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COMBATING THE PARTHENIUM POLLUTION BY ENVIRONMENTALLY SUSTAINABLE VERMICOMPOSTING TECHNOLOGY USING *EISENIA FOETIDA*

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ABSTRACT

Parthenium is a poisonous weed which is pernicious and allergic. It causes serious problems to human being and livestock. At present it is one of the most troubleshooting and obnoxious weed of wasteland forest, agricultural land and cause nuisance to mankind. *Parthenium* is a very dominant weed in all over India in general and Karnataka, Tamilnadu West Bengal in particular. Chemically parthenin is one of the main toxic substances present in the weed and is the causative factor for many problems. The complete eradication of these weeds is very difficult and costly. Various attempts have been taken to control, utilize or destroy *Parthenium* weed but found unsuccessful. The main objective of this study is to find an alternative biological, ecologically sustainable and economically viable technology to combat the *Parthenium* weed from the surrounding environment. The green matters of these weeds have tremendous potential for being used organic manure. In the present investigation an attempts has been made to try *Parthenium* biomass as a substrate for vermicomposting and to study the adverse effects of the product, if any, in soil The results show that by using *Parthenium* as a substrate for vermicomposting along with cow dung and press mud show good source of biofertilizer. It shows more or less similar results as compared to straw as a raw substrate. Total microbial count and dehydrogenase activity was found more or less similar in both straw vermicompost & *Parthenium* vermicompost. For any toxicity Seed germination rate, plant biomass, plant length and flowering parameter were taken for study. Germination rate is found to be more or less 100% both. Plant length, plant biomass and flowering ability have very negligible difference between these two composts.

KEYWORDS: *Parthenium*, weed, vermicomposting, dehydrogenase, germination.

INTRODUCTION

Parthenium is a poisonous weed which is pernicious and allergic. It causes serious problems to human being and livestock. At present it is one of the most troubleshooting and obnoxious weed of wasteland forest, agricultural land and cause nuisance to mankind.[1] Chemically parthenin is one of the main toxic substances present in the weed and is the causative factor for many problems. Analysis has indicated that the plant parts including pollen and trichomes contain parthenin toxins which is basically a sesquiterpene lactones. Parthenin is the main bioactive component in *Parthenium hysterophorus* L. (Asteraceae). Parthenin has also shown remarkable cytotoxicity to CHO[2] and bovine kidney cells[3] in culture (1–3 _g/ml). It inhibited genetic materials like RNA, DNA and protein synthesis as well as some enzymes involved in metabolism. The oxidative phosphorylation chain system and succinate dehydrogenase were inhibited.[4] Inhibition of DNA polymerase was observed in mouse splenocytes at 0.5 g/ml.[5] Systemic toxicity studies of parthenin have evolved as a result of *P. hysterophorus* eliciting severe cattle intoxication and death as well as contact dermatitis (type IV allergy, delayed hypersensitization) in humans. Parthenin being recognized as a one of the major causal agent for human health disorder such as it induces chromosomal aberrations in CHO cells in peripheral blood lymphocyte and has an evidence of chromatid breaks.[6,7,8,9] Another phenolic acid such as caffic acid, vanillic acid and p-anisic acids are lethal to human and animals.[10] Anisic acid causes serious skin irritation and eye irritation to human being. Inhalation causes respiratory tract irritation. Vanillic acid selectively and specifically inhibits 5' nucleotidase activity. The complete eradication of these weeds is very difficult and costly. Owing to the absence of effective natural enemies, it's allelopathic effects and photo and thermo insensitivity it flourish throughout the year suppressing native vegetation which may lead to eradication of Natural diversity.[11]

Soil microbial biomass and earthworms are prime indicators of soil health. One ton of these creatures (one million earthworms) consume their own body weight every 24 hours. So, this possesses immense possibility to produce many tons of natural fertilizer each year. Waste problems can also be solved as vermicomposting is four times faster than normal composting. Singh[12] reported that microbial count, dehydrogenase activity, phosphatase activity and IAA contents increased in presence of vermicompost prepared from farm wastes and cattle with *E.foetida*.

The green matters of these weeds have tremendous potential for being used organic manure. The direct incorporation of their green matter in soil causes poor germination of seed and reduction of crop yield.[13] Various attempts have been taken to control, utilize or destroy parthenium weed.[14,15] Parthenium is a very dominant weed in all over India in general and karnataka, Tamilnadu West Bengal in particular.

The main objective of this study is to find an alternative biological, ecologically sustainable and economically viable technology to combat the *Parthenium* weed from the surrounding environment. The green matters of these weeds have tremendous potential for being used organic manure. In the present investigation an attempts has been made to try *Parthenium* biomass as a substrate for vermicomposting and to study the adverse effects of the product, if any, in soil.

MATERIALS AND METHODS

Earthworm – **Earthworm** -*Eisenia foetida* was collected from the Department of Soil & Agriculture Chemistry, Agiculture University, Sriniketan, Bolpur, west Bengal, India.

Parthenium was collected from college campus (photograph 1). Shredded straw was collected from local agricultural market. Cow dung was collected from local market.

Vat Size – Three consecutive 3’ x 3’ x 3’ size tank was prepared for vermicomposting (Photograph – 2,3).

Preparation of Vermicompost

Parthenium was dried and cut into pieces 2-3 cm length. Cut pieces of *Parthenium* /straw were placed in vat, sprinkled with water and kept for three weeks for partial digestion. The moisture content was maintained at about 70% level. After three weeks, partially digested parthenium/ straw was placed in vat. About half of the vat was filled with the substrate. Then after dry cow dung was placed over substrate covering about two inches thickness. Above cow dung layer one inch thick press mud layer was over layered.

About 1000 earthworm was inoculated on the composted bed in the vat. Gunny bags were covered at the top to maintain the moisture level of about 60-70% throughout the experimental period. The vat was covered with net to protect the earthworm from rat and a temporary shed to protect the vat from direct sunlight and rain (enclosed photograph 2 & 3).

After 30 days interval samples were withdrawn from different treatment and earthworms were separated. The compost was dried, meshed used for analyzing different physic-chemical properties. The pH was determined using double distilled water suspension of each vermicompost that had been agitated mechanically for 30 min and filtered through Whatman No. 1 filter paper. During this period. the chemical composition such as N_2, P, K, C and pH are measured against a control blank by using standard kits.

Study of Colony Forming Unit (CFU)

To enumerate the colony forming unit (CFU) of the microorganisms in vermicompost aliquots (10g) were removed at 30 days intervals from the experimental sets suspended in 90 ml sterile distilled water serially diluted and plated in soil extract agar medium. Plates were incubated at $30^0 \pm 2^0$ and colonies were counted after 72 hrs.

Dehydrogenase assay

Dehydrogenase activity was measured colorimetrically using triphenyl tetrazolium chloride (TTC). Aliqouts of vermicompost (2g each) were weighed into 15 ml culture tube and mixed with 0.2 ml of 3.0% aqueous TTC solution, 0.5 ml 1% glucose solution and 2.0 ml distilled water. The combinations were thoroughly mixed and incubated in dark for 96 hrs at $28^0 \pm 2^0$C. After incubation the developed colour was extracted in methanol and kept for 6 hrs in dark and measured at 485 nm in Shimadzu UV /VIS Spectrophotometer.[16,17] Enzyme activity was expressed in terms of formazan produced and the quality of formazan was calculated from standard curve by using triphenyl formazan (TPF, Sigma) in methanol.[18] The results presented are mean of six replicates.

Germination and effect on plant growth

Seed germination was tested against straw vermicompost & *Parthenium* vermicompost. Seed of chili (*Solanum esculantum*) were collected from local nursery. Fifty seeds of chili were sown in earthen pot - 6" Die 6" height containing soil amended with straw vermicompost & *Parthenium* vermicompost (20 %by weight. All sets were placed in identical ambient condition s with ambient temperature of $32^0 \pm 3^0$ degree centigrade and relative humidity 40% and sunlight exposure of about 9-10 hours. Germination was count to be successful when seed exhibited radial extension of 4 mm. After germination 10 plants were harvested from each set at regular interval of 15d, 30d,45d and 60 d. The dry weight, plant height and no of flowers were recorded.

Vermiwash: It was collected from the VAT when the vermicompost was completed. The earthworms were separated from the compost and sprinkled with water. The vermiwash was then collected from the outlet pipe of the VAT after 24 hrs. The vermiwash was filtered through cheese cloth and stored at refrigerator for further use.

An experimental set was prepared to compare the adverse effect of *Parthenium* vermiwash in the seedling of *Solanum esculantum.* The vermiwash was used as foliar spray in ten seedling planted at pots with soil amended with cow dung. The vermiwash was sprayed at 7 days interval and the effects were measured after 15 days interval upto 60 days. The dry weight, plant height and no of flowers were recorded.

RESULT AND DISCUSSION

Table 1: Chemical analysis of the vermicompost by using different substrate.

Substrate	pH	P (g/kg)	K(g/kg)	Carbon(%)	NH_4(g/kg)	NO_3(g/kg)
Control	8.0	20	50	1.0	50	0.5
Straw -1	8.5	21	60	0.75	30	1.8
Straw -2	8.2	22	65	0.70	30	2.0
Straw -3	6.5	27	75	0.5-0.8	30	8.08
Straw -4	7.0	30	110	0.5-0.8	5.9	20.4
control	8.0	20	50	1.0	50	0.5
Parth-1	7.5	29	70	0.5-0.8	25	1.8
Parth-2	7.4	30	75	<0.5	20	2.2
Parth-3	7.4	30	90	<0.5	25	8.08
Parth-4	7.5	32	120	<0.5	5.9	20.8

Control = Soil + Straw + Cow Dung – Earthworm (After 0 Day); Straw -1 = Soil + Straw + Cow Dung – Earthworm (After 30 Day); Straw -2 = Soil + Straw + Cow Dung – Earthworm (After 60 Day); Straw -3 = Soil + Straw + Cow Dung + Earthworm (After 30 Day); Straw -4 = Soil + Straw + Cow Dung + Earthworm (After 60 Day); Control = Soil + Straw + Cow Dung – Earthworm (After 0 Day); Parth -1 = Soil + *Parthanium* + Cow Dung – Earthworm (After 30 Day); Parth -2 = Soil + *Parthanium* + Cow Dung – Earthworm (After 60 Day); Parth -3 = Soil + *Parthanium* + Cow Dung + Earthworm (After 30 Day); Parth -4 = Soil + *Parthanium* + Cow Dung + Earthworm (After 60 Day); Control = Soil + *Parthanium* + Cow Dung – Earthworm (After 0 Day).

Table 2: Study of Seed germination and Plant growth by applying straw vermicompost, *Parthenium* vermicompost and vermiwash.

		TIME (Days)			
		15	**30**	**45**	**60**
control	Dry weight (gm)	.065	.135	.200	.220
	Plant height (Cm)	16.0	30.0	35.0	37.8
	No. of flowers	0	0	2.5	5.4
Straw	Dry weight (gm)	.067	.132	.196	.231
	Plant height (Cm)	15.3	28.6	34.3	37.2
	No. of flowers	0	0	2.3	5.5
Parthenium	Dry weight (gm)	.065	.135	.195	.23
	Plant height (Cm)	15.0	28.5	35.1	36.9
	No. of flowers	0	0	2.1	5.35
Vermi Wash	Dry weight (gm)	.070	.130	.210	.235
	Plant height (Cm)	15.5	28.0	34.0	35.5
	No. of flowers	0	0	2.0	5.2

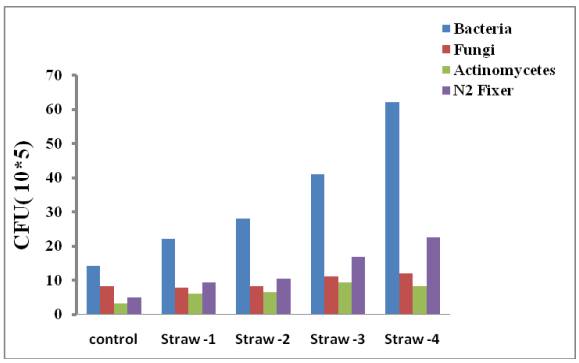

Fig. 1A

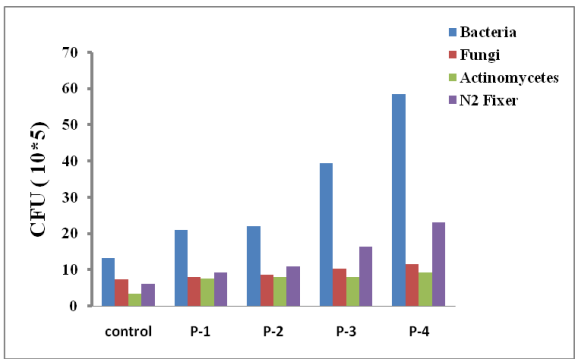

Fig. 1B

Fig. 1A & 1B: Effect of Straw vermicompost & *Parthenium* Vermicompost) on soil microbial population (Result expressed in nx10^n cfu/g dry soil and are average of 3 sample replicate on Petri plates).

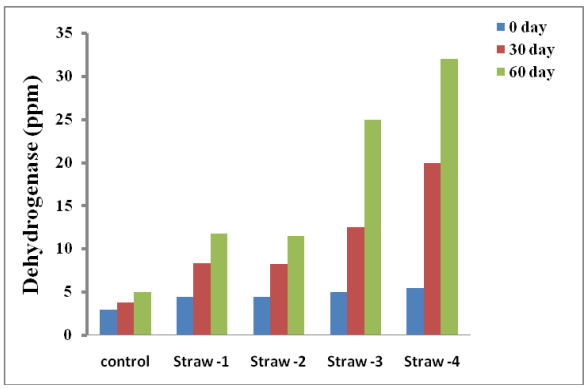

Fig. 2A

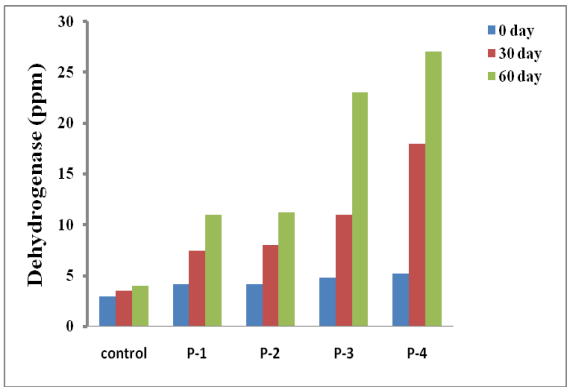

Fig. 2B

Fig. 2A & 2B: Dehydrogenase enzyme assay of Straw vermicompost & *Parthenium* Vermicompost) (Result expressed are average of 3 sample replicate).

1. Parthenium plants in our college campus

2. Three chambered vermicompost Vat.

3. Construction of vat

4. Mature vermicompost

The result shows that by using *Parthenium* as a substrate for vermicomposting along with cow dung and press mud show good source of biofertilizer. It shows more or less similar results as compared to straw as a raw substrate. Total microbial count and dehydrogenase activity was found more or less similar in both Straw vermicompost & *Parthenium* Vermicompost. In dehydrogenase study, the enzyme activity was increasing with incubation period. After 60 days of incubation, TPF produced upto 32 ppm in straw vermicompost and 27 ppm in *Parthenium* (Fig.-1A, 1B, 2A, 2B). Total Microbial count was also gradually increasing up to sixty days of incubation. TPF produced upto 32 ppm in straw vermicompost and 27 ppm in *Parthenium.*

With duration of incubation period the pH decreases in all sets. In Straw vermicompost, pH decreases from 8.5 to 6.5 and in case of *Parthenium* Vermicompost pH decreases from 8.0 to 6.8. Available phosphorus increases from 20 to 30 (g/kg) in Straw vermicompost & *Parthenium* Vermicompost. Available potassium increases from 50 to 110 (g/kg) after 60 days (8 weeks) in Straw vermicompost and 50 to 120 (g/kg) in parthenium vermicompost. Carbon concentration from 1.0% to 0.5% in Straw vermicompost and <0.5 in *Parthenium*

Vermicompost. NH_4 concentration decreases from 50 ((g/kg)) to 5.9 (g/kg) in Straw vermicompost & *Parthenium* Vermicompost. Available nitrate increases from 0.5 ((g/kg)) to 20.8 (g/kg) in *Parthenium* Vermicompost. Vermi wash was also showing more or less same observation (Table-1).

For any toxicity in soil or plants, the Straw vermicompost & *Parthenium* Vermicompost was used as a source of biofertilizer. Seed germination rate, plant biomass, plant length and flowering parameter were taken for study. Germination rate is found to be more or less 100% both in Straw vermicompost & *Parthenium* Vermicompost.. Plant length, plant biomass and flowering ability have very negligible difference between Straw vermicompost & *Parthenium* Vermicompost (Table -2).

The decreasing tendency in pH during vermicomposting corroborates with the findings of other researchers.[19, 20] The decrease in pH during vermicomposting may be due to CO2 and organic acids produced by microbial metabolism.[21] Therefore, the effects of earthworms on pH during vermicomposting is probably related to increases in the mineral nitrogen content of the substrates, changes in the ammonium-nitrate equilibrium and accumulation of organic acids from microbial metabolism or from the production of fulvic and humic acids during decomposition.

Gosh et al.,[22] reported that the increase in Total Phophorous content during vermicomposting is probably through mineralization, release and mobilization of available P content from organic waste performed partly by earthworm gut phosphates, and further release of Phosphate.

According to Elvira et. al. (1998) the production of CO_2 and organic acids with the dual action of earthworms and microbial decomposition during vermicomposting lower the pH of substrate.

Billion of tonnes of *Parthenium* biomass that generate annually across the world remain unutillized. Besides causing other mention above it contributes to global warming as the debris and the dead plants of *Parthenium* degrade aerobically /anaerobically in the open air releasing CO_2 and CH_4.[23]

In the present investigation an experimental set was design to detect the adverse effect of *Parthenium* after vermicomposting. It was observed that *Parthenium* Vermicompost does not

have any adverse effect on germination & plant growth and in soil health. So, by using this sustainable and economically viable technology, the weed may be eradicated and the biomass can be converted into a useful biofertilizer.

CONCLUSION

From the above investigation an environmentally sustainable and economically viable technology was developed by which we can eradicate the *Parthenium*, the allergic weed biomass biologically and ultimately transformed into useful biofertilizer. The adverse effect, if any, was also studied. In *Solanum esculantum* (chili plant), no adverse effect was observed in seed germination, plant growth and flowering.

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