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Parthenium, water hyacinth and *Medicago hispida* weed substrates effect on population, biomass of earthworm *Eisenia fetida* and yield of compost

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ABSTRACT

Farmers uproot plenty of weed biomass from their crop fields during weeding process and such biomass are generally thrown on the bunds and road side. Such weed biomass can be used for making vermicomoist to enrich crop soil. This study was done to see the effect of abundantly occurred weed biomass of *Parthenium*, water hyacinth and *M. hispida* as substrate on growth of earthworm *Eisenia fetida* and vermicompost yield. Increase in length and weight biomass of earthworms indicated that although *E. fetida* fed on all the three substrates provided to them, but most preferred weed species was *Medicago hispida* for the reproduction and development for the earthworm. The weight gained by total number of juveniles in different substrates indicated highest weight gain in the substrate of *M. hispida* (17.16 g/pot) followed by *Parthenium* (15.63 g/pot) and water hyacinth (13.21 g/pot). The number of cocoons recovered from which different substrates was highest in *M. hispida* and was statistically significant with other two substrates, while it was non-significant in *Parthenium* and water hyacinth. The maximum yield of vermicompost was obtained from *Parthenium* substrate (55.22%) followed by water hyacinth (46.05%) and *M. hispida* (45.22%). The vermicompost yield was not significantly different in water hyacinth and *M. hispida*, however, it was significantly different in case of *Parthenium*. Germination of *Parthenium* seedlings was recorded in vermicompost collected in form of the pellets of excreta individually from the vermicompost. This test unequivocally revealed that *Parthenium* seeds are not killed even if passed through the intestine of earthworm.

INTRODUCTION

India is a country of villages. Only about 30 years of excessive use of chemicals have caused devastating ecological implications on soil health. Organic farming is an alternative farming practice that may overcomes ill effects of fertilizers and pesticides by using natural materials and products. Organic agriculture is considered as a development vehicle for developing countries like India in particular and other countries in general because it requires less financial input and more reliance on the natural and human resources available (Ramesh *et al.* 2005). Due to continuous and large scale use of chemical fertilizers, fertility of land has been decreased gradually on sustainable basis. Therefore, bio-fertilizer like compost, vermincompost has become a boon to increase soil health. A huge amount of plant biomass is available in the form of weeds in the farmers' field itself. Proper utilization of these weeds can improve soil physical condition and environmental quality as well (Bhardwaj 1995, Verma and Kaur 2015). The recycling, reuse and resource recovery has been considered as one of the best options for waste management programme it is well documented that earthworm excreta has higher amounts of nutrients than that of the substrates or soil on which the earthworms feed. Moreover, the nutrients are changed to assimilable forms in the gut, that are more rapidly taken up by the plants (Gunadi and Edwards 2003, Baghel *et al.* 2005, Reddy *et al.* 2007).

We can make bio-fertilizer in the form of vermicompost from abundantly occurred biomass of weeds like *Saccharum munja* (Singh 2013), *Chenopodium murale* (Verma and kaur 2015), puncture wine *Tribulus terristris* (Kaur and Verma 2016) *etc.* Farmers uproot plenty of weed biomass from their crop fields during weeding process and such biomass are left generally in the field or thrown on the bunds and road side, which enrich the soil there only after decomposition. This uprooted weed biomass may be converted into compost or vermicompost. It is well documented that vermicompost is richer in macro and micro nutrients than compost simply prepared by the farmers in the form of a heap.

Weed biomass is one of the easily available sources of organic matter and plant nutrients, which hitherto, have not received required attention. The favourable climatic condition of India leads to the production of huge weed biomass of diverse species composition both in crop and non-cropped areas. The biomass production in weeds roughly ranges from 5-20 t/ha depending upon the weed species, season and growing conditions. *Parthenium hysterophorus* locally known as 'congress grass' or 'gajar ghas' is a dangerous alien invasive weed which is poisonous, pernicious, allergic and aggressive and poses a serious threat to human being and livestock. At present, it is one of the most troublesome and obnoxious weed of wasteland, forest, pasture, agriculture land and cause nuisance to mankind. The estimated biomass production of *Parthenium* is 5-8 t/ha/year (Sushilkumar and Varshney 2007, Sushilkumar 2014). Water hyacinth tops the list of all aquatic weeds and now spread to all around the country. It has successfully resisted all attempts of eradicating it by chemical, biological, mechanical, or preventive means. Water hyacinth from its native place of South America, Venezuela in particular, has now spread to over 50 countries around the earth. It is found in all types of aquatic bodies like ponds, lackes, dams, rivers, water channels and low lying area filled-up with the water. Many lacks in India were reported to be infested with water hyacinth. The estimated biomass production of water hyacinth is estimated about 7-12 ton/ha/year (Sushilkumar 2011). The weed *Medicago hispida* occurs in crop land during *Rabi* season, which may spread 30 inches in all direction from its centre crown and may reach 24 inches in height and contributes towards low yield of crops, such as wheat. The estimated biomass production of *M. hispida* is about 2-5 t/ha/year.

Earthworms are very important creatures of the earth for the maintenance of soil fertility and nutrient cycling besides promoting microbial activity in organic waste and break them down into materials, which can be used in crop production. This process also deals with management of agro-waste from various sources to generate useful products. Weeds uprooted during agricultural operation are also bio-waste, which can easily be recycled by the activity of the earthworms to produce a marketable biofertilizer in the form of 'vermicompost'. It is a good substitute for chemical fertilizers and has more NPK than normal heap manure and the compost prepared by NADEP methods and by other farmer practices (Sushilkumar *et al.* 2005).

Eisenia fetida, also known as red wrigglers, is the most common earthworms used for vermicomposting. The earthworm has been recognized as efficient bio-converters of organic residues in to high grade compost. Biomass production of *E. fetida* may attained an increase of 10-50 times in a period of 3-6 months, but it has been found to be regulated by availability of nutrients from substrate mixture. It is a potential organism for the management of organic waste (Tsukamoto and Watanabe 1977, Nauhauser *et al.* 1980). Gunadi and Edwards (2003) studied the effects of multiple applications of different organic wastes on the growth, fecundity and survival of *E. fetida* Edwards and Arancon (2004) has given emphasis of converting agro-waste and weed biomass with the help of earthworms in agriculture sector.

Considerable work has been carried out on the use of earthworms to recycle various organic wastes. However, there is not much published report available regarding the vermicomposting of weeds. In view of this lacuna and for better understanding of the process of vermicomposting from weed biomass, this study was done to see the effect of abundantly occurred weed biomass of *Parthenium*, water hyacinth and *M. hispida* as substrate for earthworm *Eisenia fetida* development and conversion of weed biomass to vermicompost.

MATERIALS AND METHODS

The experiment was undertaken during February to May 2012 at ICAR- Directorate of Weed Research, Jabalpur, comprised of three treatments with six replications. Three substrates of weed species namely *Parthenium hysterophorus, Eichhornia crassipes* and *Medicago hispida* were taken for study. Rag weed (*Parthenium hysterophorus*) and water hyacinth (*Eichhornia crassipes*) were collected from the road side and nearby pond, respectively, while *Medicago hispida* was collected from the farm of Directorate of Weed Research. The *Parthenium* plants were having flowers while *Medicago hispida* plants were having green seeds formation. Water hyacinth plants were not having flowers. The earthworms (*Eisenia fetida*) were obtained from vermicomposting unit of the Directorate for using in the experiment.

Weed biomass of different weed species was collected, chopped and heaped for about 30-35 days. Water was sprinkled at every two days till the biomass was half digested. Each pot having the size of 1.5×1×1 feet (depth × width × length) was filled up with seven kg of half-digested weed biomass of the respective weed species. In each pot, 50 earthworms after initial measurement for weight and length were released. The pots were kept in shady place and moisture of about 70-80% was maintained by sprinkling water as and when required.

Estimation of vermicompost yield: Earthworm castings were carefully removed periodically from the surface with the help of hard paper sheets and weighted for final vermicompost yield calculation. At the end of 95 days, the observations were stopped and all the vermicompost was removed and weighted. Vermicompost was carefully inspected for any cocoons and juveniles and if found, were counted for final calculation.

Estimation of earthworm growth parameters: All the earthworms including juveniles and cocoons were removed carefully and counted at 95 days. Observations were taken for mortality of adult earthworm, which were released initially in the pot. Each pre-released adult earthworm was again measured for its length and weight. Total number of juveniles per pot was counted and total weight per pot was taken for estimating increase in biomass of earthworm through reproduction.

Germination test for available *Parthenium* seeds: It was suspected that *Parthenium* seeds may be eaten by the earthworm along with weed humus because of its tiny size and plenty in numbers. This experiment was conducted to test whether the seeds of *Parthenium* may be passed through the intestine and may survive in the earthworm castings. To rule out the *Parthenium* seeds contamination from outside through air or by other means in the castings in the pots, well-formed biggest size castings were meticulously removed one by one from the freshly produce vermicompost with the help of forceps and kept in Petri-dishes for seed germination test in six replications. In each Petri-dish, 40 grams of castings were placed. Moisture was maintained and fortnightly observations were taken up to 45 days for *Parthenium* germination. After counting, seedlings were uprooted with the help of forceps. The vermicompost was again turn up and observations were taken for further germination.

Estimation of macro and micro nutrients from vermi-compost of different substratum: Organic carbon, phosphorus, nitrogen, pottasium and sulphur content were estimated by standard methods. Micronutrients (Cd, Fe, Cu) in the form of heavy metal were estimated from the vermicompost prepared from different substratum**.** An amount of each 0.5 g of vermicompost samples was digested using diacid solution (3:1) comprising of nitric acid and perchloric acid and the samples were filtered using Whatman no.1 filter paper and volume was made up to 100 ml in volumetric flask. The filtered samples were read for (cd, Fe, cu) using atomic absorption spectroscopy (THERMO S4).

Determination of vermicompost reaction (pH): pH of vermicopost was measured taking 5 g of vermicompost in a 100 ml beaker to which 50 ml of distilled water was added. The suspension was stirred well at regular in and pH was recorded with the help of pH metre.

Measurement of electrical conductivity: The clear extract after pH determination was used for electrical conductivity measurement. The conductivity of the supernatant liquid was determined with the help of salt (conductivity) bridge. The measurement of EC was adjusted (usually) at 25 ^{0}C for a known temperature of the solution by setting the knob provided for this purpose. The suspension was stirred well, just before the electrodes was immersed.

RESULTS AND DISCUSSION

Effect of weed substratum on population and biomass of earthworm

The initial average length and weight of each earthworm taken for study ranged between 8.70 to 8.84 cm and 0.92 to 0.95 g, respectively (**Table 1**). The average length and weight of each earthworm taken after 95 days of initial release ranged between 10.24 to 12.87 cm and 1.09 to 1.59 g, respectively. There was no significant difference in the average length and weight of earthworm fed on the substrates of *Parthenium hysterophorus* and *Eichhornia crassipes,* however there was significant difference in both the growth parameters of earthworm fed on the substrate of *Medicago hispida* (**Table 1)**. This increase in length and biomass indicated that although *E. foitida* fed on all the three substrates provided to them, but most preferred weed species was *Medicago hispida* for the reproduction and development of earthworm.

Mortality of earthworms in different substrates

The average total mortality of earthworm from initial 50 numbers was 3.0, 2.71 and 1.67 in substrates of *P. hysteroporus, E. crassipes* and *M.*

Table 1. Comparative growth parameters (average) of earthworms after 95 days of initial release

Weed substrate	Initial length (cm)	Initial weight (g)	Length after 95 days (cm)	Weight after 95 days (g)	No. of juveniles/pots after 95 days	Additional weight of juveniles/ pots	No. of cocoons/ pots	Mortality of initially released earth worm /substrate
Parthenium hysterophorus	8.71±0.08	0.95±0.02	10.4±0.07	1.09±0.01	509.3±32.0	15.6±0.72	84.8±9.28	3.0±0.89
Eichhornia crassipes	8.70±0.10	0.92±0.04	10.2±0.19	1.10±0.02	376.7±25.2	13.2±0.94	85.8±8.80	2.71±1.03
Medicago hispida	8.84±0.09	0.95±0.02	12.9±0.47	1.59±0.18	593.7±29.1	17.2±0.20	115.7±10.1	1.67±0.52
LSD (p=0.001)	0.11	0.13	0.36	0.13	35.58	1.03	11.58	1.03

hispida, respectively. Mortality of earthworm after 100 days was not found statistically significant (**Table 1**). Therefore, it can be inferred that mortality of earthworm may equally occur in all the substrates used in the study.

The weight gained by initially released earthworms and total number of juveniles in different substrates indicated highest weight gain in the substrate of *M. hispida* (17.16 g/pot) followed by *Parthenium* (15.63 g/pot) and water hyacinth (13.21 g/pot) (**Table 1, Figure 1**). This was statistically significant with each other.

Comparative development of juveniles and cocoons in three different substrates: Earthworms reproduced and produced juveniles and cocoons in all the substrates, but maximum number of average juveniles/pot were obtained from the substrates of *M. hispida* (593.7) followed by *Parthenium* (509.3/pot) and water hyacinth (376.7/pot).

The number of cocoons recovered from the different substrates were highest in *M. hispida* and

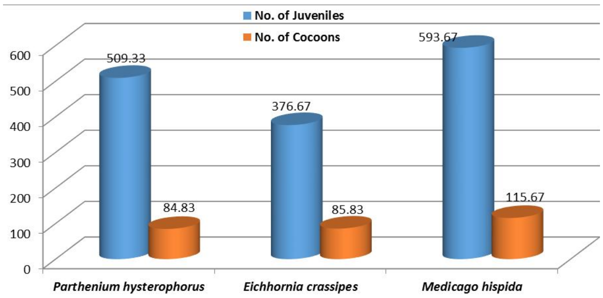

Figure 1. Juveniles and cocoons (in number) developed in different weed substratum after initial release

was statistically significant with other two substrates while it was non-significant in *Parthenium* and water hyacinth (**Figure 1**).

Yield of compost in different substrates: The maximum yield of compost was obtained from *Parthenium* substrate (55.22%) followed by water hyacinth (46.05%) and *M. hispida* (45.22%) (**Table 2**). The vermicompost yield was not significantly different in water hyacinth and *M. hispida*, however,

Table 2. Vermicompost yield (kg) after 95 days from 7 kg of weed substrats of each species

Weed substrat	Net yield (kg)	Unconverted weed substratum (gm)	%	Average conversion (%)	LSD (p=0.001)
Parthenium hysterophorus	3.43	783.3	55.2	55.2	
Echhorina crassipes	2.95	566.7	62.7	46.05	0.36
Medicago hipsida	3.11	137.55	45.3	45.22	

it was significantly different in case of *Parthenium*.

It was observed that maximum biomass of *M. hispida* (7.0 kg) was consumed by 80 days, but yield of vermicompost was significantly lower than the *Parthenium*, while maximum weed biomass of *Parthenium* and water hyacinth was converted into vermicompost by 95 days. It was interpreted that although *M. hispida* substrate was more palatable to earthworms and on this substrate, growth of earthworms was also high, but vermicompost yield was less in comparison to *Parthenium*. In *Parthenium*, the higher yield may be due to higher cellulose and fibre content. In *Parthenium*, cellulose content may be upto 42 to 47% (Jain *et al.* 2008).

Germination of seeds in *Parthenium* vermicompost: Germination of *Parthenium* seedlings was recorded from the vermicompost collected from the heaps of the pots as well as from the pellets of excreta collected individually from the vermicompost. The germination of seeds was high during first week, which decreased gradually by second week. This test unequivocally revealed that *Parthenium* seeds are not killed even if passed through the intestine of earthworm. This study suggests that vermicomposting from *Parthenium* should be done before flowering to check further seed proliferation through application of vermicompost prepared from *Parthenium*.

Nutrients status in vermicompost prepared from different substrates: The nutrients status of N, P, K, S, Fe, Cu, Cd and EC and pH of vermicompost prepared from different substrates are given (**Table 3**).

Table 3. Nutrient status in vermicompost of different weed substrates

Type of weed substrate	N (%)	P (%)	S (%)	Fe (ppm)	Cu (ppm)	Cd (ppm)	EC (mS/cm)	pH (1:10)
Parthenium histerophorus	0.74	0.22	0.95	> 2144.99	30.86	ND	1.07	8.31
Medicago hipsida	1.91	1.17	1.05	> 2015.21	25.14	ND	0.61	7.49
Eichhornia crassipes	1.26	1.15	1.12	> 2077.58	33.73	ND	0.83	6.61

The total N ranged from 0.74 to 1.91%, maximum in *Medicago hispida* and minimum in *Parthenium*. The total P and S ranged from 0.22 to 1.17 and 0.95 to 1.12%, respectively. Maximum P was found in *M. hispida* followed by water hyacinth and *Parthenium*, while maximum S was recorded in water hyacinth followed by *M. hispida*. Cadmium could not be deducted in any samples in spite of the fact that water hyacinth was collected from a city ponds which was suspected to be rich in heavy metals and *Parthenium* from road side. Copper was high in water hyacinth followed by *Parthenium* and *M. hispida*.

Electrical conductivity (EC) and pH was recorded highest in *Parthenium* (1.07µs/cm and 8.31, respectively) while pH was towards acidic (6.61) in case of water hyacinth (**Table 3**).

This study revealed that reproduction and development of off springs may vary and depends on type of substrate provided to earthworms. In the present study, though there was highest increase in biomass, juveniles and cocoons number in *M. hispida* substrates, which was evidenced by the facts that all the biomass of 7 kg weeds was converted to vermicompost by 50 number of earthworms in 80 days, but total vermicompost yield by weight was significantly less than the *Parthenium* substrate where growth parameters were relatively less.

Verma and Kaur (2015) found significant variations in food preference in earthworm when the cattle dung was mixed with weed in different combination. Their study revealed that addition of weed in cow dung not only enhanced the growth of the worm but also increased cocoon production thus providing a possible tool towards proper utilization of weed for production of value added product. However, our study suggest that even effective utilization of weeds can be done to make vermicompost even without mixing of dungs.

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