight (g.)		Roots dry weight (g.)	
	2013	2014	2013	2014	2013	2014	2013	2014
Control	34.33de	36.50c	5.66de	6.33cd	9.07e	9.48d	2.92c	3.64c
25 % sanitary water (SW)	36.00d	37.18c	6.00d	6.67c	13.30d	13.74c	4.66bc	4.53bc
50 % S.W.	48.67ab	50.33a	8.67b	9.00ab	16.23b	17.10ab	5.69ab	6.02a
75 % S.W.	43.92b	45.10b	8.00bc	7.67b	14.70c	15.03bc	5.10b	4.98bc
100 % S.W.	33.58e	35.72c	5.00e	5.39d	8.79e	9.36d	2.83c	3.58c
25 % S.W. + 3 ml/l EM	40.67c	41.50bc	7.93c	7.54b	15.03c	15.34b	5.27b	5.41ab
50 % S.W. + 3 ml/l EM	51.00a	50.96a	10.00a	9.76a	18.97a	18.51a	6.58a	6.31a
75 % S.W. + 3 ml/l EM	49.33a	50.00a	9.33ab	9.27a	16.79b	17.00ab	5.43b	5.60ab
100 % S.W. + 3 ml/l EM	43.50b	44.33b	7.24c	7.39bc	13.90cd	14.00c	4.48bc	5.31b

Means within a column or row having the same letters are not significantly different according to Duncan's Multiple Range Test at 5 % level.

B- Chemical composition:

A similar response to that of vegetative and root growth criteria occurred as well in respect of leaf content of chlorophyll a, b and carotnoids (mg/g.f.w.) and the percentages of total soluble sugars and nitrogen in the stem, leaves and roots (Tables, 7 and 8), as such components were increased in response to the different treatments of sanitary water used in such trial with few exceptions compared to control. This may be reasonable because sanitary water usually contains variable amounts of most nutrients and organic matter that increase leaf greening, and consequently activate photosynthesis and other vital processes. An additional increment was also observed in the means of these active constituents when EM solution at 3 ml/l was amended or mixed with either level of sanitary water employed in this study, but the highest content at all was scored by the combining between 50 % sanitary water and 3 ml/l EM. The results of phosphorus and potassium content in the stem, leaves and roots (Table, 8) were fluctuated, with no specific trend relative to the control or among water treatments.

As for lead (Pb) and cadmium (Cd) contents (ppm), data in Table (8) exhibit that their content in stem, leaves and roots was progressively increased with increasing the rate of sanitary water in water irrigation, while applying of EM at 3 ml/l to any level of sanitary water greatly reduced content of these two metals to the minimum values comparing with the values of them recorded by the corresponding level of sanitary water applied alone. This may indicate the role of EM biostimulant in bioremediation of waste water and rendered it suitable for safe use (Quang, 2001). In this concern, Karthik *et al.*, (2011) mentioned that addition of 3 ml/l EM solution to sewage water under aerobic condition reduced its environmental impact through the great reducing of BOD, COD, TDS and TSS by 85, 82, 55 and 91 %, respectively after only 3 days of treatment. The present results are consistent with previous reports mentioned by Kirithiga (2010), Mohammed *et al.*, (2013) and Khan *et al.*, (2014) on *Albizia lebbeck, Coffea arabica* and *Acacia auriculiformis*.

From the aforementioned results, it can be advised to apply EM biostimulant at the rate of 3 ml/l when sanitary water used for irrigation of Neem (*Azadirachta indica* L.) plants to minimize the harmful effects of such water, especially when used at 75 or 100 % levels.

Table (7): Effect of sanitary water at various percentages, alone or combining with EM biostimulant on leaf content of pigments and total soluble sugars content in the stem, leaves and roots of *Azadirachta indica* L. plant during 2014 season.

Treatments	Pigments content (mg/g.f.w.)			Total soluble sugars (%)		
	Chlor (a)	Chlor (b)	Carotenoids	Stem	Leaves	Roots
Control	0.862	0.578	0.152	2.206	3.053	2.639
25 % sanitary water (SW)	0.873	0.593	0.163	3.500	3.682	3.418
50 % S.W.	0.910	0.659	0.168	4.136	5.911	6.019
75 % S.W.	0.880	0.616	0.222	3.718	6.043	5.335
100 % S.W.	0.823	0.402	0.226	2.820	3.318	4.565
25 % S.W. + 3 ml/l EM	0.875	0.674	0.173	4.780	4.899	5.366
50 % S.W. + 3 ml/l EM	1.034	0.938	0.180	9.223	8.571	8.556
75 % S.W. + 3 ml/l EM	0.931	0.723	0.276	6.294	6.625	8.512
100 % S.W. + 3 ml/l EM	0.876	0.566	0.260	5.473	6.437	5.366

Table (8): Effect of sanitary water at various percentages, alone or combining with EM biostimulant on some constituents in the stem, leaves and roots of *Azadirachta indica* L. plant during 2014 seasons.

Treatments	N (%)			P (%)			K (%)		
	Stem	Leaves	Roots	Stem	Leaves	Roots	Stem	Leaves	Roots
Control	1.820	1.653	1.493	0.278	0.412	0.213	1.543	1.332	1.476
25 % sanitary water (SW)	1.960	2.106	1.726	0.354	0.187	0.140	1.390	1.504	1.504
50 % S.W.	2.240	2.120	1.913	0.210	0.168	0.219	1.495	1.390	1.428
75 % S.W.	2.100	1.960	1.820	0.299	0.197	0.206	1.313	1.100	1.437
100 % S.W.	1.193	1.253	1.500	0.377	0.048	0.383	1.390	1.524	1.390
25 % S.W. + 3 ml/l EM	2.006	2.110	1.960	0.361	0.229	0.272	1.648	1.552	1.524
50 % S.W. + 3 ml/l EM	2.256	2.306	2.240	0.244	0.694	0.260	1.552	1.390	1.370
75 % S.W. + 3 ml/l EM	2.196	2.100	2.053	0.197	0.278	0.550	1.447	1.367	1.361
100 % S.W. + 3 ml/l EM	1.586	1.913	1.960	0.728	0.743	0.654	1.514	1.439	1.390

Table (8): Continued.

Treatments	Pb (ppm)			Cd (ppm)		
	Stem	Leaves	Roots	Stem	Leaves	Roots
Control	0.129	0.104	0.160	0.034	0.012	0.039
25 % sanitary water (SW)	1.274	0.156	0.413	0.101	0.084	0.225
50 % S.W.	1.491	0.172	0.805	0.197	0.173	0.241
75 % S.W.	1.945	0.804	2.175	0.334	0.224	0.385
100 % S.W.	3.136	1.705	5.303	0.674	0.509	1.072
25 % S.W. + 3 ml/l EM	0.186	0.069	0.205	0.072	0.051	0.102
50 % S.W. + 3 ml/l EM	0.249	0.078	0.325	0.089	0.078	0.133
75 % S.W. + 3 ml/l EM	0.606	0.287	0.678	0.193	0.139	0.252
100 % S.W. + 3 ml/l EM	0.823	0.438	1.392	0.297	0.286	0.745

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هل يستطيع المنشط الحيوى (EM) أن يقلل أضرار مياه الصرف الصحى عند استخدامها بمستويات مختلفة لرى شتلات النيم

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أجرى هذا البحث تحت الشمس الساطعة بمشتل معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر خلال موسمى ٢٠١٣، ٢٠١٤ لدراسة تأثير الرى بمياه الصرف الصحى بمستويات: صفر، ٢٥، ٥٠، ٧٥، ١٠٠ % بمفردها أو فى وجود المنشط الحيوى EM (والذى أضيف مع مياه الرى بمعدل ٣ مل/لتر ماء) على النمو والتركيب الكيميائى لشتلات النيم (*Azadirachta indica* L.) عمر عشرة أشهر والمنزرعة فى أكياس بلاستيك سوداء عالية الكثافة قطرها ١٦ سم مملوءة بحوالى ٣.٥ كجم من مخلوط الطين والرمل بنسبة (١ : ١ حجما).

أوضحت النتائج المتحصل عليها أن متوسطات جميع صفات النمو الخضرى والجذرى قد زادت معنويا نتيجة للرى بمياه الصرف الصحى حتى مستوى ٧٥ %، مع تفوق معاملة مياه الصرف بمعدل ٥٠ % والتى أعطت أعلى المتوسطات مقارنة بمتوسطات الكنترول ومستويات مياه الصرف الأخرى المستخدمة فى كلا الموسمين. ولقد أدى الرى بمياه الصرف بمعدل ١٠٠ % إلى خفض طفيف فى متوسطات مختلف قياسات النمو مقارنة بالكنترول وبدون أى فروق معنوية فيما بينهما فى معظم الحالات بكلا الموسمين. كما أدى المنشط الحيوى بتركيز ٣ مل/لتر تحسنا إضافيا فى جميع قياسات النمو الخضرى والجذرى، حتى مع المعاملة بمياه الصرف الصحى بمستوى ١٠٠ % والتى سجلت معدلات نمو أفضل من معدلات الكنترول وبفروق معنوية فيما بينهما فى معظم الحالات بكلا الموسمين. إلا أن السيادة فى جميع القياسات السابقة كانت للمعاملة المشتركة بين الرى بمياه صرف صحى بنسبة ٥٠ % وإضافة الـ EM بمعدل ٣ مل/لتر والتى أعطت أعلى المتوسطات مقارنة بالمعاملات الفردية أو المشتركة الأخرى المطبقة بهذه الدراسة. تم الحصول أيضا على أتجاه مشابه لقياسات النمو الخضرى والجذرى فيما يتعلق بمحتوى الأوراق من كلوروفيللى أ، ب والكاروتينويدات ومحتوى الساق، الأوراق والجذور من السكريات الكلية الذائبة والنتروجين. أما محتوى الفوسفور والبوتاسيوم فى الساق والأوراق والجذور فقد كان متقلبا وليس له أتجاها محددا كما هو الحال فى المكونات الكيميائية الأخرى التى تم قياسها. أوضحت الدراسة كذلك حدوث زيادة تصاعدية فى محتوى الساق، الأوراق، الجذور من عنصرى الرصاص والكادميوم كلما زادت نسبة مياه الصرف الصحى فى مياه الرى، بينما إنخفض محتواهما بدرجة كبيرة عند إضافة المنشط الحيوي EM بمعدل ٣ مل/لتر من مياه الرى بصرف النظر عن جودة المياه المستخدمة، مما يشير إلى قدرة هذا المنشط على المعالجة الحيوية للمياه العادمة.

وعليه؛ يمكن التوصية بإضافة المنشط الحيوى EM بمعدل ٣ مل/لتر من مياه الصرف الصحى المعالجة أوليا عند استخدامها فى رى شتلات النيم عمر عشرة أشهر لتقليل الآثار الضارة لهذه المياه إلى الحد الأدنى، خاصة عند استخدامها بمعدل ٧٥ أو ١٠٠ %.