Vermicomposting of *Parthenium hysterophorus* with different organic wastes and activators

Satish Kumar Ameta*, Rakshit Ameta, Dipti Soni and Suresh C. Ameta

Department of Chemistry, PAHER University, Udaipur-313003 (Raj.), India
Email: skameta@yahoo.com

Abstract: *Parthenium* has become a menacing weed throughout the world. Although various attempts have been made for its control and reducing its hazards; but, these are insufficient. Presently there is a growing concern about adverse impacts of chronic use of pesticides for controlling weeds. A lot of work has also been reported on the adverse impacts of chemical fertilizers on soil fertility in long term. Controlling *Parthenium* weed by composting and providing nutrients to the desired crops will be an ecofriendly step. Compost of this weed has been made using different methods with variety of organic wastes. In present work, compost of the weed has been prepared using earthworm (*Eisenia fetida*) in addition with different organic wastes (cow dong, sawdust, dry leaves, wheat straw, wood ash, etc.), activators (old farm yard manure, *Trichoderma viride,* etc.) and rock phosphate to reduce the time of decomposition and to obtain more nutrient rich compost. Importance of use of an activator in composting process was also observed for the partial decomposition of the feedstock simultaneously.

[Satish Kumar Ameta, Rakshit Ameta, Dipti Soni and Suresh C. Ameta. **Vermicomposting of *Parthenium hysterophorus* with different organic wastes and activators.** *Academ Arena* 2016;8(4):34-38]. ISSN 1553-992X (print); ISSN 2158-771X (online). http://www.sciencepub.net/academia. 5. doi:10.7537/marsaaj08041605.

Key words: Compost; earthworms; *Eisenia fetida*; environment; nutrients; *Parthenium*; soil; vermicompost; weed

1. Introduction

Invasive plant species i. e. *Parthenium* weed has the potential to damage our crops, industries, environment and public health and hence, it was realized that such invasive species are serious environmental threats for the 21st century (Masum et al., 2013). Weeds are defined as undesirable and non-economic plants that compete with crops for natural resources like water, nutrients and sunlight. A weed is established in any ecosystem due to several reasons, such as high growth rate, high reproductive potential, adaptive nature and above all, interference by resource depletion and allelopathy (Kohil and Rani, 1994). *Parthenium hysterophorus* (Figure 1) is an invasive alien weed of global significance (Kapoor, 2012). The sesquiterpene lactones namely parthenin and coronopilin present in the trichomes of leaves and stems of *Parthenium*, are responsible for causing various allergies like contact dermatitis, hay fever, asthma and bronchitis in human beings (Wiesner et al., 2007; Kapoor, 2012).

Parthenium is a genus of North American shrubs. *Parthenium hysterophorus* has got a position among the list of top ten worst weeds of the world and has been listed in the global invasive species database (Callaway and Ridenour, 2004). Although, huge quantities of this weed is produced in India, but its economic use as a food source is impaired by its toxicity. Therefore, composting might be a useful alternative to convert the weed biomass to a useful material that could be used as soil conditioner (Anbalagan and Manivannan, 2012; Jelin and Dhanarajan, 2013). The *Parthenium hysterophorus* compost contains two times more nitrogen, phosphorus and potassium than farm yard manure (FYM) (Channappagoudar et al., 2007; Angiras, 2008). Although, enough quantity of various essential macro and micro plant nutrients is present in *Parthenium* compost; but, it is not commonly practiced by farmers. Use of organic fertilizers had been shown to be a good means of improving soil quality and promoting sustainable agriculture (Rezende et al. 2014). Many factors such as temperature, pH, moisture, C/N ratio and aeration affect the composting process (Boulter *et al.,* 2000). The C/N ratio of *Partenium hysterophorus* found in this locality was 10:1 (Ameta et al., 2016a). Vermicomposting has gained popularity, as compared with conventional composting, because it provides a way to compost organic materials more quickly with good concentration of nutrients and therefore, more beneficial to plant mediums.

Vermicompost is a nutrient rich, microbiologically active organic amendment which results from the interactions between earthworms and microorganisms in the breakdown of organic matter (Lazcano and Dominguez 2010). Compost prepared by worms is rich in nutrients and organic matter and therefore, serves as a good source of manure for growing crops. Certain earthworms like *Eisenia fetida*, *Perionyx excavatus* and *Eudrilus eugeniae* are specifically suitable for the preparation of vermicompost. Nutritional status of vermicompost usually depends upon the raw materials used. Addition of vermicompost to soil improves the chemical and biological properties of soil and hence, improves its fertility (Purakeyastha and Bhatnagar, 1997). Worm composts can also be used to clean up heavy metals (Pattnaik and Reddy, 2012).


Figure 1. *Parthenium* plant

In India so far, 509 species, referable to 67 genera and 10 families have been reported (Kale, 1991). The digestive systems of worms also add beneficial microbes to help create a living soil environment for plants. Presence of certain plant hormones such as indole acetic acid adsorbed into the low-weight humic substances extracted from earthworm feces have been reported by Canellas et al. (2002) and Quaggiotti et al. (2004). *Eisenia fetida* is the species, which supports the tropical climatic conditions. This species can reproduce normally at a temperature ranging between 20 and 25°C and it can tolerate a temperature upto 29°C (Tomlin 1981; Lee 1985; Curry 1998). Adult worms require 60-80% moisture content, optimal temperature of 15-25°C and pH 6.8-7.8 for development (Juarez et al., 2011).

Several efforts have been made for preparation of a quality vermicompost from *Parthenium* weed. Such as *Parthenium hysterophorus* was blended with cow dung and press mud at various proportions, kept for pre-treatment for 21 days and subsequently vermicomposted for a period of 60 days under shade using earthworm *Eisenia fetida* (Anbalagan et al., 2012). Sivakumar et al. (2009) also composted *Parthenium* plants and neem leaves using the epigeic earthworm, *Eisenia fetida.* They indicated that the *Parthenium* composting at low amendments with cow dung may help its eradication for better utilization. Yadav and Garg (2011) indicated that *Parthenium* can be a raw material for vermicomposting, if mix with cow dung in appropriate quantity.

Therefore, composting of the weed may be used for sorting out the problems associated with it. It may also give us comprehensive benefits such as control of weed population, reduced use of chemical fertilizers, giving nutrients back to the desired crop that are sucked by the weed and that too, in an environmental friendly way.

2. Materials and methods

2.1 Materials

Parthenium was collected from Kurabad a township in Udaipur district of Rajasthan (India), Rock phosphate and *Trichoderma viride* fungus culture powder were procured from a private organisation in Udaipur (Rajasthan), cow dung, dry fallen leaves, sawdust, wheat straw, wood ash, farm yard manure etc. were collected locally.

2.2 Methodology

Four different recipes were prepared for vermicomposting of *Parthenium hysterophorus* using various organic wastes such as cow dung, dry fallen leaves, sawdust, wheat straw, wood ash etc. Rock phosphate was also added in couple of recipes to make compost nutrient rich. *Trichoderma viride* fungi and farm yard manure was used in some of recipes as an activator for partial decomposition of the material; however, the use of any activator in composting process is still controversial. Because some scientists are of the opinion that use of activator is unnecessary in the process. Ratio of each constituent in each recipe has been reported in Tables 1.

Table 1. Raw materials used in different recipes- (on the basis of volume)

RecipeNo.	***Parthenium***	**Cow dung**	**Rock phosphate**	**Saw dust**	**Wood ash**	**Dry fallen leaves**	**Wheat straw**	**Old FYM**	***Trichoderma viride* fungi powder**
1	8	1	1	-	-	-	-	-	10 g
2	6	1	0.5	1	0.5	0.5	0.5	-	10 g
3	8	1.5	-	-	-	-	-	0.5	-
4	5	1	-	-	-	2	2	-	-

The materials were in this proportion in each recipe and mixed in plastic containers allowing it to partially decompose for 20 days. Turning to the material in each plastic container was provided alternate days. Moisture content was maintained by sprinkling water and temperature was monitored throughout the process in each container. After 20 days, half decomposed material was transferred to containers for vermicomposting. 2-3 inch thick vermin-bed was prepared using sawdust in the container.

After transferring the partially decomposed material in the containers; earthworms (*Eisenia fetida*) were introduced in it. During this process, the experimental setups were placed in shaded area and covered with jute bags to maintain adequate moisture content and temperature for survival of the earthworms. Two to three turnings were also provided to the material for proper aeration and to keep moisture content appropriate during vermicomposting. The vermicompost of good quality was prepared in all the four setups within 2 months. Samples were taken out from each setup and different parameters were analyzed to determine the suitability of recipe and the quality of the as prepared vermicompost.

3. Results and discussion

Compost of *parthenium* weed was also prepared by Ameta et al. (2016b) using a pit of size 180 x 90 x 75 cm. They used cow dung, rock phosphate and *trichoderma viride* fungi culture powder in addition with the weed for composting it. Its effect on seed germination and survival of radish (*Raphanus sativus*) was also observed (Ameta et al., 2015). It took a long time of about 6-7 months in preparation of compost. Therefore, the vermicomposting may be useful for composting the weed as it prepares compost in only 2-3 months with almost the same nutritional status.

In present experiment, the temperature was measured and monitored during the whole process. It ranged between 30.6° to 38.1°C in 20 days for partial decomposition of the material. Temperature was found around 25°C during vermicomposting, which is suitable for the growth of earthworms. Some physico-chemical parameters in the prepared compost have been analyzed and the results are reported in Table 2.

Table 2. Physico-chemical parameters (Thompson et al., 2001) (Analysis on dry basis except the moisture content)

S. No.	Parameter	Test value (Sample 1)	Test value (Sample 2)	Test value (Sample 3)	Test value (Sample 4)	Method
1.	Moisture, percent by weight	30.23	28.52	34.26	28.45	TMECC 03.09-A
2.	Total organic carbon, percent by weight	10.60	13.25	15.61	18.96	TMECC 04.01-A
3.	Total nitrogen, percent by weight	1.30	1.41	1.50	1.82	TMECC 04.02-A
4.	Phosphorus as P, percent by weight	0.32	0.55	0.67	0.89	TMECC 04.03-A
5.	Total potash, percent by weight	0.59	0.76	0.72	0.45	TMECC 04.04-A
6.	C:N Ratio	8.20	9.40	10.41	10.42	TMECC 05.02-A
7.	pH	7.50	8.00	8.30	7.90	TMECC 04.11-A
8.	Conductivity ($dS\ m^{-1}$)	2.10	2.10	1.50	2.40	TMECC 04.10-A
9.	Zinc ($mg\ kg^{-1}$)	36.80	60.30	41.36	68.40	TMECC 04.05-Zn
10.	Calcium as Ca, percent by weight	0.96	0.47	0.70	0.63	TMECC 04.05-Ca
11.	Magnesium as Mg, percent by weight	0.64	0.26	0.73	0.51	TMECC 04.05-Mg
12.	Chloride as Cl, percent by weight	0.42	0.45	0.41	0.29	TMECC 04.05-Cl
13.	Sulphur as S ($mg\ kg^{-1}$)	50.90	38.96	40.25	50.78	TMECC 04.05-S

4. Conclusion

Vermicomposting of *Parthenium hysterophorus* was carried out using different organic wastes and activators. All the four setups, where different organic wastes in different proportions were used for vermicomposting, gave appreciable results having satisfactory nutritional status for the crops. The recipe No. 4, where *Parthenium*, wheat straw, cow dung, dry fallen leaves were used for vermicomposting gave comparatively better results than the remaining three recipes. Surprisingly, no activator was used in this recipe only. Thus, the findings of our experiment also discourage the use of any activator because it was found unnecessary. Vermicomposting of *Parthenium* may be quite significant for its appropriate management because the strategy has the potential, as the nutrients sucked by the weed may be recycled and again reach to the desired crop.

Acknowledgement

Author wish to thank Mr. Megh Singh Shekhawat, Dr. Gopal Singh Mahecha, Dhawan Saini, Mayank Bhawsar and Shilpi Sadhu for their valuable advice and corporation while carrying the experiment.

Correspondence to:
Satish Kumar Ameta
Research scholar
Department of chemistry
PAHER University
Udaipur (Raj.)
India
Mobile: +919828885458
Email: skameta@yahoo.com

References

1. Ameta SK, Ameta R, Dave D, Ameta SC. Carbon to nitrogen ratio of the combinations of feedstock prepared for composting of *Parthenium hysterophorus* weed. International Journal of Chemical Sciences. 2016a. (in press)
2. Ameta SK, Ameta R, Dave D, Ameta SC. An approach for bringing nutrients back into soil by composting weed *Parthenium.* Sky Journal of Soil Science and Environmental Management. 2016b. (in press)
3. Ameta SK, Sharma S, Ameta R, Ameta SC. Effect of compost of *Parthenium hysterophorus* on seed germination and survival of radish (*Raphanus sativus):* A Comparative Study. International Journal of Bioassays. 2015: 4(9): 4325-4328.
4. Anbalagan M, Manivannan S, Prakasm BA. Biomanagement of *Parthenium hysterophorus* (Asteraceae) using an earthworm, *Eisenia fetida* (Savigny) for recycling the nutrients. Advances in Applied Science Research. 2012: 3(5): 3025-3031.
5. Anbalagan M, Manivannan S. Assessment of impact of invasive weed *Parthenium hysterophorus* L. mixed with organic supplements on growth and reproduction preference of *Lampito mauritii* (Kinberg) through vermitechnology. International Journal of Environmental Biology. 2012: 2(2): 88-91.
6. Angiras NN. International *Parthenium* Research News: 2008: 1(5): www.iprng.org.
7. Boulter JI, Boland GJ, Trevors JT. Compost: A study of the development process and end-product potential for suppression of turfgrass disease. World Journal of Microbiology and Biotechnology. 2000: 16(2): 115-134.
8. Callaway RM, Ridenour WM. Novel weapons: invasive success and the evolution of increased competitive ability. Frontiers in Ecology and the Environment: 2004: 2(8): 436-443.
9. Canellas LP, Olivares FL, Okorokova-Facanha AL, Facanha AR. Humic acid isolated from earthworm compost enhance root elongation lateral root emergence and plasma membrane H^+-ATPase activity in maize roots. Plant Physiology. 2002: 130(4): 1951–1957.
10. Channappagoudar BB, Biradar NR, Patil JB, Gasimani CAA. Utilization of weed biomass as an organic source in sorghum. Karnataka Journal of Agricultural Sciences. 2007: 20(2): 245-248.
11. Curry JP. Factors affecting earthworms abundance in soils. In: Edwards CA (Ed) Ecology. St. Lucie press, Boca Raton. 1998: 38
12. Jelin J, Dhanarajan MS. Comparative physicochemical analysis of degrading *Parthenium* (*Parthenium Hysterophorus*) and saw dust by a new approach to accelerate the composting rate. International Journal of Chemical, Environmental and Biological Sciences. 2013: 1(3): 535-537.
13. Juarez PDA, Fuente JL, Paulin RV. Vermicomposting as a process to stabilize organic waste and sewage sludge as an application for soil. Tropical and Subtropical Agroecosystems. 2011: 14: 949–963.
14. Kale R. Vermiculture: Scope for New Biotechnology. Calcutta: Zoological Survey of India. 1991.
15. Kapoor RT. Awareness related survey of an invasive alien weed, *Parthenium hysterophorus* L. in Gautam Budh Nagar district, Uttar Pradesh, India. Journal of Agricultural Technology 2012: 8(3): 1129-1140.
16. Kohil KK, Rani D. *Parthenium hysterophorus*- A review, Research Bulletin (Sci.) Panjab University, 1994: 44: 105-149.

17. Lazcano C, Dominguez J. Effects of vermicompost as a potting amendment of two commercially-grown ornamental plant species. Spanish Journal of Agricultural Research. 2010: 8(4):1260–1270.
18. Lee KE. Earthworms: their ecology and relationship with soils and land Use. Academic press, New York. 1985: 411.
19. Masum SM, Hasanuzzaman M, Ali MH. Threats of *Parthenium hysterophorus* on agro-ecosystems and its management: a review. International Journal of Agriculture and Crop Sciences. 2013: 6(11): 684-697.
20. Pattnaik S, Reddy MV. Remediation of heavy metals from urban waste by vermicomposting using earthworms: *Eudrilus eugeniae*, *Eisenia fetida* and *Perionyx excavatus*. International Journal of Environment and Waste Management. 2012: 10: (2/3): 284 – 296.
21. Purakeyastha TJ, Bhatnagar RK. Vermicompost: A promising source of plants nutrients. India Fmg. 1997: 46(2): 35-37.
22. Quaggiotti S, Ruperti B, Pizzeghello D, Francioso O, Tugnoli V, Nardi S. Effect of low molecular size humic substances on nitrate uptake and expression of genes involved in nitrate transport in maize. Journal of Experimental Botany. 2004: 55:803–813.
23. Rezende MOO, Dores-Silva PR, Silva MD, Zozolotto TCB, Landgraf MD. Understanding the vermicompost process in sewage sludge: A Humic fraction study. International Journal of Agriculture and Forestry. 2014: 4(2): 94–99.
24. Sivakumar S, Kasthuri H, Prabha D, Senthilkumar P, Subbhuraam CV, Song YC. Efficiency of composting *Parthenium* plant and neem leaves in the presence and absence of an oligochaete, *Eisenia fetida*. Iranian Journal of Environmental Health Science & Engineering. 2009: 6(3): 201-208.
25. Thompson WH, Leege PB, Millner PD, Watson ME. Test Methods for the Examination of Composting and Compost. USDA and U.S. Composting Council. 2001.
26. Tomlin AD. Elevage des vers de terre, no. 489. Agriculture Canada. Canadex. 1981: 4.
27. Yadav A, Garg VK. Vermicomposting – An effective tool for the management of invasive weed *Parthenium hysterophorus.* Bioresource Technology. 2011: 102(10): 5891–5895.
28. Wiesner M, Taye T, Hoffmann A, Wilfried P, Buettner P, Buettner C, Mewis J, Ulrichs C. Impact of the pan-tropical weed *Parthenium hysterophorus* L. on human health in Ethiopia, Utilization of diversity in land use systems: Sustainable and organic approaches to meet human needs, Tropentag, Witzenhausen. 2007: October 9-11.

4/19/2016