International Journal of Applied Research 2018; 4(3): 563-567

ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2018; 4(3): 563-567
www.allresearchjournal.com
Received: 18-01-2018
Accepted: 27-02-2018

Deepak Kholiya
Department of Environmental Science, Graphic Era Hill University, Dehradun, Uttarakhand, India

Correspondence
Deepak Kholiya
Department of Environmental Science, Graphic Era Hill University, Dehradun, Uttarakhand, India

Study the bioaccumulation and transfer of CD, PB and NI from soil to the host plant castor and then to the insect eri silkworm

Deepak Kholiya

Abstract

About dozen species of sericigenous insects are native to the northeastern part of India. The polyphagous eri silkworm mostly consumes leaves from the Euphorbiaceae, Araliaceae, Apocynaceae, and Simaroubiceae families. Eri silkworms mostly feed on castor and kesseru. In times of primary host plant shortage, eri silkworms can be reared on secondary host plants like tapioca, Barpat, Barkesseru, Payam etc. Although castor is the primary host plant for the eri silkworm, it is primarily an annual and must be replanted every six months.

Keywords: Bioaccumulation, sericigenous, silkworms, polyphagous, castor

Introduction

Protein fibers released by arthropods are referred to as "silk" for convenience. It is softer than any other natural or synthetic fiber, and it is smoother, stronger, and lasts longer because of the protein it contains. The sensuality, opulence, and beauty of silk textiles have long been associated with the finest in women's fashion. An air of mystery, intrigue, and romance permeates the fabric thanks to the enchanting tales and pictures that surround it. The silkworm belongs to the Phylum Animalia, Kingdom: Arthropoda, Phylum: Arthropoda, Class: Insecta, Order: Lepidoptera, Ditrysia, a lower taxonomic division this group includes the superfamily Bombycoidea and the families Bombycidae, Saturnidae, Lasiocampidae, Thaumatological, etc. Over 80 species in Asia and Africa are known to generate commercially viable wild silk. Total petroleum hydrocarbon analysis shows an uptick in hydrocarbon content (5-10%) in polluted soils, proving their existence. Moreover, FTIR results support this. Even 7 weeks after the transplanting, the plant growth increased and the TPH concentrations in the polluted soils decreased by as much as 50%-60%. So, the plant species under consideration have a great potential for removing oil from polluted soil.

The *Philosamia ricini*, Hutt. Silkworm, also known as the Eri silkworm, the Endi silkworm, and the Errandi silkworm, is a member of the saturniidae family. This silkworm species is one of the most often farmed kinds because it can be kept in captivity all year long. Eri silk is the name given to the silk spun by the *Philosamia ricini* Moth. *Commercial ericulture* is practiced in the Indian states of Assam, Bihar, Orissa, Uttar Pradesh, and West Bengal, where the production of eri silk has a long and storied history.

Literature Review

Parvinder Kaur (2018) [2] Contaminated soil and water lower the quality of the food that can be grown and the nutrients that can be absorbed by human and animal biota. One of the leading causes of soil pollution is the discharge of industrial effluents, which may include both metallic and non-metallic contaminants. When plants are employed for decontamination, the process is called phytoremediation. Phytoextraction is studied with other phytoremediation techniques. Developing microbial consortiums for phytoremediation of Jalandhar's industrially damaged regions was the focus of this study (Punjab). For various purposes, researchers selected four locations in the industrial area of Jalandhar, where heavy metal pollution was found to be much higher than in usual field soil. This study reports the isolation, 16S rRNA sequencing-based identification, and subsequent submission to NCBI for accession numbering of nine novel bacterial species.

Hanzhi Zhang *et al* (2016) [5] The impact of chelates on castor bean development was the primary focus of our research (*Ricinus communi*s L.). Plant tissues were shown to collect Cd and Pb, and their chemical behavior was studied in the rhizosphere and extra-rhizosphere of plants. In a greenhouse, the rhizobag method was tested. Plants of the Zibo-3 and Zibo-9 kinds showed respective increases in biomass output of 28.8 and 59.4 percent after being grown in soil treated with EDDS. While CA and EDTA stifled development of the two varieties. Zibo-9 survived chelate toxicity exposure better than Zibo-3. Due to the fact that EDDS can be taken up by plants when EDTA cannot, it may be used as a substitute in Cd phytoremediation. Although EDTA showed the most promise among the three chelates tested for Pb phytoremediation, its toxicity and environmental persistence exclude it as a practical choice.

Boda Ravi Kiran *et al* (2017) [3] Phytoremediation, the use of plants to clean up contaminated regions, has the potential to lessen the environmental impact of a contaminant's discharge by trapping, sequestering, and degrading it. The data reflect its expanding importance all around the globe. Recent results have been encouraging for new approaches that take use of the abundance of organic, natural ingredients. *Ricinus communis* L., or the castor bean, has several applications in agriculture, the energy sector, environmental sustainability, and manufacturing. For long-term success, we must make the most of the current scenario in which knowledge is abundant yet scattered. The study here brings together the many data points and provides a critical overview of how to make the most of them. First, its origin and scope of distribution. Two: Testing for lead toxicity in living organisms Recent advances in phytoremediation using arbuscular mycorrhizal fungus Strong biofuel potential; may also be useful for pytoremediation. Being a renewable source for several bioproducts, which brings us to our fifth point, Moreover, it may be used as a bioindicator and biomonitor of urban air pollution (point number six), Enhanced chelate-assisted cleaning is the seventh The actions in the rhizosphere that enhance the effectiveness of natural damping, Castor bean excels in phytoremediation (12), linked phytoextraction (11), and ecocatalysis (12), and is a good option for aided Phyto stabilization (9) in soils contaminated by crude oil (10).

Cleide Aparecida Abreu *et al* (2012) [4] To determine how much of an effect organic matter addition has on Ba availability, we planted *Helianthus annuus* L., *Raphanus sativus* L., and *Ricinus communis* L. in a scrap-residue-polluted Neossolo Litólico Chernossólico fragmentário (pH 7.5). Filter rates of 0, 20, 40, and 80 Mg ha1, organic carbon basis, were tested three times each in peat and sugar cane. Many kinds of flowering plants were cared for as they neared maturity. Nevertheless, adding sugar cane filter cake to the soil was proven to increase the dry matter production of sunflower and castor oil plants, while having no effect on oilseed radish. The oilseed radish, castor oil plant, and sunflower all had Ba transfer efficiency below 60%, but the oilseed radish achieved an astounding 89%. Liming the soil reduced Ba availability, but adding organic matter had little difference.

Shanying He *et al*. (2012) [1] The Ni soil contamination problem was formerly limited to metalliferous soils, but it has now expanded due to growing human activity. Ni-contaminated soils may be cleaned up using plant-based remediation techniques that are less expensive, less harmful to the environment, and have less negative effects. Nickel is an essential micronutrient, yet it may be toxic to plants in high concentrations. Certain plants, called hyperaccumulators, may accumulate large quantities of the element nickel in their young growth. Studies conducted during the last two decades have shed light on the physiological and molecular mechanisms involved in Ni absorption, transport, and detoxification in Ni-hyperaccumulator plants. This lays the groundwork for cell and genetic engineering methods to create suitable plants for phytoremediation, which might increase the efficiency of phytoremediation in cleaning up Ni-contaminated soils. It's possible that rhizosphere microorganisms, in addition to endophytes, will contribute to cleaning up the area. Optimal plant and soil management measures, Changing the soil's pH and adding fertiliser or chelates from outside sources may both aid in the phytoremediation of Ni-contaminated soils. The major purpose of this research was to review the most current findings from both theoretical and practical studies on phytoremediation of Ni-contaminated soils.

Methods

Sample Collection and Pre-Treatment

Based on the predominance of the species, Triplicate soil and plant samples were collected from the dump and the control location. Soil samples were taken using random and composite sampling methods, and were taken between 0 and 25 centimetres down using a stainless steel auger, as instructed. Then, plastic bags were used to carry the soil samples to the lab, where they were kept cold until analysis.

Selected host plants

The eri silkworm relies on three host plants for survival: castor, kesseru, and tapioca. Each of these three plants was specifically chosen so that eri silkworms could be raised on them (Figs. 1-3). The eri silkworm was raised in 2010 during the fall (Oct-Nov) season. The Central Muga Eri Research and Training Institute in Lahdoigarh, Assam, provided the seeds (cocoons) of a pure white eri silkworm species.

Rearing of Eri Silkworm (Figs. 4-6): For cultivating eri silkworms, we stuck to the tried-and-true methods described by Chowdhury (1982). Before the worms could be reared, the rearing space and equipment had to be cleansed with a 2% formalin solution. The eri silkworm larvae were reared in the lab from the first to the fifth instar on castor, kesseru, and tapioca plants. There are five replicates per treatment, each with 100 larvae per host plant. The freshly hatched larvae were carried to the fragile leaves of the host plants using feathers. The castor, kesseru, and tapioca plants were all used.

Data Analysis

Physiochemical Characteristics of Soil

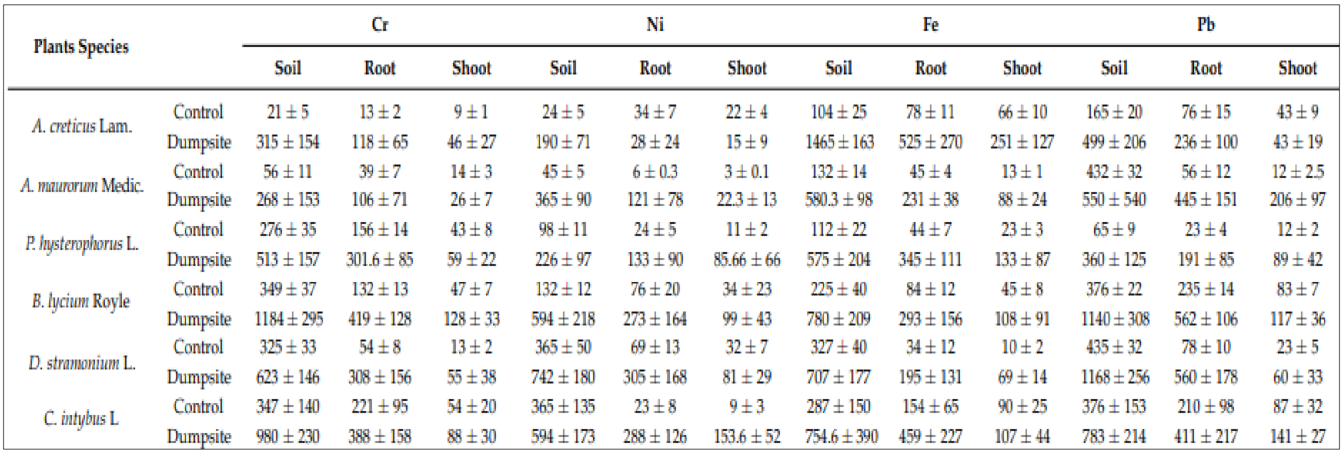
Soil contamination with heavy metals (HMs) and metalloids was ubiquitous and fast industrialization in the last several decades has led to a noticeable growth, which has brought about major hazards to the environment and human health. Concentrations of HM are strongly influenced by the soil's pH, moisture, organic matter, and texture. Table 1 displays the physicochemical information of the soil samples collected from the solid waste dumpsite and the control site.

Table 1: Physicochemical characteristics

Parameters	Observations	Dumpsite (Mean SD)	Observations	Control Site (Mean SD)
pH	18	6.9 1.6	6	7.1 0.87
EC (S cm 1)	18	700 40	6	180 28
TDS (mg L 1)	18	170 15	6	44 5
OM (mg kg 1)	18	18.42 1.54	6	0.65 0.04
Porosity (%)	18	80 9	6	21 2
Bulk density (g cm ^{3})	18	3.54 0.43	6	1.02 0.03
Texture	18	Sandy loam	6	Silty clay loam

The levels of HM in plant and soil samples taken near the dumpsite were significantly higher than those found at the control site (p 0.05). All metals tested at the dumpsite were found to be at or above US-EPA guidelines. The increased metal content may have resulted from the dumping of industrial trash at the investigated landfill. Crushing, fusing, refining, reducing, etc. in the recycling of Pb-acid batteries release various species of Pb, including anglesite (PbSO4), cerussite (PbCO3), metallic lead (Pb), and Pb oxide (PbO), all of which eventually end up in the landfill.

Table 2: Descriptive statistics



Plants Species		Cr			Ni			Fe			Pb		
		Soil	Root	Shoot	Soil	Root	Shoot	Soil	Root	Shoot	Soil	Root	Shoot
A. creticus Lam.	Control	21 ± 5	13 ± 2	9 ± 1	24 ± 5	34 ± 7	22 ± 4	104 ± 25	78 ± 11	66 ± 10	165 ± 20	76 ± 15	43 ± 9
	Dumpsite	315 ± 154	118 ± 65	46 ± 27	190 ± 71	28 ± 24	15 ± 9	1465 ± 163	525 ± 270	251 ± 127	499 ± 206	236 ± 100	43 ± 19
A. maurorum Medic.	Control	56 ± 11	39 ± 7	14 ± 3	45 ± 5	6 ± 0.3	3 ± 0.1	132 ± 14	45 ± 4	13 ± 1	432 ± 32	56 ± 12	12 ± 2.5
	Dumpsite	268 ± 153	106 ± 71	26 ± 7	365 ± 90	121 ± 78	22.3 ± 13	580.3 ± 98	231 ± 38	88 ± 24	550 ± 540	445 ± 151	206 ± 97
P. hysterophorus L.	Control	276 ± 35	156 ± 14	43 ± 8	98 ± 11	24 ± 5	11 ± 2	112 ± 22	44 ± 7	23 ± 3	65 ± 9	23 ± 4	12 ± 2
	Dumpsite	513 ± 157	301.6 ± 85	59 ± 22	226 ± 97	133 ± 90	85.66 ± 66	575 ± 204	345 ± 111	133 ± 87	360 ± 125	191 ± 85	89 ± 42
B. lycium Royle	Control	349 ± 37	132 ± 13	47 ± 7	132 ± 12	76 ± 20	34 ± 23	225 ± 40	84 ± 12	45 ± 8	376 ± 22	235 ± 14	83 ± 7
	Dumpsite	1184 ± 295	419 ± 128	128 ± 33	594 ± 218	273 ± 164	99 ± 43	780 ± 209	293 ± 156	108 ± 91	1140 ± 308	562 ± 106	117 ± 36
D. stramonium L.	Control	325 ± 33	54 ± 8	13 ± 2	365 ± 50	69 ± 13	32 ± 7	327 ± 40	34 ± 12	10 ± 2	435 ± 32	78 ± 10	23 ± 5
	Dumpsite	623 ± 146	308 ± 156	55 ± 38	742 ± 180	305 ± 168	81 ± 29	707 ± 177	195 ± 131	69 ± 14	1168 ± 256	560 ± 178	60 ± 33
C. intybus L.	Control	347 ± 140	221 ± 95	54 ± 20	365 ± 135	23 ± 8	9 ± 3	287 ± 150	154 ± 65	90 ± 25	376 ± 153	210 ± 98	87 ± 32
	Dumpsite	980 ± 230	388 ± 158	88 ± 30	594 ± 173	288 ± 126	153.6 ± 52	754.6 ± 390	459 ± 227	107 ± 44	783 ± 214	411 ± 217	141 ± 27

Pollution Indices

Peshawar dumpsite soil was analysed for HMs contamination using several pollution indicators, including the geo-accumulation index (Igeo), contamination factor (CF), and enrichment factor (EF) (Table 3). Very considerable contamination (CF > 6) was found for every element tested; the highest CF value was for Fe (41.86), followed by Ni (18.99), Pb (17.18), and Cr (13.16). DC values in the range shown in Figure 2 (35.08–78.76) indicate a high level of contamination (DC > 24). Ni, (92.95), Pb (83.82), Fe (27.90), and Cr (8.77) all had high Eri values; however, only Ni and Pb posed moderate hazards (40 Eri 80), while Fe and Cr posed low risks (Eri > 40). (Table 3).

Table 4: Soil pollution indices of the dumpsite's soil.

Sample	Contamination Factor					Geoaccumulation Index					Enrichment Factor				Monomial Ecological Risk			
	Cr	Ni	Fe	Pb	Zn	Cr	Ni	Fe	Pb	Zn	Cr	Ni	Pb	Zn	Cr	Ni	Pb	Zn
S_1	3.52	4.25	41.86	7.34	0.35	2.33	3.17	27.9	4.89	0.24	0.48	1.65	0.68	0.08	7.76	23.27	36.69	0.35
S_2	2.98	9.49	16.57	8.09	2.21	1.99	6.32	11.05	5.39	1.47	1.03	2.31	1.93	1.33	5.96	45.43	40.44	2.21
S_3	5.72	5.30	16.43	5.29	3.35	3.83	3.21	10.95	3.53	2.24	1.98	0.02	1.25	2.04	11.4	28.51	26.47	3.35
S_4	13.16	14.79	22.29	16.76	4.22	8.77	9.52	14.86	11.18	2.86	3.37	0.04	2.92	1.88	26.31	74.96	83.82	4.25
S_5	6.92	18.99	20.20	17.18	3.17	4.61	12.66	13.47	11.45	2.11	1.96	3.52	3.38	1.57	13.84	92.95	85.88	3.17
S_6	10.89	14.79	21.54	11.51	3.77	7.26	9.53	14.36	7.68	2.51	2.54	1.56	3.76	1.43	21.78	74.96	57.57	3.77

The elevated HMs values further support our assumption that the landfill is being used inappropriately to dispose of both hazardous and nonhazardous garbage, despite the fact that this is against both the letter and spirit of the law. Biosolids and manures, such as manure from animals, compost, and municipal sewage sludge, may lead to an increase in HMs such As, Cd, Cr, and Pb in the soil if they are dumped in open dumpsites. Soil HM buildup is possible, even though most organic waste includes a lesser quantity of HMs than other types of waste. Higher values of the pollution indices for Ni, Cr, Pb, and Fe in the present research may be attributed to a variety of sources, including industrial waste, burned hospital waste, trash from barbershops, and other mixed forms of waste streams from the local population.

Cocoon colour (% of respondents) (Figs. 7, 8): The three cocoons were classified as either "A" (white), "B" (brilliant white), "C" (creamy white), or "D." (dull white). Table 1 shows that 47% of respondents found castor cocoons to be a "C" (creamy white) color, whereas 30% found them to be "white," 15% found them to be "bright white," and 8% found them to be a "D." (dull white). Half of the respondents assessed the color of the cocoons made by larvae fed tapioca leaves as C (creamy white), 40% rated them as A (white), 10% rated them as B (bright white), and none rated them as D (off-white) (dull white). Almost 60% of respondents described the color of the kesseru cocoons as "C" (creamy white), 20% as "A" (white), 15% as "B" (bright white), and the other 5% as "D." (dull white).

Fig 1-8: 1. Castor (Ricinis communis L.); 2. Kesseru (Heteropanax fragrans Seem); 3. Tapioca (Manihot esculenta); 4. First instar feeding on castor leaves; 5. First instar feeding on Kesseru; 6. First instar feeding on Tapioca; 7. Cocoons obtained from Castor, kesseru and Tapioca; 8. Obtained silk from Castor, kesseru and Tapioca

Table 5: Effect of host plants on cocoon colour of eri silkworm

Host plants	Colour (% of respondents)			
	White (A)	Bright white (B)	Creamy white (C)	Dull white (D)
Castor	30	15	47	8
Tapioca	40	10	50	-
Kesseru	20	15	60	5

Conclusion

The tightness or firmness of a cocoon's shell is an indication of the texture and hardness of its lining. Cocoons from eri silkworms fed castor leaves were the softest, followed by those from eri silkworms fed tapioca and Kesseru. Cocoons from eri silkworms on a meal of castor leaves were the softest, followed by those from worms fed a diet of tapioca and Kesseru. The eri silkworm, which feeds on Kesseru leaves, produces the hardest cocoons, followed by those produced by the tapioca and castor plants.

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