NUMERICAL DATA

Assembly of root-associated microbiomes of typical rice cultivars in response to lindane pollution (2019)

The height and biomass of different rice cultivars, and their accumulation amount for lindane

Cultivars[a]	**Pollution dose**[b]	**Root**			**Shoot**		
		Length	Biomass	Lindane	Height	Biomass	**Lindane**
	(mg kg^{-1})	(cm)	(g FW plant^{-1})	(μg kg^{-1})	(cm)	(g FW plant^{-1})	**(μg kg^{-1})**
XS	0	19.6 ± 1.2cd[c]	5.04 ± 0.65bc	nd[d]	69.7 ± 0.9e	24.7 ± 2.81 cd	**nd**
	5	18.2 ± 2.4d	5.00 ± 0.37bc	59.1 ± 13.5b	66.4 ± 1.4f	25.2 ± 0.75 cd	**16.5 ± 6.81ab**
	20	19.1 ± 1.5 cd	4.12 ± 0.19c	164.0 ± 40.0a	68.0 ± 1.5ef	20.8 ± 1.05d	**31.2 ± 10.1a**
HHZ	0	23.3 ± 1.6a	6.75 ± 0.58a	nd	83.2 ± 1.1bcd	34.4 ± 2.80ab	**nd**
	5	22.5 ± 1.3ab	6.09 ± 0.36ab	64.7 ± 49.6b	87.5 ± 1.2ab	36.0 ± 5.50ab	**nd**
	20	23.1 ± 1.6a	4.12 ± 0.60c	137.4 ± 43.2a	88.1 ± 4.9a	32.2 ± 0.43bc	**26.7 ± 15.4a**
YY	0	20.2 ± 1.8bcd	5.97 ± 0.29ab	nd	80.5 ± 1.9d	42.0 ± 3.65a	**nd**
	5	21.3 ± 1.0abc	6.09 ± 0.71ab	72.3 ± 16.1b	81.3 ± 2.1 cd	40.1 ± 1.89a	**6.4 ± 2.62b**
	20	**21.5 ± 0.7abc**	**6.75 ± 1.25a**	**167.3 ± 28.8a**	**85.7 ± 0.8abc**	**37.2 ± 7.20ab**	**22.3 ± 14.7ab**

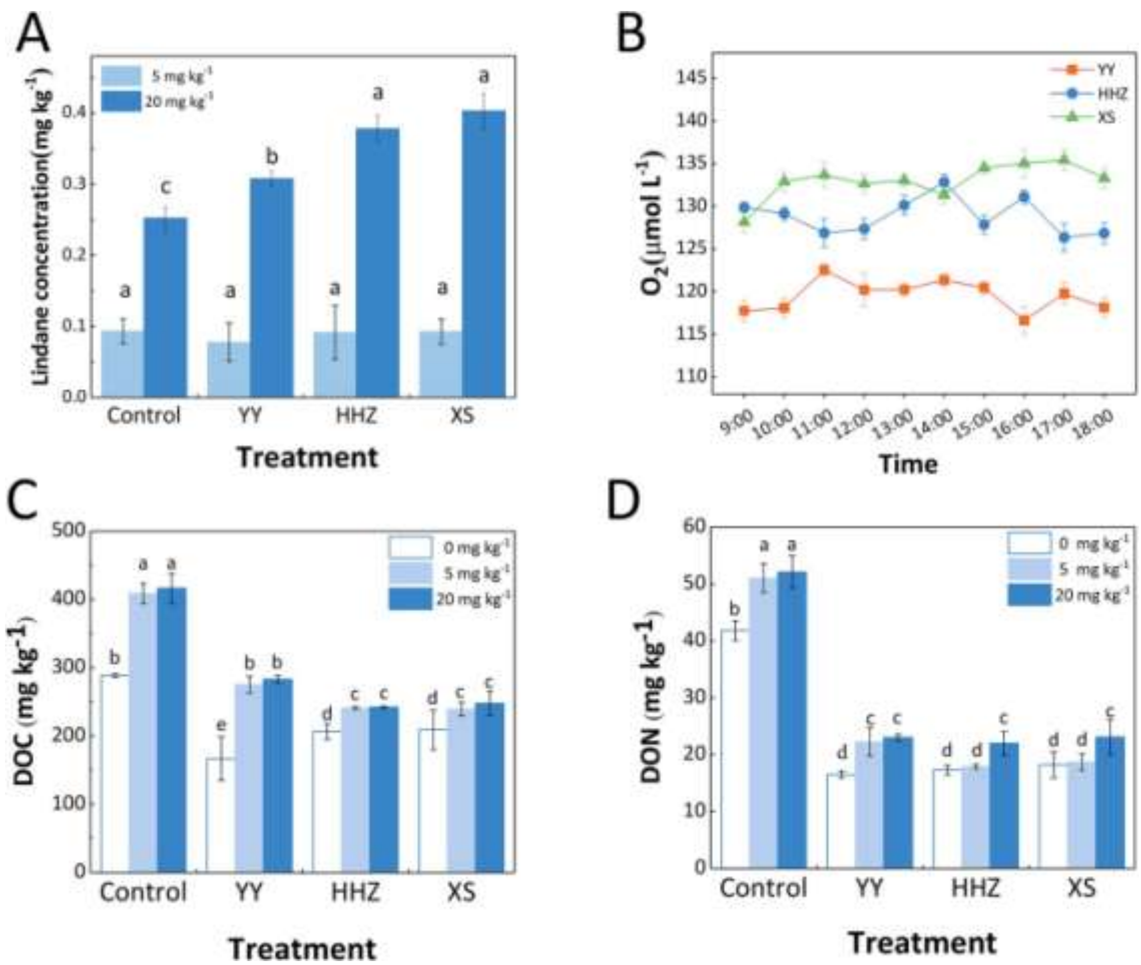
a Abbreviations: XS, japonica cultivar XS519; HHZ, indica cultivar HHZ; YY, hybrid cultivar YY12.
b Lindane spiked concentration (mg kg−1).
c Values are means ± standard errors of three replications; values within a column followed by a common letter are not significantly different ($P < 0.05$).
d nd: not detected.

After 60 days of growth, no visible symptoms of lindane toxicity were observed for all cultivars of rice. The root length, shoot height and biomass of roots and shoots presented no consistent difference between polluted and unpolluted treatments. The hybrid YY showed the maximum biomass in both roots and shoots (6.75 g and 41.95 g respectively), and indica HHZ had the highest while japonica XS the lowest shoot height and root length.

Source: http://sci-hub.tw/https://doi.org/10.1016/j.envint.2019.104975

Assembly of root-associated microbiomes of typical rice cultivars in response to lindane pollution (2019)

The concentration of residual lindane in rhizosphere soils after 60-day growth of rice (A), the average radial oxygen loss (ROL) among different rice cultivars (B), and concentrations of dissolved organic carbon (DOC) (C) and dissolved total nitrogen (DTN) (D) among three rice cultivars at lindane doses of 0, 5 and 20 mg kg^{-1}.



Bars are the standard error of means of three replicates. Different letters indicate significant differences among treatments at the $P < 0.05$ level. Abbreviations for treatments: Control: the control without rice; XS, japonica cultivar XS519; HHZ, indica cultivar HHZ; YY, hybrid cultivar YY12.

The unplanted control resulted in the lowest concentration of residual lindane in soils, with 0.09 and 0.25 mg kg^{-1} at 5 and 20 mg kg^{-1} of lindane, respectively; while rice growth significantly inhibited lindane dissipation in soils in highly polluted soil, with a residual concentration ranging from 0.30 to 0.40 mg kg^{-1} ($P < 0.05$). Among the three cultivars, lindane concentration in rhizosphere soils of hybrid YY was significantly lower than those of conventional indica HHZ and japonica XS at highly polluted treatments ($P < 0.05$).
Source: http://sci-hub.tw/https://doi.org/10.1016/j.envint.2019.104975

Evaluation of the effectiveness of a bioremediation process in experimental soils polluted with chromium and lindane (2019)

Inhibition of germination [IG (%)] in L. esculentum, R. sativus, L. sativa and Z. mays. Treatments: I) Non-contaminated soil; II) Soil contaminated with lindane 25 μg kg^{-1}; III) Soil contaminated with Cr(VI) 50 mg kg^{-1} ; IV) Soil contaminated with Cr(VI) 50 mg kg^{-1} and lindane 25 μg kg^{-1} ; V) Soil contaminated with Cr(VI) 50 mg kg^{-1} and lindane 25 μg kg^{-1} and after 14 days of stabilization, inoculated with the quadruple actinobacteria consortium. Values that sharing the same letter were not significantly different ($p < 0.05$).

Treatment	Residual concentrations	(Inhibition of germination) IG (%)			
	Lindane (μg kg^{-1})	*L. esculentum*	*L. sativa*	*R. sativus*	*Z. mays*
I	0	5 ± 2%[a]	5 ± 2%[a']	4 ± 3%[a'']	3 ± 3%[a''']
II	25	17 ± 3%[b]	2 ± 1%[a']	2 ± 1%[a'']	6 ± 2%[a''']
III	0	57 ± 1%[c]	72 ± 4%[b']	65 ± 5%[b'']	3 ± 1%[a''']
IV	25	± 4%[d]	75 ± 3%[b']	63 ± 3%[b'']	8 ± 4%[a''']
V	5	26 ± 2%[e]	48 ± 4%[c']	31 ± 4%[c'']	0 ± 0%[a''']

a Media ± standard deviation.

b The values indicated in treatments II, III and IV corresponds to the concentration achieved after the stabilization period (14 days) and maintained after the incubation period (14 days); in V corresponds to the concentration determined after stabilization and bioremediation periods (28 days).

The IG, evaluated in L. sativa and R. sativus, did not show significant differences between the control (treatment I) and the soil contaminated with lindane (treatment II), indicating that the concentration of lindane used did not cause an appreciable toxic effect for these species. The IG of L. esculentum presented significant differences among the five treatments tested, demonstrating differential sensitivity to individual toxicants.

Source: http://sci-hub.tw/https://doi.org/10.1016/j.ecoenv.2019.06.019

Lindane degradation by root epiphytic bacterium Achromobacter sp. strain A3 from Acorus calamus and characterization of associated proteins. (2019)

Average rate and kinetic parameters for lindane degradation at different concentrations by isolated bacterial strain Achromobacter sp. A3.

Lindane concentration (mg l^{-1})	Average rate of degradation (mg l^{-1} day^{-1})	K (d^{-1})	$T_{1/2}$ (d)	R^2
10	0.61	0.169	4.1	0.993
50	2.96	0.146	4.75	0.971
100	4.55	0.077	9	0.977

Average rate of lindane degradation increased with increase in lindane concentration as the rate of reaction at any time depends on the concentrations of the reactants at that particular time.

Source: https://sci-hub.tw/10.1080/15226514.2018.1524835

Lindane dissipation in a biomixture: Effect of soil properties and bioaugmentation (2018)

First-order kinetic parameters for lindane removal in biomixtures formulated with different soil types bioaugmented and non-bioaugmented, with two successive pesticide additions (100mgkg^{-1}, each one). Different letters indicate significant differences between bioaugmented and non-bioaugmented systems ($p < 0.05$, Tukey test)

Biomixtures	**Parameters**					
	k (d^{-1})	**$t_{1/2}$ (d)**	**k (d^{-1})**		**$t_{1/2}$ (d)**	
	Fist lindane contamination		**Second lindane contamination**			
CS-bioaugmented	0.028 ± 0.002^{b}	25.0 ± 2.0^{a}	0.022	$\pm 0.002^{a}$	32.2	$\pm 3.0^{b}$
CS-non-bioaugmented	0.013 ± 0.001^{a}	51.7 ± 1.4^{b}	0.043	$\pm 0.001^{b}$	16.0	$\pm 0.4^{a}$
SS-bioaugmented	0.034 ± 0.002^{b}	20.2 ± 1.0^{a}	0.011	± 0.003	63.1	± 16.1
SS-non bioaugmented	0.021 ± 0.001^{a}	32.9 ± 2.0^{b}	ND		ND	
SLS-bioaugmented	0.029 ± 0.002^{a}	23.8 ± 1.9^{a}	0.037	$\pm 0.003^{b}$	18.8	$\pm 1.7^{a}$
SLS-non bioaugmented	0.026 ± 0.001^{a}	27.2 ± 1.3^{a}	0.007	$\pm 0.001^{a}$	99.8	$\pm 1.6^{b}$

CS: clayey soil; SS: Sandy soil; SLS: silty loam soil; k: degradation constant; t1/2: half life time; ND: not determined.

Source: https://doi.org/10.1016/j.ecoenv.2018.03.011

Microbial-enhanced lindane removal by sugarcane (Saccharum officinarum) in doped soil-applications in phytoremediation and bioaugmentation.(2017)

Table 1: Comparison of reported works on the phytoremediation of lindane.

Plant species/Microorganism	**Concentration of lindane**	**Lindane dissipation**	**References**
Spinacia oleracea L.	20 mg/kg	61% after 45 days	Dubey et al., 2014
Withania somnifera Dunal	20 mg/g	73% after 145ays	Abhilash and Singh, 2010a
Sesamum indicum L	20 mg/g	58.7% after 124 days	Abhilash and Singh, 2010b
Lolium multiflorum Rye grass		120 h	Li et al., 2002
Transgenic Nicotiana tabacum		25% more removal	Singh et al., 2011
Jatropha curcas L	20 mg/kg	72% after 300 days	Abhilash et al., 2013
Transgenic Arabidopsis thaliana			Dick, 2014
Maize plants/Streptomyces strains	2 mg/kg	94.4% after 21 days	Alvarez et al., 2015
Maize plants/Streptomyces A5		55%	Alvarez et al., 2013
Cytisus striatus/Rhodococcus erythropolis ET54b & Sphingomonas sp. D4	35 mg/kg		Becerra-Castro et al., 2013a
Cytisus striatus/Rhodococcus erythropolis ET54b & Sphingomonas sp. D4	65 mg/kg	43-53% enhanced removal in 2 weeks	Becerra-Castro et al. 2013b
Saccharum sp/Candida VITJzN04	100 mg/kg	95% in 30 days	Present study

The Table briefs the previously reported works on phytoremediation of lindane using various plants. The lindane degradation efficiency exhibited by others reports were less compared to the results presented in this study. Therefore, treatment of lindane contaminated soil using phyto- myco treatment along with bio-stimulation is superior due to the great efficiency of Candida VITJzN04 both as a lindane degrader as well as plant growth promoter. The Saccharum-Candida inoculation could be useful as cheap and effective alternative for the bio- treatment of lindane impacted soil.

To survey the BCF for the radish in farm level, two sites contaminated with endosulfan (2.274 and 51.00 mg kg^{-1}) were selected at Gochang in South Korea. In this study, the BCF of endosulfans in the root was 0.015 and 0.071, respectively. The BCF of endosulfan sulfate was of the range 0.069–0.097. These BCFs for the radish were similar to the previous reports (Hwang et al. 2016).

Source: J Environ Manage. 2017 May 15;193:394-399. doi: 10.1016/j.jenvman.2017.02.006. Epub 2017 Mar 1.

Shoot length; shoot dry weight, root length, root dry weight and seed germination of four plants grown in varying concentration of lindane-contaminated alkaline soil for 10 days. Values are the mean ±SD (2016)

Plant	**[Lindane] (mg/kg dry soil)**	**% seed germination**	**Shoot length (cm)**	**Shoot dry weight (mg)**	**Root length (cm)**	**Root dry weight (mg)**
	0	100±0a	20.6± 1.5a	54.0±13.5a	14.6± 1.4a	**54.0± 13.5a**
Corn	0.2	85±5.8a	14.5± 1.5b	55.8±20.5a	10.4± 1.7b	**55.8± 20.5a**
	2	80±10a	14.0± 1.7b	53.0±15.1a	9.2±1.8bc	**48.4± 14.0a**
	20	75±5a	13.0± 1.2b	43.5±10.6a	7.0± 1.1c	**41.0± 18.3a**
Sunflower	0	100±0a	8.4± 1.0a	28.5±7.33a	7.9± 1.8a	**16± 3.6a**
	0.2	95± 5.8a	6.8±1.4ab	26.4±6.07a	4.3± 1.9b	**20.6± 8.8a**
	2	95± 5.8a	4.2± 0.9c	23.2±4.33a	3.9± 1.7b	**17.7± 4.2a**
	20	85± 5.8a	5.6±1.4bc	25.8±7.28a	4.0± 1.3b	**10.1± 5.5b**
Water morning glory	0	85± 5.8a	7.7± 0.9a	18.4± 2.8a	7.3± 0.6a	**7.0± 3.0a**
	0.2	75±5a	6.8±0.7ab	16.8± 6.0a	4.9± 0.9b	**6.9± 1.2a**
	2	45±**15b**	6.4±**0.9b**	16.7±**8.4a**	4.0±**0.7b**	**5.8±2.1a**
	20	65±15a	5.6±0.7b	14.3± 2.8a	3.6± 0.9b	**5.2± 1.3a**
Pumpkin	0	90±10a	2.3± 1.2a	63± 2.6a	6.5± 1.7a	**15± 1.0a**
	0.2	60±10b	8.0± 1.3b	61.0±1.7ab	1.8± 0.2b	**10.±4.5a**
	2	50±10b	3.8± 1.8c	57.0± 3.0b	1.8± 0.2b	**9.0±2.6b**
	20	**55±5b**	**4.4± 1.7c**	**54.7± 5.8b**	**1.8± 0.4b**	**9.0±.6b**

Source: Organochlorine phytotoxicity to alkaline soil/International journal of agricultural biology, vol. 14, no. 5, 2016