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Bio-remediation: A Boon or Bane .....!

The present deteriorated environmental scenario is a warning to the human society. We are facing problems of speedy declining soil fertility, toxicated water and polluted air. Such crisis is deepening day by day. The seasons are changing. The age - old pattern of rainy and winter months has been shifted and its duration has reduced. The summer months have been proliferated. Such crumble state of the climate would be the result of various anthropogenic activities. Indiscriminate and excessive use of chemical fertilizers and pesticides in the agricultural lands over the years, faster urbanization, uncontrolled deforestation and industrialization are some of the major steps in curving the natural state of the environment. We have forgotten the ancient system of farming. Our farmers are now not growing and using green manures, dung compost and neem cakes etc. to the soil and not following crop rotation system. They have even not giving rest to their land after harvesting the crops to resume its normal health. Toxic effluents of factories have polluted the river water and soil and their smoke - the air. The level of poisonous elements is increasing in our all the three life-lines, the soil, the water and the air.

However, several new technologies have been developed to forestall or minimize such state of the environment and improve the soil health too viz. extensive use of biomanure like vermicompost, vermiwash, vermifilter and vermitea; useful bacteria like *Rhizobium* and *Azotobacter* etc.; but increasing level of persistent pollutants in the environment is still an alarming signal to us. If we do not start to work on this aspect especially to lower or remove such pollutants from the environment and search out suitable, scientific options, the people will perish.

Bio-remediation is a pristine technology to reduce or remove persistent biodegradable pollutants from soil, water and air using microorganisms like bacteria and fungi, certain varieties of plants (like grasses, herbs, shrubs and trees) and earthworms. It is known that the amount of heavy metals and synthetic pesticides from the farming land and contaminated soils could be minimized by this technology as certain plants and few species of earthworms are wonderful bio-accumulators. Conducive environmental conditions and physico-chemical and biological parameters of the medium favour microorganisms as well as plants and the earthworm species used for the speedy bio-remediation process. Ecologists, like Prof. Reddy, have said that this technology is beneficial for complete removal of a wide variety of target contaminants and could be carried out on site without any disruption of normal activities and transportation. It is less expensive than other technologies used.

Bio-remediation, on the other side, takes more time than the other treatment techniques and there are no suitable end-points for bio-remediation treatments. Not only this, it may be bane as biodegraded products,

Vice-Chancellor's Message

An excessive and imbalanced use of chemical fertilizers and pesticides may have enhanced the quantity of agricultural yield but it has also created many unforeseen problems. Serious adverse effect on the quality of soil, increase in environmental pollution and damage to the quality of food are serious concerns of the day. To avoid any disaster and protect the interests of future generations, there is a need to explore the ways in which we can gradually recover the quality of food, land and water.

Adoption and promotion of new technology can help in maintaining, sustaining and improving the soil health as well as better food for health status of the human society. The Centre for Vermiculture and Vermicomposting of the University is striving in the direction of finding efficient ways of organic farming, and to percolate this knowledge from laboratory to fields by organizing training programmes for the farmers and students.

I hope that this bulletin of the society will continue to serve as a plateform for all those who are concerned with protection of environment.

(Prof. Satya P. Gautam)
President (SEEER)

sometimes, are more persistent and toxic than that of the parent compounds. In addition, fate of accumulated toxicants and heavy metals in the body of such plants and earthworms is still not properly known when such plants are harvested or eaten up by the animals and when the earthworms died in the soil or in solid waste? VERMECO discusses about its usefulness and fate with two senior researchers of the country, Prof. M. Vikram Reddy of Pondicherry University, Pondicherry, who is working on bio-remediation technology using earthworms (Vermi-remediation) and Prof. V.P. Singh of Mahatma Jyotiba Phule Rohilkhand University, Bareilly, on plants (Phyto-remediation).

Satyendra M. Singh
Editor

Recently held International Meet on Earthworms

An International Oligochaete Taxonomy Meeting (5th IOTM) was held under the auspices of the Laboratory of Soil and Vegetation, University of Neuchatel, Beatenberg (Switzerland) from April 11th to 15th, 2011, under the Convenership of Dr. Tomas Pavlicek. In this meeting, besides Oligochaete taxonomy, different aspects of biodiversity, ecology and new methods of their study were discussed. More than 41 Oligochaete scientists, taxonomists and earthworm ecologists from 26 countries round the globe attended the event. Drs. Satyendra M. Singh and Shweta Yadav from Uttar Pradesh and Shibani Chaudhury from West Bengal participated from India.


Participants of 5th IOTM, Beatenberg (Switzerland)

Centre's Role in Transfer of Technology

i) The Vermiculture and Vermicomposting Centre (VVC) of the University has organized an extension program on "**Kaynchua Paalo - Paryavaran Bachaoo**", i.e. Save Environment: Culture Earthworms" in a village Baisra (District Shahjahanpur, U.P.) on October 9th, 2010.


Dr. S.M.Singh delivering the lecture to the village people

ii) The Centre conducted a farmer's training program on, "**Organic Farming: Need of the Day**" in village Devrania, Block Faridpur (District Bareilly) on March 3rd, 2011 in collaboration with NABARD. Ch. Harveer Singh, a Progressive farmer inaugurated the program. Centre- In charge, Dr. S.M.Singh advised farmers about the importance of organic farming and its need in today's life. Mr. A.K. Srivastava, AGM (NABARD), suggested the farmers to culture earthworms produce vermicompost and earn money. Mr. RBL Sharma, Lead District Manager, Bank of Baroda, Bareilly, answered the quarries of the farmers in getting loan. Nearly 150 farmers participated in the program. The program was supported by SEEER too.


Speakers during the program


Group of farmers in Devrania village

NEW RESEARCH PUBLICATION

Singh, S.M., Gangwar, G.R., Prakash, O. and Rachna (2010): Biocomposting of extracted Peppermint plant residue *(Mentha piperita)* using red worm, *Eisenia fetida* and its effect on the growth of *Vigna mungo*. *J. Adv. Nat. Sci.*, **2** (2): 305-312.

NEW PROJECT

A **NABARD** project on "***Transfer of Vermitechnology for Organic Farming/Sustainable Agriculture***" sanctioned to Vermiculture &Vermicomposting Centre of the University for extension cum awareness programs at village and college level for the year 2011-12.

Vermi-remediation: A Potential technology for removal of persistent pollutants from contaminated soils

A bioremediation technology using certain varieties of earthworms and their associated microorganisms to remove or render contaminants from the soil or solid waste that causes major environmental and health problems. It may be carried out in-situ like bio-degradation and ex-situ like vermi-composting. Vermi-extraction, vermi-transformation, vermi-stimulation and vermi-augmentation are various types of other bio-remediation techniques. The main species of earthworms that have been found to remove persistent pesticides and heavy metals from contaminated soils and accumulate them in their body tissues are: *Eisenia fetida, Eudrilus eugeniae, Aporrectodea tuberculata, Allolobophora chlorotica, Lumbricus terrestris, L. rubellus, Dendrobaena rubida* and an indigenous species, *Perionyx excavatus*. Out of these, *E.fetida, E. eugeniae* and *P. excavatus* are wonderful bio-accumulators especially for heavy metals such as Cd, Hg, Pb, Cu, Mn and Zn in their tissues. The accumulated concentrations of heavy metals in body tissues of earthworms depend upon their concentrations in the substrate or soil on which the worms devour.

In a research study on vermi-remediation of heavy metals from municipal solid waste (MSW), conducted in our laboratory, it has been found that out of all the metals, Cd and Pb appear to accumulate in most of the earthworm species at a high level and the earthworms collected from contaminated sites (MSW dump sites) and road sites showed higher level of Pb. It has also been noticed that *P. excavatus*, the local species of earthworm, being more effective in accumulating higher concentration of heavy metals (Cd, Pb and Zn) in its body tissues than that of other two species (see Table). The metal concentration in earthworm tissues and its Bio Accumulation Factor (BAF) was significant higher in *P.excavatus* as compared to that in *E. fetida* and *E. eugeniae* grown across the three substrates ($p<0.05$), probably because the former is a indigenous species. The metal concentrations were low at the beginning of vermicomposting process i.e. at 15 days of processing and increased gradually towards the end of the process in order of 15<30<45<60 days. Thus vermicomposting should be continued till its maturation. The concentration of Cd was higher in earthworms cultured in MSW and that of Pb, Zn were higher in those cultured in market waste (MW). The lower concentration of heavy metals in vermicompost as compared to the simple compost is because of their accumulation in the body tissues of earthworms.

It is also observed that heavy metal concentrations were found relatively higher in plants when grown with treatments of organic fraction of different urban wastes-municipal solid waste, vegetable waste and flower waste and their compost; but not with vermicompost, and were in the ranking order of wastes > composts > vermicompost of *P. excavatus* > than that of *E. fetida* > that of *E. eugeniae* (Table). Therefore, it is recommended that despite direct use of urban waste and its simple compost, use of vermicompost may serve as best organic amendment for growing plants particularly edible ones for metal-pollution free agriculture.

Table: Vermi-remediation of heavy metals Cadmium, lead and zinc by three earthworm species *Perionyx excavatus, Eisenia fetida* and *Eudrilus eugeniae* from urban solid waste

Heavy Metals	Media of Heavy Metals	Organic Fraction of Waste	Normal Compost (without worms)	Vermicompost of		
				P. excavatus	*E. fetida*	*E. eugeniae*
CADMIUM (Cd)	MSW	0.55	0.164	0.145	0.125	0.107
	MW	0.38	0.150	0.127	0.097	0.072
	FW	0.19	0.098	0.082	0.073	0.062
LEAD (Pb)	MSW	7.11	2.142	2.045	1.953	1.837
	MW	12.5	2.517	2.302	2.097	1.948
	FW	4.00	1.986	1.873	1.762	1.656
ZINC (Zn)	MSW	29.68	9.64	8.735	7.107	6.363
	MW	23.11	8.586	8.024	7.565	7.064
	FW	11.42	6.498	6.337	6.124	5.913

*MSW= Municipal Solid Waste; MW=Market Waste; FW=Flower Waste

Epilogue

- Although, earthworms seems to be a suitable tool for metal remediation from urban waste and organic pollutants from agricultural soils, the fate of earthworm tissue containing the metal or organic pollutants and its possible risks in environmental contamination should be a research priority before recommendation of this technology for waste treatment and vermi-remediation.
- Vermicompost contained wide range of plant nutrients and even relatively low concentrations of metal pollutants but its prolonged application in the agriculture may be a limiting factor because of persistent nature of heavy metal pollutants and their bioaccumulation and biomagnifications in the higher trophic levels.

M. Vikram Reddy, Professor of Ecology & Environmental Sciences, Pondicherry University, Pondicherry.

Phyto-remediation: An innovative soil clean-up technology for heavy metals

It is the use of certain varieties of grasses, herbs, shrubs and trees to remove, reduce or destroy sequester hazardous contaminants from soil, water and air. The adjoining areas of most of the cities have been polluted by domestic and industrial waste water. This water contains heavy metals in toxic amounts and adversely affecting the quality and quantity of various agronomically important crops. These metals finally enter into the human body through food chain causing various serious health problems.

The conventional remediation methods like solidification, soil washing and immobilization etc. for heavy metal contaminated soils are highly expensive and environmentally destructive while phyto-remediation is a green technology in the field of innovative clean-up strategies. On an average, it is ten times cheaper and eco-friendly technique than the conventional methods. Out of six remediation methods, phyto-stabilization and phyto-extraction are the two common techniques that are particularly used for *in -situ* hybridization of heavy metals. In phyto-stabilization, the soil contaminants are immobilized through absorption and accumulated by plant roots and get precipitated within the root zone, while in phyto-extraction technology, the contaminants after taking up by the roots, these are transported into the aerial parts of the plants.

It has been noted that the efficiency of phyto-stabilization and phyto-extraction is different for different plants. The work on phyto-stabilization efficiency of a common plant, Khas-Khas (*Vetiveria zizanoides)* and phyto-extraction efficiency of *Brassica juncea, Tagetes erecta, Zea mays and Helianthus annuus* against different heavy metals like Cu, Zn, Cd, Cr and Pb is going on in Genetics and Environmental Management Laboratory of the Department of Plant Science since more than a decade. It has been further recorded that the use of chemical chelates like EDTA, synthetic and natural chelates such as citric acid, NTA, oxalic acid may boost up the efficiency of phyto-stabilization and phyto-extraction of the plants. The efficiency of phyto-remediation can further be enhanced by the increase of plant growth, decrease in phyto-remediation period, use of plant growth promoting rhizobacteria and genetically engineered approaches i.e. development of transgenic plants.

This would be one of the very fruitful technology especially for those agro-ecosystems with shallow contamination and within root zone of remediative plants but harvested plant biomass may have hazardous waste and its disposal should be managed. In case of deep rooted crops like most of the leguminous crops, removal of heavy metals contamination is a question still to be answered.

V.P. Singh, Professor of Plant Science,
Mahatma Jyotiba Phule Rohilkhand University, Bareilly-243 006 (India)

Indian Earthworm Ecologist -1

Prof. M. Vikram Reddy (b.1950)

Professor Reddy is a senior professor of Ecology and Environmental Sciences at Pondicherry Central University (Pondicherry). Earlier he served as Professor of Zoology at Kakatiya University, Warangal (Andhra Pradesh).

He has been awarded the Fulbright Fellowship and worked at Kansas State University at Manhattan, Kansas (USA), the prestigious Rockefeller Foundation Environmental Research Fellowship in International Agriculture and worked at International Crops Research Institute for Semi-Arid Tropics (ICRISAT) at Patancheru in India, and INSA-JSPS (Tokyo) Fellowship and worked at Yokkaichi University, Yokkaichi (Japan). He was awarded the first *Dr. M. C. Dash Gold Medal* for his outstanding research in Zoology/Environmental Science/ Wildlife Biodiversity Conservation; the *E P Odum Gold Medal* by International Society for Ecological Communications.

He is a Fellow of Andhra Pradesh Academy of Sciences (Hyderabad), a Foundation Fellow of the Entomological Academy of India (Chennai), Life Member of the International Union of Soil Sciences - IUSS (The Netherland) and Life Member as well as one of the Vice Presidents of the Indian Society for Soil Biology and Ecology (Bangalore).

He was invited to the Membership of the American Association for the Advancement of Science-AAAS (Washington, DC); New York Academy of Sciences (New York) , The Xerces Society (Invertebrate Conservation), Portland (USA), and the Society for Tropical Ecology, Bonn (Germany).

He has published about 200 research papers in international and national reviewed journals, proceedings of conferences and book-chapters. Written four books published by Westview Press and Scientific Publishers (USA). Guided 16 Ph. D. students and his primary research interest is earthworm ecology and biotechnology including vermi-remediation.

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