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Research Journal of Agricultural Sciences
An International Journal

P- ISSN: 0976-1675
E- ISSN: 2249-4538

Volume: 13
Issue: 04

Res. Jr. of Agril. Sci. (2022) 13: 1124–1126

CARAS

Res. Jr. of Agril. Sci. (Jul-Aug 2022)
13(4): 1124–1126

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

www.rjas.org

Short Communication

Physiochemical Properties of Four Species of Earthworm Casts from Clay-loam Soil in West Bengal, India

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Received: 13 Mar 2022 | Revised accepted: 23 Jul 2022 | Published online: 25 July 2022
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***Key words*:** Earthworm, C:N ratio, Total Kjeldahl nitrogen, Available phosphorus, Available potassium, Organic carbon

The beneficial effects of earthworm casts in increasing soil fertility well documented since the time of Darwin [1]. Casts that deposited beneath the soil surface contribute to pedogenesis, but those deposited on the surface are probably more significant in terms of soil profile development [2]. Earthworms, mites, collembola, termites and ants are considered as the important soil ecosystem engineers. These saprophagous ingest both organic and mineral soil particles. During ingestion, residues are fragmented, organic elements are mixed with mineral particles, complexed with mucous, partly assimilated and mineralized and released in the soil in the form of biogenic organo-mineral aggregates known as casts [3-4]. Several author viz. Lunt and Jacobson [5], Joshi and Kelkar [6], Nijhawan and Kanwar [7], Nye [8], Roy [9], Parle [10], Madge [11], Dash and Patra [12-13], Reddy [14], Bhattacharya and Chakraborti [15], Chowdhury *et al*. [16], Vidal [17] have contributed on various aspects of earthworm cast. However, so far, no such information is available on the physiochemical properties of earthworm cast from alluvial clay-loam soil. The present study conducted to fill up these lacunae.

Cast of four earthworm species viz. *Eutyphoeus orientalis* (Beddard), *Lampito mauritii* Kinberg, *Metaphire posthuma* (Vaillant), *Perionyx excavatus* Perrier collected separately by means of their shape and size from an orchard in the district of North 24 Parganas, West Bengal at regular monthly interval from May 2018 to December 2018. Before collection, all casts cleared off from the selected area of sampling site and after a day fresh casts were collected, which kept frozen until analyzed and at the same time, adjacent soil samples (10-20 cm profile) collected. Standard procedure as described by Basak [18] adopted for determination of available phosphate, available potassium, total kjeldahl nitrogen, available nitrogen, electrical conductivity, organic carbon and pH (in water).

Soil of this site was Gangetic alluvium in nature, brown in colour and clay loam in texture. The plots covered with grasses, sedges and herbs like, *Cynodon dactylon*, *Euphorbia hirta*, *Chrysopogon aciculatus*, *Solanum nigrum*, *Centella asiatica*, *Coccinia grandis*, *Eclipta prostrata*, *Marsilea minuta*, *Colocasia esculenta*. The dominant plant species is *Mangifera indica*. The other vegetation mainly belongs to *Annona squamosa*, *Cocos nucifera* and *Musa paradisiaca*.

The (Table 1) shows different physiochemical parameters of earthworm cast and surrounding soil. Distinct seasonal variation of different parameters recorded in the cast as well as in surrounding soil (Table 1). Variation in different parameters of cast also observed among the studied species (Table 1). Casts usually have a higher or nearly same pH, more total kjeldahl and available nitrogen, available phosphorus, available potassium, electrical conductivity, organic carbon and C: N ratio than surrounding soil (Table 1).

Seasonal variation in activities of earthworm and microorganisms inhabiting earthworm gut, which occurs mainly due to the changes in soil temperature, moisture and organic carbon, leads to the seasonal changes in composition of casts. Syers *et al*. [19] recorded seasonal variations in the carbon and nitrogen content of casts in a New Zealand pasture soil where the dominant surface casting species was *Lumbricus rubellus*. Cast of all the studied species have higher or nearly same pH compared to that in the adjacent soil samples. Probable explanation is that soils neutralized by secretions from the intestine and or from calciferous glands and by ammonia that excreted [20]. The pH of earthworm casts is generally closer to neutrality than that of the soils from which they derived [21]. Cast of *Eutyphoeus orientalis*, *Lampito mauritii* and *Metaphire posthuma* have higher pH than *Perionyx excavatus*. It may be because the casts of the meronephridial species enriched with more nitrogenous urine than those of holonephridial species, as meronephridial species discharge their urine into the intestine, whereas holonephridial species excreted directly to the exterior. Organic carbon content was higher in worm cast than in the adjacent soil, this finding, however, is not in agreement with

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Bhattacharya and Chakraborti [15] but Satchell [22]; Gupta and Sakal [23], Madge [11], Reddy [14] have similar observations. This could occur if earthworms ingested food material that enriched with carbon. The casts of *P. excavatus* has higher amount of organic carbon than other studied species. This is because being epigeic in nature this species took their nutrient from organic matter rich material [16]. In all cases, available and total nitrogen content of casts is higher than that of surrounding soil. Aldag and Graff [24] in an experiment also have similar findings with *Lumbricus terrestris*. Dash and Patra [12-13] also made similar observation in grassland at Orissa while studied a mixed population of *Lampito mauritii* and an unidentified ocnerodrilid. Increase nitrogen content in cast might be due to the nitrogenous excretory product and enzymatic digestion of organic material in the gut of earthworm. But Lee [3] opined that concentration of nitrogen available for plant growth is low in casts and probably has little influence on plant growth.

Table 1 Various physiochemical properties of earthworm cast and surrounding soil

Month	Soil							
	pH	EC (dSm^{1})	OC (%)	Available N_2 ($Kg\ ha^{-1}$)	Available P_2O_5 ($Kg\ ha^{-1}$)	Available K_2O ($Kg\ ha^{-1}$)	Total N_2 (%)	C: N
May 2018	6.7	0.39	1.8	335	111	340	0.36	5.0
June 2018	6.5	0.22	1.2	345	114	175	0.32	3.75
July 2018	6.4	0.29	1.7	260	95	400	0.43	3.95
August 2018	6.8	0.15	1.8	305	105	395	0.28	6.42
September 2018	6.9	0.2	1.54	230	45	427	0.37	4.16
October 2018	6.9	0.28	1.71	205	90	495	0.42	4.07
November 2018	6.6	0.36	1.4	225	75	565	0.4	4.25
December 2018	6.6	0.3	1.05	355	86	505	0.45	3.33
Cast of *Metaphire posthuma*								
May 2018	7.4	0.56	3.4	610	215	1200	0.48	7.08
June 2018	7.2	0.48	3.72	595	185	1005	0.53	7.01
July 2018	7.6	0.48	3.9	522	125	905	0.48	8.12
August 2018	7.1	0.56	2.86	485	225	678	0.32	8.93
September 2018	7.1	0.65	3	560	185	739	0.38	7.89
October 2018	7.2	0.82	3.2	530	135	735	0.42	7.61
November 2018	7.4	0.55	2.5	660	290	850	0.31	8.06
December 2018	7.4	0.79	2.7	610	305	690	0.36	7.5
Cast of *Eutyphoeus orientalis*								
May 2018	7.2	0.5	3.2	685	228	1340	0.34	9.41
June 2018	7.2	0.33	3.23	615	200	1300	0.36	8.97
July 2018	7.1	0.3	3.7	560	165	1205	0.3	12.33
August 2018	7.4	0.3	3.45	660	220	722	0.28	12.32
September 2018	7.3	0.48	3.45	630	170	910	0.42	8.21
October 2018	7.1	0.7	3.2	590	168	1220	0.28	11.42
November 2018	7.5	0.8	3.1	480	185	885	0.33	9.39
December 2018	7.5	0.8	2.9	435	205	956	0.33	8.78
Cast of *Lampito mauritii*								
May 2018	7.2	0.62	2.9	775	228	840	0.46	6.30
June 2018	7.2	0.23	2.9	415	225	660	0.41	7.07
July 2018	7.6	0.28	3.5	401	265	605	0.36	9.72
August 2018	7.3	0.46	3.8	560	180	756	0.51	7.45
September 2018	7.3	0.7	3.5	550	170	810	0.5	7.0
October 2018	7.1	0.7	3.6	690	188	620	0.38	9.47
November 2018	7.1	0.8	3.7	660	245	685	0.53	6.98
December 2018	7.3	0.55	2.6	490	174	712	0.29	8.96
Cast of *Perionyx excavatus*								
May 2018	7.8	0.8	4.2	545	138	885	0.51	8.23
June 2018	7.9	0.8	4.2	515	120	702	0.56	7.50
July 2018	7.6	0.6	3.9	481	195	605	0.39	10.0
August 2018	8.1	0.6	3.7	560	220	831	0.58	6.37
September 2018	7.9	0.48	4.35	485	166	756	0.42	10.35
October 2018	8.2	0.56	4.2	675	179	822	0.58	7.24
November 2018	7.7	0.9	3.2	642	285	905	0.46	6.95
December 2018	7.7	0.4	3.8	565	249	575	0.58	6.55

The C: N ratios of casts generally higher compared to soil. It was also the observation by Lee [25], Aldag and Graff [24], Kale and Krishnamoorthy [26]. However, other workers have found the C: N ratio of earthworm casts to be lower than that of the surrounding soil [27]. This increase in C: N ratio perhaps due to the utilization of nitrogen for production of protein, nitrogen losses through excretion and some part of the ingested carbon though utilized in metabolism to derive energy but most of the ingested plant material remain undigested. Present study pointed out that casts have higher concentrations of available phosphorus and potassium than underlying soil. Satchell [22], Gupta and Sakal [23], Sharpley and Syers [27] also recorded similar result. The increased availability of phosphorus and potassium in earthworm casts is not only due

to enhanced microbial and enzymatic activity but might depends on the type of food, they intake. Higher electrical conductivity in the cast than neighbouring soil confirms the previous observation of Joshi and Kelkar [6] this denotes an increase in the level of soluble salts. The elevated level of nutrients in the cast indicates that the nutrients, which locked up in the organic matter, mobilized into plant-available forms in the cast during passage of this plant material through the gut of the worms. Inter specific variation of nutrients in the cast's attributes to selective feeding habit of earthworm species.

SUMMARY

The physiochemical properties of cast of four different species of earthworm viz. *Eutyphoeus orientalis* (Beddard), *Lampito mauritii* Kinberg, *Metaphire posthuma* (Vaillant) and *Perionyx excavatus* Perrier evaluated in comparison to surrounding clay-loam alluvial soil of an orchard. Seasonal variation of different parameters recorded in the cast as well as in surrounding soil. Casts usually have a higher or nearly same pH, more total kjeldahl and available nitrogen, available phosphorus, available potassium, organic carbon and C:N ratio than surrounding soil. Inter specific variation of nutrients in the casts signifies selective feeding habit of earthworm species. Earthworm activities in the soil cause change in the physiochemical properties of the soil and increase soil fertility. From present study, it concluded that earthworm activities in the soil cause change in the physiochemical properties of the soil and increase soil fertility. The nature of change depends on the type of the soil, presence or absence of litter and the species of earthworm involved in the process. Nevertheless, the question arises whether the form and the concentrations of this nutrient is able to produce favourable environment for plant growth. For which further studies is going on.

Acknowledgement

Author is grateful to the Principal, East Calcutta Girls' College for providing laboratory facilities.

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