Viability of growing Sampaguita in heavy metal contaminated media

M.A.N. Tanchuling*[1)], A.S. Toribio[2)]
[1)]Institute of Civil Engineering, University of the Philippines Diliman
2) Environmental Engineering Graduate Program, University of the Philippines Diliman
** mntanchuling@up.edu.ph*

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Introduction

This study examined the viability of growing a flowering plant on contaminated media composed of dredged materials from a river, and coco-peat which was used to sorb heavy metals from wastewater. Dredged materials from San Juan River in Metro Manila, as well as those from other rivers in the Philippines, have not been well-managed owing to the absence of local laws and regulations regarding its proper management and disposal. Most of the materials are disposed in an open dumpsite. As these materials contain pollutants such as high oil and grease, organics, heavy metals, pesticides, and other contaminants, this practice poses health risks to the community and introduces environmental issues (Gangwar et al., 2014, Eisler, 2004). Contaminated coco peat is filter material used to remove heavy metals through bio-absorption from an effluent of a small-scale gold mining (SSGM) facility. This material contained high concentrations of heavy metals, especially Pb (4,300 mg/kg). Both of these contaminated materials need to be managed well to protect the environment and public health.

The general objective of the study is to investigate the viability of growing Sampaguita (*Jasminum sambac* L.*)* in dredged material mixed with heavy metal contaminated coco peat as a management alternative for the disposal of these contaminated materials. Sampaguita is a sweet-smelling plant the flowers of which are usually strewn together to form garlands.

Material and Methods

The dredged materials (DM) used in the study were collected from San Juan River, in Barangay Damayang Lagi, Quezon City in Metro Manila. These were excavated from the bottom and the sides of the river. Samples were taken on February 2, 2013 and on January 2, 2014 and placed in plastic containers for dewatering.

Heavy metal contaminated coco peat (CCP) were spent materials from an on-site filter bed system installed in a tailings pond of a small scale gold mining facility in Paracale, Camarines Norte, Philippines. Heavy metal contents and other characteristics of the CCP are as follow: Oil and grease (160 mg/kg), Organic matter (336 %), ph (3.11), As (6.37 mg/kg), Ba (60.21 mg/kg), Cd (36.39 mg/kg), Pb (4300 mg/kg), Hg (6.87 mg/kg), Bulk density (525.60 kg/m3), Nitrogen (1,800 mg/kg), Phosphorus (300 mg/kg), and Potassium (1896.27 mg/kg).

Four treatments were prepared with varying volume ratios of CCP and DM, as follows: Substrate 1 (100% DM), Substrate II (30% CCP – 70% DM), Substrate II (50% CCP – 50% DM), Substrate IV (70% CCP – 30% DM), Control using Garden Soil. The combinations were mixed using a trowel and turned over at least 20 times until the mixtures were uniform. It was made sure that no clods were present. Plastics and other extraneous materials were not removed to simulate field conditions. For each substrate, six replicates were prepared for planting.

Six (6) sampaguita seedlings were planted in each of the six replicates for each substrate. The plants were watered every day during the 3 month observation period, except on rainy days. The following data were gathered over the 12-week growing period: a) Plant height - Measured weekly using a tape measure from the base of the stem to the tip of the main branch. b) Number of leaves - Counted weekly, including the tips of new leaves just starting to emerge. c) Number of flowers - Counted weekly, including buds and d) Time of first flowering - Recorded as the number of weeks to which the emergence of the first flowers/buds was observed.

At the end of the 12th week, the roots, stem, leaves, flowers were harvested separately. The flowers throughout the plant observation period were collected. The roots were washed with water to remove adhering soil particles. The different plant parts were then cut into smaller pieces at least two inches in length, and were air- dried for one month. The soil was collected and air-dried for one month

Results and Conclusions

The characteristics of the dredged material and different substrates and the control are shown in Tables 1 and 2, respectively.

Based on different standards for topsoil, DM was suitable to be used as topsoil. There was no significant difference in the net number of leaves and number of flowers observed in sampaguita in DM compared to the control. This further indicated that DM could be used for topsoil purposes. Moreover, DM could be used as substrate of sampaguita for commercial purposes because of the low accumulation of heavy metal in the shoots. There was negative relationship between an increasing As, Hg, Pb, and Cd concentration with the plant height, number of leaves, and flowers. Also, there was a general delay in the time of first flowering (weeks) with the trials that were planted on contaminated media. There was generally a decrease in plant growth with increasing heavy metal concentration. Moreover, sampaguita plants in CCP and DM substrate showed stresses. Browning of leaves was observed starting week 7.

Generally, there was higher heavy metal concentrations in roots than in shoots. This is desirable in a phytostabilization context (metal concentrations were stabilized in roots and surrounding soils), where transmission of elements into the food chain can be avoided.

Accumulation was low as shown by the low accumulation factor (AF) values. This indicated that sampaguita excludes heavy metal (metal excluder) to the above ground biomass.

Furthermore, material balance computations showed that the initial heavy metal content for some mixtures are higher than final content, while other mixtures showed the opposite. The loss in final content could be attributed to plant defense mechanism, volatilization, and leaching. The gain final content could be attributed to initial seedling concentration prior to the experiment and atmospheric deposition.

Table 1. *Characteristics of the Dredged Material*

Soil Characteristics	Dredged Material	Soil Characteristics	Dredged Material
Textural Class	Sandy clay loam	As, mg/kg	8.67
Total Sand %	61.8	Ba, mg/kg	76.37
Total Silt %	10.6	Cd, mg/kg	<0.03
Clay %	27.6	Pb, mg/kg	0.4
pH	6.5	Hg, mg/kg	188.2
Oil and Grease (mg/kg)	278.32	Water holding capacity %	66.55
Organic Matter (%)	20.57	Field Capacity %	19.95
Nitrogen (%)	0.1	Permeability (cm/s)	0.3
Phosphorus (mg/kg)	76.71	Bulk density (g/cm^3)	1.1
Potassium (%)	0.73		

Table 2. *Initial concentration of organic matter, oil and grease, As, Ba, Cd, Pb, Hg, nitrogen, phosphorus, and potassium at different CCP-DM mixtures and control.*

	Control	30%CCP-70%DM	50%CCP-50%DM	70%CCP-30%DM
Oil and Grease, mg/kg	303.80	242.82	219.16	195.50
Organic Matter, %	46.10	15.41	11.97	8.52
As, mg/kg	4.32	7.98	7.52	7.06
Ba, mg/kg	30.62	71.52	68.29	65.06
Cd, mg/kg	1.45	10.94	18.21	25.48
Pb, mg/kg	5.64	1,290.28	2,150.20	3,010.12
Hg, mg/kg	0.004	133.80	97.53	61.27
Nitrogen, mg/kg	1,100.00	1,240.00	1,400.00	1,560.00
Phosporus, mg/kg	209.00	143.70	188.36	233.01
Potassium, mg/kg	12,100.00	5,678.88	4,598.14	3,517.39

References

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