

BIOACCUMULATION OF Cd, Pb AND Ni IN *Eucalyptus* SPP. AS AFFECTED BY SPECIES AND SLUDGE CONCENTRATION

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ABSTRACT

The work was carried out at the Experimental Farm of El-Kassassin Horticulture Research Station, Horticulture Research Institute to study the effects of various sewage sludge application rates (0, 10%, 20%, 30% and 40%) on growth and Cd, Pb and Ni content in the roots, stems and leaves of two *Eucalyptus* species, *Eucalyptus citriodora* and *E gomphocephala* . Also, to study the possibility of using specific transplants for bioaccumulation some heavy metals on new reclaimed soils in semi arid areas using treated municipal sewage sludge. The highest value of plant height and stem diameter obtained from *Eucalyptus gomphocephala* with 30% or 40% of sewage sludge application. High amount of Ni was observed in leaves of the studied plants

Keywords: Plant genera and species ; - *Eucalyptus citriodora* - *Eucalyptus gomphocephala* ; sewage sludge ; heavy metals ,Cd, Pb and Ni.

INTRODUCTION

Sewage sludge, also referred as biosolids (Singh and Agrawal, 2008), have resulted in new installations and extension of the existing facilities, thus leading to an increase in wastewater sludge production. Although the use of sludge fertilizer in agriculture still accounts for a significant proportion of the total municipal sludge disposal in many countries (Spinosa, 2007), concerns on the possible risks – derived from the presence of pathogens, heavy metals and organic pollutants in sludge (Harrison *et al.*, 2006) – tend in some cases to decrease the agricultural use in favor of incineration. El-Baha (2001) found that application of sewage sludge increased tree height and diameter of *Eucalyptus camaldulensis*. *Eucalyptus* species (Myrtaceae). However, *E.* species are believed to be introduced into Egypt in the 1800's, (El-Lakany *et al.*, 1980). They are highly adapted to local environmental conditions and grown very fast. These species are traditionally planted as windbreaks, shade and to supply wood for lumber, particle board and charcoal production. Androde *et al.* (2000) found that biosolids application did not increased Cd, Cr, Cu and Ni movement through soil profile and the increase in Zn level in 30 – 60 cms layer. Bozkurt and Yarlac. (2003) The sewage sludge application did not cause any significant increase in Ni, Cr and Cd concentrations in leaf samples on apple tree, Abd El-Kader (2006) reported that, Fe, Zn, Pb and Cd contents in dry leaves of *Pinus halapensis* seedlings were significantly increased as a result of using different treatment of sewage sludge

MATERIALS AND METHODS

This study was carried out at the Experimental Farm of El-Kassasin - Horticultural Research Station, Horticulture Research Institute, Agricultural Research Center (ARC), Egypt during two successive seasons of 2004/2005 and 2005/2006. The aim of this work is to study the effects of species and sewage sludge levels on the growth and the uptake and accumulation of some heavy metals into seedlings.

Experimental factors:

- **Plant species:** *Eucalyptus citriodora* L. and *Eucalyptus gomphocephala* Dehn. One year old transplants were brought from the Horticultural Research Institute nurseries. All transplants were planted in mid of March 2004/2005 and 2005/2006 seasons in poly ethylene bags of 17 X 25 cm. Each bag contains 4 kg. media consists of sand and sewage sludge as well as one plant for each species

-**Sewage sludge treatments:** The sewage sludge bulk samples were taken from Ismailia Waste Water Treatment Plant (I.W.W.T.P.) at Sarabium. The chemical analysis of the sewage sludge was carried at the (I.W.W.T.P.) at Sarabium shown in Table (1).

Table (1): Chemical analysis of the sewage sludge for Ismailia Waste Water Station.

Sewage sludge			
parameter	value	Total heavy metals ppm	
Organic matter	23.69 %	Fe	94.50
Organic carbon	12.26 %	Mn	170.00
Total nitrogen (N)	1.80 %	Zn	254.00
C/N ratio	6.81 %	Cu	750.00
Available phosphorus (p)	0.46 %	Cd	3.00
Total potassium (K)	0.06 %	Ni	45.00
pH (1 : 2.5 sludge : water)	7.5	Pb	201.06
E. C. (1:1 sludge : water. d s/m)	3.8		

- Treatments:

Each of the tow species under study was combined with each concentration of sewage sludge (0, 10%, 20%, 30% and 40%) to form 10 interaction treatments

The following data were recorded:

1- Vegetative growth

-Plant height: For each treatment of the tow species, total height of the selected three was measured from ground level to the seedling top by using a graduated stake to the nearest 0-5 cm.

-Stem diameter: The stem diameter outside bark of the same three seedlings selected to determine height growth was recorded at 10 cm distance. above the ground, by using seedlings calliper to the nearest 1 mm

2-Heavy metals studies

The samples were dried in 70 °C until constant weight, finally ground samples of 1.00 gm, each were used to determine some heavy metals (Cd, Pb and Ni) were measured by Atomic Absorption Spectrophotometer (Perkin Elmer, 3300).(Mazumder and Majumder (2003) .

RESULTS AND DISCUSSION

Plant height (cm): Data tabulated in Table (2) show the effect of species, different levels of sewage sludge and their interaction, on differences between data in zero time and data after one year for plant height of seedlings under study during 2004/2005 and 2005/2006 seasons.

Data presented in Table (2) showed a significant increment in plant height between the species, the highest mean value of plant height was obtained from *Eucalyptus gomphocephala* for first and second seasons. On the other hand, the results indicate that, the addition of 30 % and 40 % of sewage sludge to the growing media gave the tallest average value for first season and second season compared to the other levels of sewage sludge. Furthermore, all treatments of sewage sludge produced significantly increment compared to control.

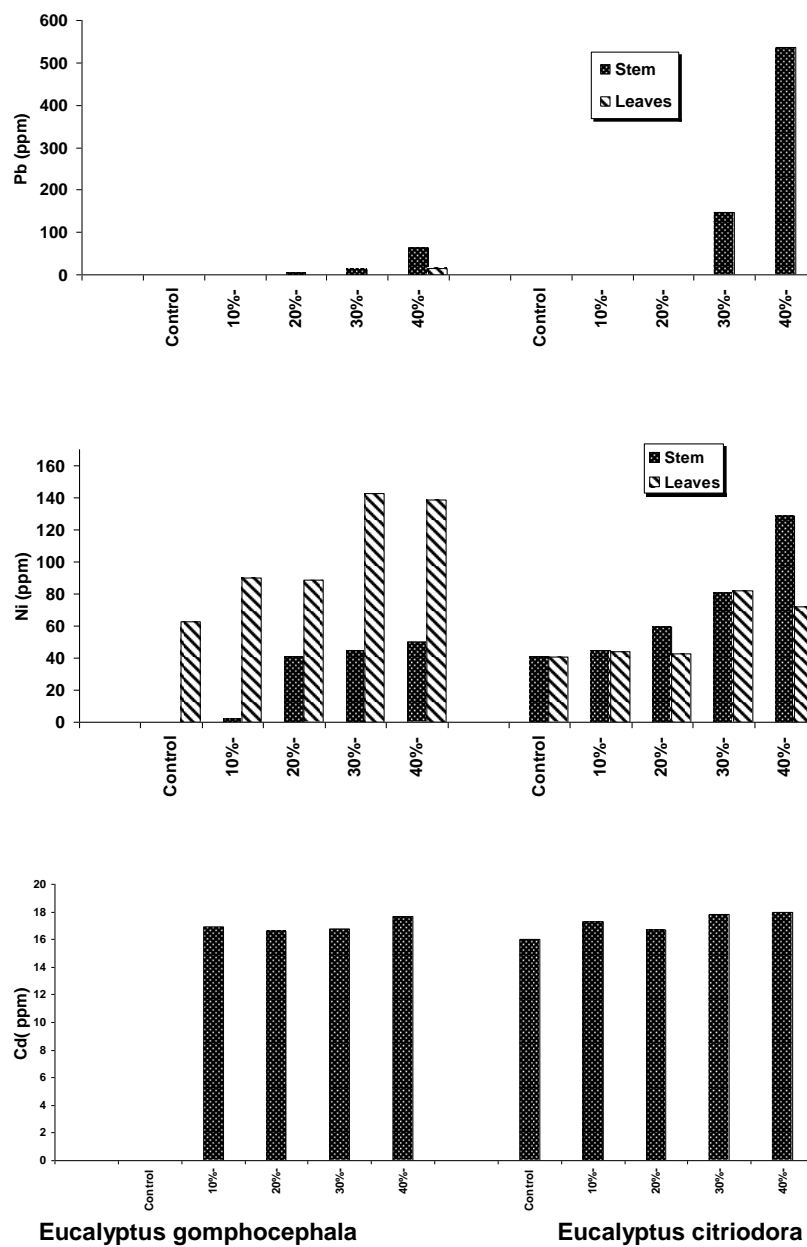
The interaction between sewage sludge and species on plant height as differences between data in zero time and after one year in Table (2) indicated that, the level of 30 % and 40 % sewage sludge gave the tallest plants during the first and second seasons, which obtained from *Eucalyptus gomphocephala*. These results are in line with those found by El-Baha (2001) who found that, the sewage sludge increased the height seedlings and stem volume.

Stem diameter (mm): Data in Table (3) for the effect of, species, sewage sludge levels, and their interaction on the differences between data in zero time and data after one year for stem diameter of seedlings under study during 2004/2005 and 2005/2006 seasons.

Data in Table (3) reveal that, the highest mean value of stem diameter resulted by *Eucalyptus gomphocephala* for first and second seasons. The results shown that, the sewage sludge at level of 20% , 30 % and 40 % gave the highest mean values of stem diameter for first and second season Also, all treatments of sewage sludge gave significant increment compared to control. Concerning the interaction between sewage sludge and species on stem diameter, data in Table (3) show that, the combination between sewage sludge at level 40% and *E. gomphocephala* highest mean value of stem diameter. These results are in line with those found by El-Baha (2001) who found that, the sewage sludge increased the stem diameter

2- Bioaccumulation of Cd, Pb and Ni in stem and leaves of plants:

Plant species differ markedly in their sensitivity to heavy metals. Many species will thrive on soils rich with nickel, lead, cadmium and other metals. Often the heavy metals are excluded from uptake by roots due to the normal selectivity of root cell membranes. Other species take up metals and accumulate them to levels that would be lethal to non-tolerant species. Such plants are called accumulator species a represent a form of true tolerant.



Fig(1): Effect of species and sewage sludge on accumulation of Ni, Pb and Cd during 2004/2005 and 2005/2006 seasons.

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Fig (1) shows the Ni, Pb and Cd in stems and leaves of plants. In all investigated plants the heavy metal Ni is much higher concentrated in leaves than in stems. In contrast to that Cd and Pb contents are always higher in stems than in leaves.

The data of Ni levels in stems were found to be higher than in leaves, may be due to decreased phloem loading of Ni. Moreover, the transfer characteristics for Ni and Cd on the one hand and Pb on the other hand are also affected by different soil properties. These results are in line with those Abd El-Kader (2006) reported that, Pb and Cd contents in dry leaves of *Pinus halapensis* seedlings were significantly increased as a result of using different treatment of sewage sludge.

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التراكم الحيوي لبعض العناصر الثقيلة في جنس الكافور بفعل الأنواع النباتية وتركيز الحمأة
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أجرى هذا العمل في المزرعة التجريبية لمحطة بحوث البساتين بالقصاصين التابعة لمعهد بحوث البساتين لدراسة نمو الشتلات وامتصاص العناصر الثقيلة الرصاص والكاديوم والنيكل وانتقالها وتراكمها فيجنس الكافور(الليموني وجمفوسوفيل *E. gomphocephala* and *Eucalyptus citriodora*) وهل توجد إمكانية لاستعمال هذه الأشجار لكي تراكم العناصر الثقيلة من الحمأة. إستخدمت الحمأة sewage sludge بكميات تعادل ١٠%، ٢٠%، ٣٠%، و ٤٠% من وزن التربة في كيس الزراعة في التجربة. درست عناصر الرصاص والنيكل والكاديوم في الساق والأوراق. وظهرت النتائج التالية
أقصى إرتفاع للنبات وقطر الجرع كانت الكافور *gomphocephala* مع إستخدام الحمأة بمعدلات ٣٠% أو ٤٠% ، كما وجدت بصفة عامة كميات أعلى من النيكل Ni في أوراق النباتات المدروسة .

Table (2): Effect of plant species, different levels of sewage sludge and their interactions on plant height (cm) of seedlings during 2004/2005 and 2005/2006 seasons.

Sludge (B)		Control	10 %	20 %	30 %	40 %	Mean _A						
Species (A)		First season											
<i>Eucalyptus citriodora</i>		93.17	d	118.00	cd	117.67	cd	183.97	bc	133.80	cd	129.26	B
<i>Eucalyptus gomophocephala</i>		112.00	cd	152.60	b	194.00	b	241.50	a	267.50	a	193.52	A
Mean _B		54.79	C	76.77	B	86.86	B	113.28	A	105.91	A		
		Second season											
<i>Eucalyptus citriodora</i>		89.83	h	106.20	gh	144.50	ef	176.50	d	167.80	de	137.00	B
<i>Eucalyptus gomophocephala</i>		122.50	fg	194.70	cd	221.20	bc	244.70	b	293.70	a	215.30	A
Mean _B		55.75	D	81.26	C	97.22	B	111.10	A	121.30	A		

Table (3): Effect of plant species, different levels of sewage sludge and their interactions on stem diameter (mM) of seedlings during 2004/2005 and 2005/2006 seasons.

Sludge (B)		Control	10 %	20 %	30 %	40 %	Mean _A						
Species (A)		First season											
<i>Eucalyptus citriodora</i>		1.30	d	1.77	d	2.60	b	2.28	b	1.39	cd	1.86	B
<i>Eucalyptus gomophocephala</i>		0.86	e	2.32	b	2.41	b	2.60	b	3.71	a	2.38	A
Mean _B		0.62	B	1.20	B	1.45	A	1.41	A	1.39	A		
		Second season											
<i>Eucalyptus citriodora</i>		1.34	fg	1.47	efg	2.41	cd	2.23	cde	1.74	def	1.84	B
<i>Eucalyptus gomophocephala</i>		0.87	g	1.97	cdef	2.69	bc	3.41	ab	4.12	a	2.61	A
Mean _B		0.58	C	0.99	B	1.39	A	1.49	A	1.53	A		