Tropical Agricultural Research & Extension 13(2): 2010

EFFECT OF SELECTED EARTHWORMS ON SOIL FERTILITY, PLANT GROWTH AND VERMICOMPOSTING

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Accepted: 10th May 2010

ABSTRACT

The study investigates the effect of the endogenic earthworm *Pontoscolex corathrurus* on soil fertility and plant growth and three epigenic earthworms *Periyonix excavatus, Eudrilus eugenia* and *Eisenia foetida* on vermocomposting. At the organic farm site, year round abundance of *P. corathrurus* ranged from 4.95-19.6 for adults, 2-13.25 for juveniles and 2.2-7.3 for cocoons and in integrated farm site from 2.2-15.6 for adults, 1.5-11 for juveniles and 0.8-4.6 for cocoons. Effect of *P. corathurus* activity on soil fertility relieved that worm casts are significantly high in N (9.7-6.5%) and C (5.7-3.5%) content than surrounding soil. The pH of casts was neutral compared to the fluctuating pH of surrounding soils, in both sites Presence of *P. corathurus* in pot experiments, significantly increased the growth of *Zea maiz* when inoculated with 7 earthworms per pot. Culturing of the 3 selected epigenic earthworms in 7 composting media, containing cow dung, vegetable refuse and rice straw in different ratios, showed that presence of cow dung significantly increased the multiplication rate. Vermicomposting yielded compost having higher N, P, Fe, and Mn levels, better particle size in comparison to the controls. Findings of the study confirm that earthworms commonly found in Sri Lanka can be easily used for soil fertility improvement and vermicomposting without having to import species from elsewhere.

Key words: *Pontoscolex corathrurus*, *Periyonix excavatus*, *Eudrilus eugenia, Eisenia foetida*, Epigenic, endogenic

INTRODUCTION

Earthworms (Annelida: Oligochaeta) contribute to soil fertility improvement, plant growth and play a key role in converting organic matter and composting garbage. There are about 3,627 species of terrestrial earthworms in the world (Reynolds 1994). Stephenson (1923) recorded 63 species of earthworms from Sri Lanka of which 47 were considered as zoo-geographically important to the Asian region. A recent study revealed 22 species of earthworms belonging to 16 genera and 9 families in 17 natural and agricultural sites in the Wet and Intermediate zones in Sri Lanka (Samaranayake 2008). These earthworms belong to three ecological categories, namely epigenic, endogenic and anecic based on morphological features, habits and location in soil (Bouche 1977). Of the endogenic species, *Pontoscolex corathrurus* showed the highest distribution in all the 17 sites. Adults, juveniles and cocoons and casts of *P. corathrurus* could be easily identified in the fields (Samaranayake 2008). According to Fragoso *et al.* (1996), *P. corathrurus* is an exotic species that originated in Central America and is now widely distributed all habitats in the tropics.

Earthworms play many different roles in soil. They play an active role in soil organic matter dynamics and nutrient turnover. A significant proportion of the ingested material assimilated by earthworms is secreted as intestinal cutaneous mucus with a greater C/N ratio than original resources (Lavelle *et al.* 1994). As a result, part of the N assimilated may be in excess and have to be excreted. Another reason for high mineral nitrogen excretion is the rapid turnover of N in earthworm biomass. Brossard *et al.* (1996) showed that the total P content was 43% higher in casts than in surrounding soil. Furthermore, conditions maintained in the gut of earthworms provide for microbial activity whereby considerable amounts of water and intestinal mucus are added to the worm casts which in turn enrich the soil. Earthworms facilitate dispersal of soil microorganisms by their feeding, burrowing and casting activity (Lavelle *et al.* 1994).

Results from laboratory experiments conducted over more than hundred years have indicated positive effects of earthworms on plant yield. Syers *et al.* (1984) have demonstrated that lumbricid earthworms from temperate regions are capable of stimulating plant growth in grasslands. Further, small scale experiments using non-lumbricid tropical geophageous earthworms have shown similar trends and indicated species- specific responses of plants to earthworm activity (Spain *et al.* 1992; Fragoso *et al.* 1996). Moreover, their findings showed that

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optimum yield enhancement is achieved when the correct species of earthworms are inoculated. Also its population enhanced by management through producing components which can be utilized by the growing roots and also enhancing the release of nutrients in synchrony with the demands of the plants. Such long term field experiments were conducted in Peru, Ivory Coast and Mexico with the introduction of *P. corathrurus* which, greatly enhanced maize yields in most cropping cycles, when maize was grown off season with the addition of fertilizer (Lavelle *et al.* 1994).

The utilization of organic wastes through earthworms is called vermicomposting. It is a technical method of producing compost in an ecologically sound, economically viable and sociologically acceptable manner. Vermicompost can supply the full requirement of major nutrients for plant growth *i.e.* N, P, K; secondary nutrients *i.e.* Ca, Mg, S and also micro nutrients *i.e.* Cu, Zn, Mn and Fe. The average nutrient content of vermicompost is much higher than in the other types of compost (Singh 1996). Only other hand vermicompost is a rich source of vitamins and growth hormones like gibberellins which regulate plant growth. Fragoso *et al.* (1996) reported that single earthworm has to digest organic matter up to 5-30 times of its body weight per day in order to enhance the growth of beneficial soil bacteria which are the most divers and speediest agents for decomposing organic matter.
At present information on the role of local earth worm fauna in soil fertility improvement is scanty and inconclusive. In this study three interrelated objectives were investigated using the common endogenic earthworm, *P. corathrurus,* and three epigenic species *Eudrilus eugenia*, *Eisenia foeitida* and *Peryonix excavatus* (Samaranayake 2008).

The specific objectives of the study were; 1. to confirm the year round occurrence of *P. corathrurus* (adults, juveniles and cocoons) in two differently managed agricultural sites; 2. to determine the pH, total C and N content in *P. corathrurus* casts in comparison to non ingested surrounding soil, in the two selected sites; 3. to determine the effect of *P. corathrurus* on growth of *Zea maize* in a pot experiments and; 4. to determine multiplication rate of three selected epigenic earthworm species in three composting media and the resulting nutritive level and particle size in comparison to controls.

MATERIALS AND METHODS

Field sites

For field studies two differently managed sites were selected; 1. an integrated farm site cultivated with winged beans at the In-Service Training Centre of the Department of Agriculture, Gannoruwa and 2. an organic farm site at Dekinda, Nawalapitiya. At each site, 20x20m plots were established to conduct the study.

Survey of *Pontoscolex corathrurus*

For the year round survey of *P. corathrurus*, 10 quadrates (25x25cm) were randomly placed in the filed plots. The surface casts found within the quadrates were collected and counted. Thereafter, soil was dug to a depth of 40cm in each quadrate, and placed in a tray. Soil was hand sorted and the number of cocoons, juveniles and adults of *P. corathrurus* in each quadrate was collected and recorded.
In this manner, ten soil samples were examined from each site at monthly intervals from July 1996 -1997. The rainfall data of these two sites were obtained from the climate database established and associated with DIVA GIS software.

Chemical composition of *P. corathrurus* casts and surrounding soil

Casts and soil collected on each sampling day were used for this experiment**.** Casts and soil were separately pooled. The pH of casts and soil was determined using the Piper method (Andreson and Ingram 1989). Total N content was determined using Kjeldhal method and total C using Walky Black method (Andreson and Ingram 1989).

Effect of *P. corathurus* on plant growth

Effect of different numbers of *P.corathurus* on the growth of *Z. maize* was determined in a pot experiments. The potting mixture consisted of 3 parts of soil (soil type RYP) and 1 part of cow dung (sterilized for 17h). This medium was put into clay pots (height 20cm, surface area 0.17m²) and inoculated with different numbers of adult *P. corathurus* as indicated in Table 1. Each treatment was replicated 5 times. Two seeds of *Z. maize* (Variety "Ruwan") were planted in each pot. Plant height, fresh and dry weight of roots and shoots of all plants were measured separately at 50d after seeding.

Multiplication of earthworms for vermicomposting

Multiplication of the 3 selected epigeic earthworms, *E. eugenia*, *E. foeitida* and*, P. excavatus* in 7 different media were studied under laboratory condition. The 7 media used in the experiment were: (1) Cow dung, (2) Vegetable refuses, (3), Straw, (4) Cow dung + Vegetable refuse (1: 1), (5) Cow dung + Straw (1: 1), (6) Vegetable refuse+ Straw (1:1) and (7) Cow dung + Vegetable refuse + Straw (1: 1: 1 ratio).

Table1. Number of *P. corathrurus* adults added to different growth media (refer text for details)

Code of the Media	No. of earthworms per pot
T_1	Control/ no earthworms
T_2	3 earthworms
T_3	5 earthworms
T_4	7 earthworms
T_5	9 earthworms
T_6	11 earthworms

The total weight of each medium was 900g. Each medium was placed separately in plastic basins (30cm dia. and 15cm height). Each basin containing a specific medium was separately inoculated with 15 mature earthworms of each of the three species used in the study. Each treatment and rearing medium was replicated 5 times. The experimental basins with earthworms were kept in an enclosed room under dark condition and the basins were watered at regular intervals using a fixed amount of water. The basins were covered with moistened newspaper to prevent drying of the media. After 50d, the number of earthworms (adults and juveniles) and number of cocoons produced in each replicate were recorded.

Effect of *Eisenia foetida* activity on nutrients and particle size of compost

The levels of plant nutrients and particle size of compost following vermiculture were determined using two of the above culture media; vegetable refuse alone and a mixture of straw+ cow dung + vegetable refuse. The media were prepared and placed in plastic basins as before. Fifteen adults of *E. foetida* were added in to each medium. A control was set up where no earthworms were added to the media. After 45d, the total dissolved N, P, Fe and Mn levels in the media were measured using the colorimetric method.

Particle size improvement (reduction in size of particles) in the media was measured using the Granular metric method (Lavelle et al. 1994). Compost samples were kept at 70°C in an oven for 1h. Thereafter, 50g of the compost sample from each treatment was sieved through mesh (sizes 1mm, 700mm, 500mm, and to 250mm) and weighed separately and compared with the control.

Statistical Analysis

Two-sample t-test was used to compare the mean abundance of *P. corathrurus* in the two selected sites over the 12 months period. Mann -Whitney test was used to compare the total C, N, and C/N ratio in casts and surrounding soil in each site. Data on the effect of different numbers of *P. corathrurus* on *Z. maize* growth was analyzed using SAS statistical package. Multiplication of the three epigeic earthworms (*E. foetida*, *P. excavatus* and *E. eugenia*) in the 7 media were analysed using One Way ANOVA and compared using Chi-square. The Chi-square test was used to compare the levels of plant nutrient in vermicompost and in the control .

RESULTS

Year round abundance of *P. corathrurus*

The variation in abundance of *P. corathrurus* adults, juveniles and cocoons in the two selected sites (organic farm and integrated farm) showed a similar pattern in their life cycle stages during the twelve month period (Figures.1 & 2). In both sites a high abundance of *P. corathrurus* was recorded in the months of August and October of 1996/1997. The range for the number of *P. corathrurus* within a quadrate (20 x 20 x 40cm) was adults (4.95-19.6), juveniles (2-13.25) and cocoons (2.2-7.3) in the organic farm site and adults (2.2-15.6), juveniles (1.5-11) and cocoons (0.8-4.6) in the integrated farm site.

The fluctuation in the abundance of *P. corathrurus* was observed to be related to rain fall pattern. The abundance of *P. corathrurus* in soil decreased from the months of February to April which are relatively dry months (Figures 1 and 2) at both sites. The numbers increased during the period from May to December when the rainfall was relatively high. Unlike at the organic farm site, at the integrated farm site where winged beans were cultivated on an extensive scale the typical picture was not observed perhaps due to various soil inputs especially agrochemicals.

The variation in the abundance of surface casts of *P. corathrurus* during the study period is shown Figures 3 and 4. Surface casts too showed a similar pattern of variation with an increase during the months of May – December and a decrease from Februay to April, with the onset of rains. Furthermore, casts of *P. corathrurus* were readily identifiable. The surface casts were spherical and hence could be easily counted. Thus, it was not necessary to disturb the soil in order to determine the abun-

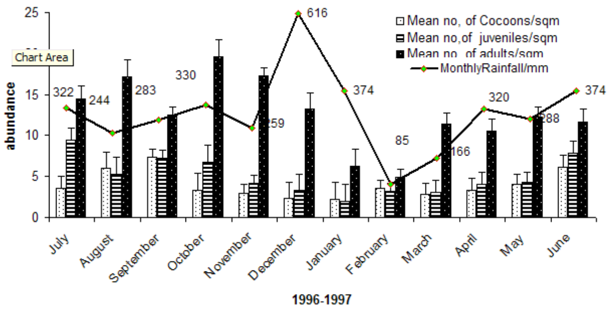

Figure 1 Mean number of cocoons, juveniles and adults of *P. corathrurus* and the rainfall at the organic farm site at Nawalapitiya

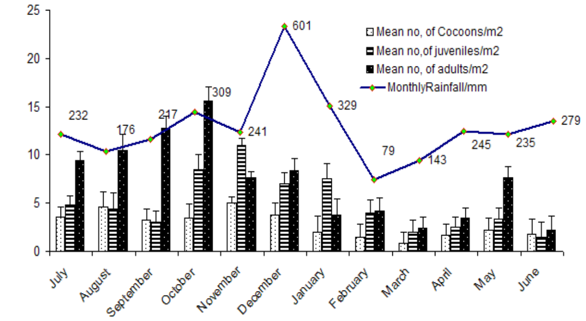

Figure 2 Mean number of cocoons, juveniles and adults of *P. corathrurus* and the rainfall at the integated farm site at Gannoruwa

dance of *P. corathrurus* casts unlike for studying the adults, juveniles and cocoon stages.

The abundance of *P. corathrurus* surface casts with in a quadrate (20 x 20cm) ranged form 30.0-125.5 in the integrated farm and from 25.5 -165.5 in the organic farm.

pH of *P. corathrurus* casts and surrounding soil

The pH of worm casts *of P. corathrurus* was found to be higher than that of non-ingested surrounding soil in both fields sites (Figures 3 & 4). The pH of casts ranged from 6.6 - 7.0 and of the surrounding soil from 5.8 – 6.8. Moreover, there was a significant difference ($P < 0.05$) in the soil pH in the two sites with the soil pH in the Organic farm site being comparatively higher. Furthermore, in the organic farm site there was a significant difference between soil pH and cast pH ($P < 0.05$) the pH in casts was always higher than that of soil. In the integrated farm, chemical fertilizer had been applied in March/April which has resulted in the disturbance of soil and earthworm casts as well as a reduction in soil pH.

Carbon content of *P. corathrurus* casts and surrounding soil

The mean carbon content was found to be higher in *P. corathrurus* casts than in the non ingested surrounding soil in both sites (Table 2). The C content of *P. corathrurus* casts was 5.76% higher in organic farm site and 3.45% higher in integrated farm, compared to the surrounding soil. There was a significant difference between the two sites with respect to total C content of cast and surrounding soil ($P = 0.05$). The overall total C content was higher in the organic farm site than in the integrated farm.

Nitrogen content of *P. corathrurus* casts and surrounding soil

Mean N content of casts was higher than the surrounding soil in both sites (Table 2). In the Organic farm, the N content of casts was 0.450 and in surrounding soil it was 0.418. In the integrated farm site the N content of casts was 0.444 and of the surrounding soil was 0.402 ($n = 5$). There was a significant increase of 9.75% in the N content of casts compared to surrounding soil in the organic farm site and a 6.54% increase in the integrated farm site ($P = 0.05$)

C/N ratio of *P. corathrurus* casts and surrounding soil

The C/N ratio was lower for casts of *P.*

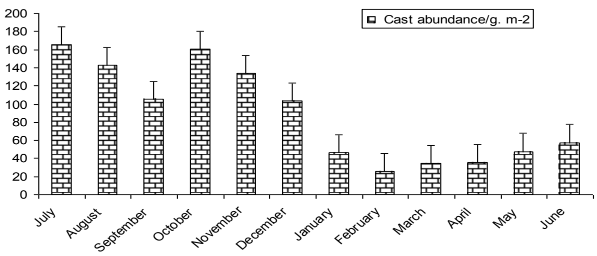

Figure 3 Abundance of cast of *P. corathrurus* in organic farm site, Nawalapitiya (1996-1997).

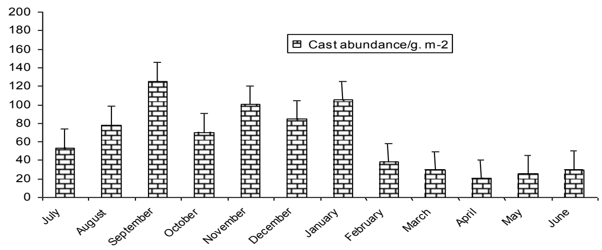

Figure 4 Abundance of cast of *P. corathrurus* in integrated farm site, Gannoruwa (1996-1997).

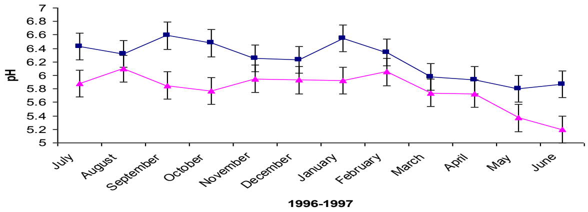

Figure 5 pH of casts of *P. corathrurus* and surrounding soil in Integrated farm site at Gannoruwa

corathrurus in both sites when compared to surrounding soil. In the organic farm; C/N ratio of casts was 8.8, and in surrounding soil it was 9.2. In Integrated farm; C/N ratio of casts was 7.9, and surrounding soil = 8.3, (n= 5).

Effect on the growth of Zea *maize*

The growth of Z. *maiz*e was significantly increased when different numbers of the endogeic earthworm *P. corathurus* was introduced into the soil mixture in pot experiments.

After 50 days, a significant increase in the root and shoot dry weight of Z. *maiz*e were recorded in the presence of earthworms (Table 3). The highest shoot and root dry weight was recorded in treatment with 7 adults per pot. However, treatments T_5 and T_6 with a higher number of adults recorded a reduction in dry weight of both roots and shoots. Values obtained for plant height, wet and dry weight of shoots and roots were significantly different at P =0.05. The highest plant production in terms of shoot and root dry wet weight was recorded in T_4.

Multiplication of earthworm for vermicompost

The mean number of cocoons and earthworms (counted separately but pooled together) produced after 50d of introduction of 15 adults of *E. foetida*, *P. excavatus* and *E. eugenia* separately into 7 different culture media is given in Table 4. These levels were analyzed using ANOVA and is indicated

Table 2 Carbon and N content of *P. corathrurus* casts and surrounding soil at two sites

	Organic farm site		Integrated farm site	
	Casts	Surrounding soil	Casts	Surrounding soil
C%	3.86±0.021	3.64±0.10	3.66± 0.01	3.45±0.037
N%	0.45±0.016	0.41±0.024	0.426±0.034	0.4±0.015
C/N	8.8	9.2	7.9	8.3

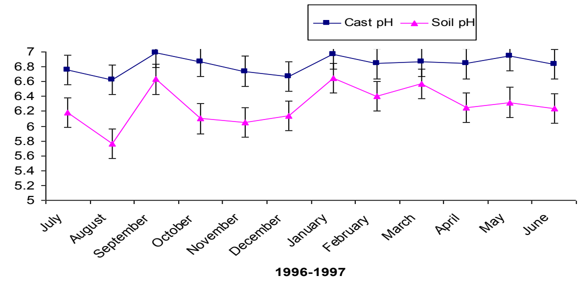

Figure 6 pH of casts of *P. corathrurus* and surrounding soil in Organic farm site at Nawalapitiya

in Table 5. A significant difference in the multiplication rate was observed (α = 0.05, P=000) in the different media.

Among the 7 culture media (Table 4) a significant increase in multiplication of *E. foetida* and *P. excavatus* was seen in media with cow dung (C), cowdung and vegetable refuse (C+V) and cow dung, vegetable refuse and straw (C+V+S). These media are thus found to be the best medium for the multiplication of these two species. The best medium for multiplication of *E. eugenia* was found be cow dung and straw (C+S), cow dung, vegetable refuse and straw (C+V+S). Thus, for all three species of earthworms culture media with cowdung alone or in combination with either straw or vegetable refuse was found to give higher multiplication rates than straw or vegetable refuse alone

Improvement of particle size and nutrients in culture media

The level of nutrients and the particle size in two of the culture media (C+ V and C+V+S) in which *E. foetida* was cultured was determined after 45 days (Table 5 & Fig. 7). These two media were selected for determining the improvement of the culture media following vermiculture as they gave the highest adult earthworm production levels (Figure 3) When the levels of nutrients in the controls and the treatments were compared using Chi square test a significant difference was obtained ($\chi 2 = 38.282$ $P < 0.05$), where the levels of nutrients following vermicompost was always higher than in the control with no earthworms. The results indicated that adequate amount of trace elements were higher in vermicompost than control.

The particle improvement (weight of different particle sizes ranging from 250-1,000um) in the control media and the media following vermicomposting with *E. foetida* (Fig. 7). The percentage of particle size range 1,000-700µm has decreased following compositing in the absence of earthworms while % of particle size in the range 500-250µm has increased in the presence of earthworms, due to cast formation by earthworms.

Table 3 Growth parameters of *Zea maize* 50d after sowing in media with known numbers of *P. corathrurus*

Treatment	Root wet weight (g)	Shoot wet weight (g)	Root dry weight (g)	Shoot dry weight (g)
T_1-Control	6.860d	36.620c	1.5180c	5.980c
T_2-3 earthworms	9.350d	50.080c	2.4900c	7.940c
T_3-5 earthworms	25.200b	78.100b	4.1600b	11.490b
T_4-7 earthworms	30.100a	142.500a	6.7480a	21.380a
T_5-9 earthworms	18.000c	91.400b	3.98008b	11.980b
T_6-11 earthworms	8.320d	42.100c	1.4520c	6.684d
F value	38.77	26.15	42.87	21.92
p value	0.0001	0.0001	0.0001	0.0001
LSD Value	4.567	17.829	1.149	3.549

Table 4 Mean number of earth worm cocoons and adults produced after 50 days in the 7 culture media

Medium	C	V	S	C+V	C+S	V+S	C+V+S	LSD
E. foeitida	28.60 ±3.5b	22.60 ±5.5a	13.60 ±2.1a	33.20 ±3.0b	22.00 ±1.4	18.80 ±3.1a	26.80 ±2.3b	8.01
E. eugenia	25.80 ±6.1a	19.40 ±2.1a	19.40 ±2.1a	18.00 ±0.7a	26.60 ±4.1b	18.80 ±3.1a	26.80 ±2.3b	8.48
P. excavatus	39.80 ±5.2b	35.60 ±5.3b	13.00 ±5.3a	40.60 ±4.1b	24.80 ±4.1b	22.60 ±4.9a	38.60 ±3.4b	11.61

C= Cow dung V= Vegetable refuse S=Straw
Mean values followed by different letters in a row significantly different at P=0.05

DISCUSSION

According study, the rainfall pattern appears to govern the variation in the abundance of casts, adults, cocoons and juveniles of the endogenic *P. corathrurus* in the two sites. The Wet and Intermediate zones of the country (where the two study sites are located) receive relatively low rainfall from the North-East monsoon from December to February. During the dry period the surviving earthworms were observed to be in a state of diapauses as evident form their inactive shrunken state. Furthermore, the clay soil in which they lived formed a compact wall round them. *P. corathrurus* is known to tolerate unfavorable conditions by diapauses mechanism especially during the drought (Fragoso *et al.* 1996) enabling them to survive under extreme climatic condition. With the on set of the South-West monsoons from March to May the abundance of *P. corathrurus* increased, leading to a recovery in their population Furthermore, the higher abundance of earthworms in the organic farm site than in the integrated farm site is likely to be due to the less disturbance of soil during field preparation, increased inputs of organic matter (composting) and the non use of chemical pesticides on crops in the organic farm site.

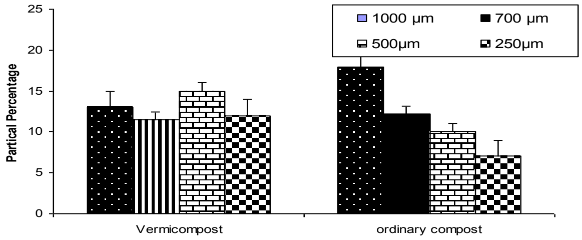

Figure 7 Particle size improvements in Vermicompost Vs Compost without earthworms

Production of surface casts throughout the year by *P. corathrurus* unlike certain earthworm species like *Polypheretima elongate* and *Lumbricus terrestris* (Lee 1985) is a useful characteristic in improving soil fertility and physical properties. Moreover, the variation in surface casts of *P. corathrurus* was found to reflect the abundance of the different life stages that live in deeper soil and hence casts could be used as an index of abundance *P. corathrurus* in field studies.

Cast formation by earthworms may be directly facilitated by mixing of organic matter with soil (aggregation), grinding of organic matter in the intestine during digestion (particle improvement), and due to the activity of gut micro flora like Rhyzobia, Vascular Arbicular Mycorhysa and an increase in available plant nutrients (Reddell and Spain, 1991). Release of mineral nitrogen from soil mineralization has been found to be a major activity in their gut during digestion. Furthermore, earthworm activity in soil is known to increase the physical structure of soil by aeration, improvement of water holding capacity and improvement of microhabitat due

Table 5 Nutrient content of vermicompost (using *E. foetida*) and control after 45 days (n = 5)

Plant nutrients (mg/g)	Vegetable refuse + (*Eisenia foetida*)	Vegetable refuse without earthworms (control)	Straw+cowdung+ Vegetable refuse + (*Eisenia foetida*)	*Straw+cowdung+ Vegetable refuse+ without earthworms (control)*
Total N	12.5	10.5	12.3	*11.7*
Total P	7.1	6.5	8.1	*7.4*
Total Fe	0.05	0.01	Nil	*Nil*
Total Mn	*0.03*	*0.01*	*0.03*	*0.01*

to the presence of casts in the non ingested surrounding soil.

The chemical composition of *P. corathrurus* casts in terms of pH, C & N content and C/N ratio was very different to that of the surrounding soil owing to earthworm activity**.** Thus, earthworm activity significantly contributed towards neutral soil pH conditions through the production of casts. This is known to be due to the release of phosphates and Ca through digestion of soil mineral particles thus making the soil less acidic (Barois *et al.* 1999). Furthermore, recording of higher pH level in soils in the organic farm site compared to the integrated farm site is likely due to the addition of organic matter and the non use of chemical fertilizers in the former site.

The increase in C content in casts compared to the surrounding soil is known to occur (Redell and Spain 1991) due to the selective feeding of earthworms whereby earthworms feed on soil mixed with organic matter releasing C and also through the digestion of soil mineral particles. Thus in soils that receive a higher organic input, C content is also high, due to earthworm activity. The increase in the total N content in casts of *P. corathrurus* arises from different sources. Excretion of nitrogenous compounds, selective feeding on organic matter releasing N, digestion of soil mineral particles and release of nitrogen fixed by gut micro flora becomes incorporated into casts (Lavelle *et al.* 1994). The Organic farm site showed a higher N content in casts than the integrated farm due to soil management by addition of organic matter and crop rotation practiced in the former site.

According to the experiments maximum growth of *Z. maize* was recorded when 7 adult *P. corathrurus* were added to pot. The maximum growth was achieved based on volume of pot, added medium and type of soil. However, this would vary with the soil medium and the earthworm species used. The overall findings of this study indicate not only an increase in plant nutrients due to earthworm activity but also an improvement in the physical and biological nature of soil. There is evidence to show that interaction between earthworms and microorganisms not only provide the nutrients, but stimulate plant growth indirectly in several other ways (Lavelle and Martin 1992)

The significant positive effect of *P. corathrurus* earthworms on the growth of *Z. maize* is likely due to a combination of interacting factors such as accumulations of earthworm casts rich in C/N, soil aeration due to earthworm movement within the root zone of soil and many other factors as extensively discussed by Fagoso *et al* (1996).

The multiplication rates of all three epigenic earthworms were high only when cowdung was a component of the culture medium inferring the important role of cowdung in the diet of earthworms. Cowdung contains digested cellulose and other organic matter and also provides optimum pH conditions for earthworm activity. Epigenic earthworms generally feed on organic matter that is nutritionally low, however partially activated cowdung contains high nutrients and an optimum C/N ratio of 30/1 conducive for earthworm growth (Arenda *et al.* 1999). Earthworm activity resulting from their feeding and metabolism in soil releases nutrients through cast production resulting in the releases of nutrients into soil. Earthworms strongly influence soil N status and N cycling, transferring N from decaying plants that can be easily recycled and taken up by plants (Syers *et al*. 1979). Activity of earthworm in soil or organic matter increase N mineralization via biological processes or through physical changes brought about by the environment. The biological influence of earthworms on N dynamics result from direct and indirect microbial (processes) activity.

N dynamics are directly related to the excretion of N-rich products and turnover of N pool in the earthworm biomass. According to Lee (1985), N containing products of earthworm metabolism are returned to the soil through casts, urine, mucoproteins and dead earthworm tissues. Surface casts usually have a lower C/N ratio than surrounding soil (Syers and Springett 1984). Earthworms ingest dead plant materials of varying C/N ratios and convert them to earthworm tissue with a lower C/N ratio. Increase in particle size that rang from 500µm to 250µm improved absorption of nutrients by plants. Symbiotic association between earthworms and microorganisms has led to the break down and fragmentation of organic matter progressively and finally, incorporating it into water-stable aggregates making it available as a plant nutrient. This is one major advantage of vermicompost compared to other methods of composting.

CONCLUSIONS

Year round abundance of *Pontoscolex corathrurus* casts, adults and developing stages was related to rainfall pattern at the two differently managed farm sites. Total C, N content and pH in casts was higher than the surrounding soil. This infers that the impact of *P. corathrurus* on soil is a continuous process while significant increase in plant growth achieved in pot experiments. This is further facilitated by the fact that *P. corathrurus* is the dominant earthworm species in disturbed soils as evident from the study carried by the author.

The three species of earthworms, *Eudrilus eugenia*, *Eisenia foeitida* and *Peryonix excavatus* can be effectively used for vermiculture and vermicomposting in Sri Lanka. Particle size improvement and available plant nutrients were higher in vermicompost. Therefore, this method of composting is efficient and enriches the plant nutrients. This method of composting could be used to recycle all types of organic waste accumulated in farms, markets and households. The overall activity of earthworms in soil improvement and vermicomposting has not been fully investigated in Sri Lanka and hence requires further research. The commonly found earthworms in disturbed sites are a resource that could be used for improvement of soil fertility and development of large-scale vermicomposting programs ensuring sustainability in agriculture.

ACKNOWLEDGEMENTS

Authors wish to gratefully acknowledge Prof JP Edirisinghe, Department of Zoology, University of Peradeniya, for the valuable guidance and constructive criticism of the manuscript.

REFERENCES

Anderson JM and Ingram J 1989 *Tropical Soil Biology and Fertility Program, Method Hand Book.* University of Exeter, UK. 89.

Aranda A, Barois I, Arellano P, Irisson S, Salazar T, Rodriguez J and Patron JC 1999 Vermicomposting in the tropics; *In Earthworm Management in Tropical Agroecosystems* (Eds.) P Lavelle, L Brussaard and P Hendix; 253- 287.

Bouche MB 1977 Strategies Lombricsennes. In Soil organisms as components of ecosystems *Ecological Bulletin* Stockholm. 25:1-122

Brossard M, Lavelle P and Laurent JY 1996 Digestion of a vertisol by the endogeic earthworms *Polypheretima elongata*, Megascolecidae, Increases soil phosphate extractability. *European Journal of Soil Biology* 32. 107-111.

Fragoso C, Brown GG, Patron JC, Blanchard F, Lavella P, Pashanasi B and Kumal T 1996 Agricultural Intensification, Soil Biodiversity in Tropics. The role of Earthworms; *Applied Soil Ecology.* 6: 17-35.

Evans AC and Guild WJMCL 1948 Studies on relationship between earthworms and soil fertility, IV. On the lifecycles of some British Lumbricidae. *Annals of Applied Biology,* 35: 471-484.

Julka JM 1988 The Fauna of India and Adjacent Countries. Megadril Oligochaeta. Earthworms Haplotaxida:Lumbricina:Megascolecidea: Octocheatidae. *Zoological Survey of India*, Calcutta.400p.

Lavelle P, Dangerfield M, Fragoso C, Eschenbrnner, Fernandez L, Pashanasi B and Brussard L 1994 The relationship between soil macro fauna and tropical soil fertility. In *The Biological Management of Tropical Soil Fertility*. (Eds) PL Woomer and MJ Smith. Pergamon.117-169

Lavelle and Martin 1992 Small–scale and large–scale effects of endogeic earthworms on soil organic matter dynamics in soils of the humid tropics. *Soil boil. Biochem.* 24:(12): 1491-1498.

Lee KE 1985 Earthworms, their ecology and relationships with soils and land use. *Academy Press.* Sydney.

Pianka ER 1970 On “r” and “k” – selection, *Journal of American Natural History.* 104: 592-597.

Reddell P and Spin AV 1991 Earthworms as vectors of viable propagules of mycorhizal fungi. *Soil Biol. Biochem* 23: 767-774.

Reynolds J 1994 Earthworms of the world. *Global Biodiversity.* 4: 11-16.

Samaranayake JWK 2008 Distribution and ecology of earthworms in selected habitats in Sri Lanka with emphasis on soil fertility and vermicomposting. (*MPhil Thesis*). PGIS, University of Peradeniya, Sri Lanka. 217p

Singh J 1997 Habitat preferences of selected Indian Earthworm Species and their efficiency in reduction of organic materials. *Soil Biology & Biochemistry*. 29(3/4): 585-588.

Spain AV, Lavelle P and Mariotti A 1992 Stimulation of plant growth by tropical earthworms. *Soil Biology & Biochemistry*. 24: 1629- 1634

Stephenson J 1923 Oligocheata, *The Fauna of British India including Ceylon and Burma*. Taylor and Francis Ltd, London 505p.

Syers JK, Sharpley AN, Keeny DR 1979 Cycling of Nitrogen by surface casting earthworm in a pasture ecosystem. *Soil Biol. Biochemistry.* 11: 181-185

Syers JK and Springett JA 1984 Earthworms and soil fertility. *Plant and Soil 76:93- 104. Martiness Nijhhoff/ Dr W Junk Publishers, The Hague, Netherlands*