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COMPARATIVE SENSITIVITY OF LEMNA GIBBA AND LEMNA MINOR TO 3,5-DICHLOROPHENOL

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INTRODUCTION

Aquatic environment is mainly contaminated with a variety of toxicants due to anthropogenic activities. 3,5-dichlorophenol (DCP) is used for manufacturing herbicides, pesticides, insecticides, fungicides, wood preserves, disinfectants, pharmaceuticals, and colouring agents. DCP is frequently detected in water bodies owing to agricultural runoff (Kloppel et al., 1997). Due to long term effect and biodegradability, it is classified as a toxic substance to aquatic biota (Zagorc-Koncan et al., 2002).

Duckweeds are key components of freshwater ecosystem. Its small size, simple structure, asexual reproduction, short generation time, and sensitivity towards chemicals make it very suitable for laboratory testing. Lemna gibba and Lemna minor, representative species for higher aquatic plants, have been studied extensively for use in phytotoxicity tests. Several endpoints have been applied in Lemna sp. toxicity testing, including frond number, dry or fresh biomass, growth rate, and yield inhibition, etc.

OBJECTIVE

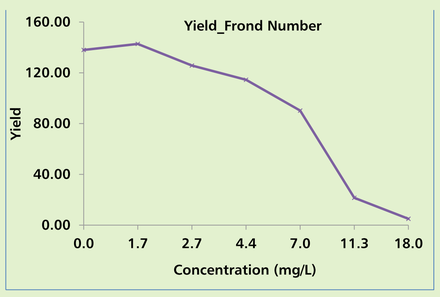
The objective of this study was to compare the sensitivity of Lemna species, namely, L. gibba and L. minor to 3,5-dichlorophenol by determining effects of DCP at different concentrations on the growth of Lemna species to derive the effective concentration (EC_x), the lowest observed effect concentration (LOEC), and no observed effect concentration (NOEC).

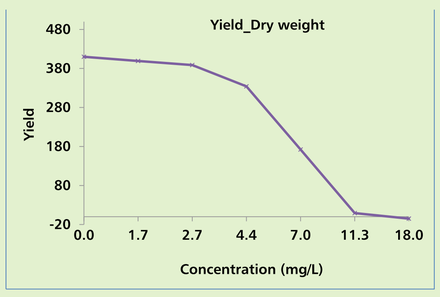
MATERIALS AND METHODS (Guidelines: OECD 221 and OCSPP 850.4400)

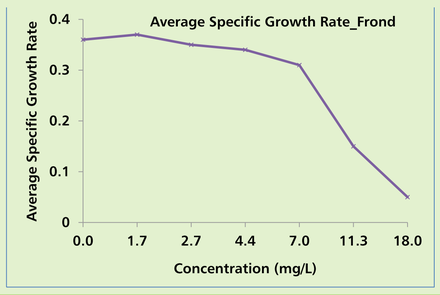
Test System	L. gibba	L. minor
Test Media	20X AAP medium	SIS medium
Test Procedure	Static	Semi-static (renewal at 48 h)
Test Item	3,5-dichlorophenol (Sigma-Aldrich, USA)	
Test Concentrations	0.0 (control), 1.7, 2.7, 4.4, 7.0, 11.3, and 18.0 mg/L	0.0 (control), 0.3, 0.7, 1.5, 3.5, and 8.0 mg/L
Replicates/group	6/control group and 4/treatment group	
Number of Fronds	Each test vessel was inoculated with 12 fronds	
Observation	Day 3, 5, and 7	
A.I. and Stability Analysis	Day 0 and 7	Day 0, 7, and at each renewal
Test Duration	7 days	
Endpoints	Yield and average specific growth rate (fronds and dry weight); E_rC_{50}, E_yC_{50}, NOEC and LOEC	
Validity Criteria (for control)		
Doubling Time of Frond Number	Less than 2.5 days (60 h)	
Average Specific Growth Rate	Atleast 0.275 per day	

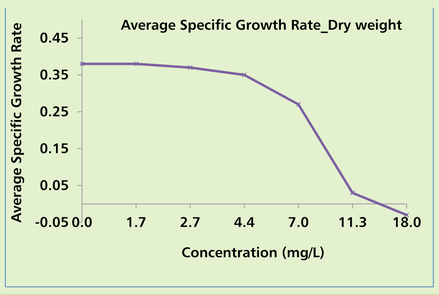
RESULTS AND DISCUSSION

L. gibba





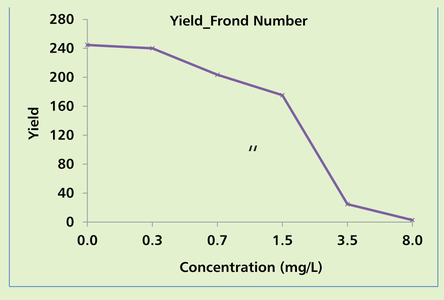


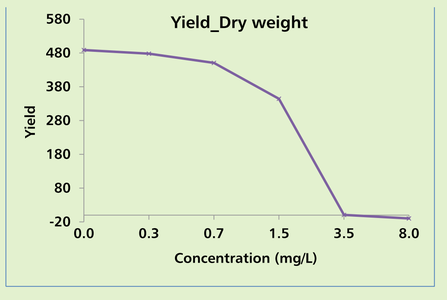


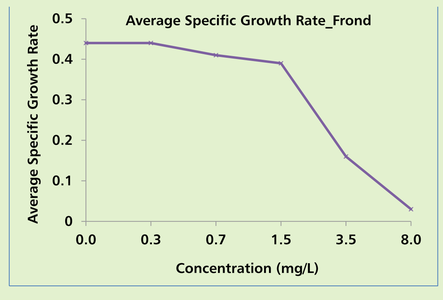
End Points	L. gibba	L. minor	Comparison
	mg/L		
For Frond			
E_yC_{50}	6.92	1.61	4.3 times
E_rC_{50}	10.46	2.75	3.8 times
NOEC	2.7	0.3	9 times
LOEC	4.4	0.7	6.3 times

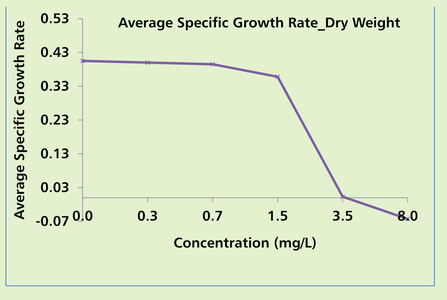
End Points	L. gibba	L. minor	Comparison
	mg/L		
For Dry Weight			
E_yC_{50}	5.44	1.16	4.7 times
E_rC_{50}	7.27	1.54	4.7 times
NOEC	4.4	0.3	14.7 times
LOEC	7.0	0.7	10 times

L. minor









For Control	L. gibba	L. minor
Doubling time of frond number	1.93 days	1.58 days
Increase in seven days	12.5	21.39
Average specific growth rate	0.36/d	0.44/d

L. gibba		L. minor	
Concentration (mg/L)	Sign of Toxicity	Concentration (mg/L)	Sign of Toxicity
0.0	Normal	0.0	Normal
1.7	Normal	0.3	Normal
2.7	Normal	0.7	Transparent fronds
4.4	Transparent Fronds	1.5	Transparent Fronds
7.0	Colony break-up, chlorosis, short root and transparent fronds	3.5	Colony break-up, chlorosis, short root, sinking of fronds, frond mortality
11.3	Colony break-up, chlorosis, short root, sinking of fronds and transparent fronds	8.0	Frond mortality
18.0	Colony break-up, chlorosis, short root, sinking of fronds and frond mortality		

Lemna sp. toxicity test is one of the crucial and classical ecotoxicity study which provides information for predicting chemical hazards to the aquatic environment (Olah et al., 2010). The most frequently measured endpoints in Lemna sp. toxicity test are frond number and dry weight. Based on the growth rate of frond number and dry weight, the most sensitive species was L. minor with E_rC_{50} 2.75 and 1.54 mg/L, respectively. These results indicate that DCP has growth inhibitory effect on L. gibba and L. minor.

CONCLUSION

Finding postulates that L. minor is more sensitive than L. gibba for DCP. Through testing the phytotoxicity of DCP to L. gibba and L. minor, it is evident that there are considerable differences in sensitivity among species and that the selection of species is necessary to provide an acceptable margin of safety in evaluating the hazard undertaken by the chemicals to the aquatic environment.

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