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EARTHWORM (*Aporrectodea longa*) EFFECTS ON SOME PHYSICAL PROPERTIES OF COMPACTED CLAY AND LOOSE SANDY SOILS

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ABSTRACT

An experiment was conducted at the farm of Agricultural Faculty, Al-Azhar University, Nasr City, Cairo, Egypt to evaluate the effect of earthworm *Aporrectodea longa* (the black-headed worm) individuals application on improving some physical properties of compacted clay soil (losing of compaction and improved the movement of water and air) and loose sandy soil (stabilization of aggregates and increase of moisture retention).

The results showed that the addition of earthworm (*Aporrectodea longa*) individuals had a marked effect for improving soil physical properties of both soils under investigation (compacted clay and loose sandy soils). Where it seen that the compaction of clay soil was reduced, which appear which the soil bulk density values was decreased and subsequently, total porosity was increased. On this concern, the hydraulic conductivity was increased, indicating a marked improvement of the pore size distribution. The results showed that aggregate size distribution and mean weight diameter affected by addition of earthworm (*Aporrectodea longa*) individuals, where the percentage of macro-aggregates increased and the micro-aggregates decreased. According to this the results indicated that mean weight diameter values increased compared to the control treatment of both soils. The same trend was observed either soil bulk density or total porosity of the loose sandy soil. This is contrast in case of both pore size distribution and hydraulic conductivity. Where the hydraulic conductivity was decrease by application of earthworm (*Aporrectodea longa*) treatments.
Keywords: earthworm, aggregate stability, pore size distribution.

INTRODUCTION

Earthworms are a major component of soil macro-fauna in the natural systems but are absent or rare in cultivated fields. Earthworm individuals can play a variety of important roles in agro-ecosystems. Their feeding and burrowing activities incorporate organic residues and amendments into the soil, enhancing decomposition, humus formation, nutrient cycling, and improvement of soil structure, (Mackay and Kladivko, 1985; Kladivko *et al.,* 1986 and Kladivko and Timmenga 1990). Blanchart *et al.,* (1990) showed that in a 2 mm-sieved of sandy soil, earthworm were responsible for the formation of high proportion of soil as macro-aggregates larger than 2 mm. while the macro-aggregates found in absence of worms were very rare. Macro-aggregates produced in presence of earthworms were found to remain for a long time, (Lee and Foster 1991; Lavelle *et al.,* 1992 and Lee and Smettem 1995). Earthworm individuals may increase levels of metabolic activity in soils, as measured by the amount of CO_2 evolved, yet nematode abundance and microbial biomass may decrease, (Smallwood, 1996).This occurs because earthworm individuals reduce the amount of substrate available to other decomposers, and because earthworm individuals ingest other decomposer organisms as they feed. This process would tend to accelerate nutrient cycling rates. Haynes and Fraser (1998) found that aggregate stability and microbial biomass C increased during the incubation of earthworm casts and soil material. Liu *et al.,* (2005) showed that earthworm treatment increased the biomass of cabbage. Jun *et al.,* (2009) indicated that the presence of earthworm strongly affected soil enzyme activities, depending on method of organic residue application.

The present work aims to study the effect of earthworm individuals application on some soil physical properties of clay and sandy soils.

MATERIALS AND METHODS

An experiment was conducted at the farm of Agricultural Faculty, Al-Azhar University, Nasr City, Cairo, Egypt to evaluate the effect of earthworm *Aporrectodea longa* (the black-headed worm) individuals application on: 1) stabilization of aggregates in loose sandy soil and 2) losing of compacted clay soil for improving some their physical properties (bulk density, total porosity, pore size distribution, hydraulic conductivity and aggregate size distribution). However, one hundred gram of some sieved (<8 mm) organic residues (broad bean and wheat) pot^{-1} was thoroughly mixed at ratio (1:1) was thoroughly mixed with two soils under investigation for feeding of earthworm. Sandy and clay soils were packet into the pots (7 kg air-dried soil pot^{-1}). At the start of experiment earthworm (*Aporrectodea longa*) individuals were added in three replicates to either soils (sandy or clay) at rates of 0 (control), 50 (E_1), 100 (E_2) and 150 (E_3) individuals pot^{-1} at the depth of 5 cm. The moisture content of the soils under investigation was kept at field capacity along the period of experiment. After 3 months for incubation of earthworms and organic residues in both soils, soil samples were taken to evaluate the effects of above treatments on some physical characteristic under consideration of two soils. The basic physical properties of the investigated soils were determined after Klute (1986) and presented in Table (1).

Table (1): Some soil physical properties of both compacted clay and loose sandy soils.

Soil property	Compacted clay soil	Loose sandy soil
Coarse sand %	7.5	40.0
Fine sand %	17.0	45.0
Silt %	27.5	10.0
Clay %	48.0	5.0
Bulk density g cm-3	1.45	1.55
Particle density g cm-3	2.55	2.50
Total porosity %	43.14	38.00
Hydraulic conductivity cm hour-1	1.00	24.10
Saturation percentage %	62.00	23.00
Hygroscopic moisture %	5.75	0.95

RESULTS AND DISCUSSION

1- Effect of earthworms (*Aporrectodea longa*) on some physical properties of the investigated soils.

Improvement of some soil physical properties of compacted clay soil and loose sandy soil by earthworm (*Aporrectodea longa*) individuals application with organic residues was shown in this experiment. In compacted clay soil, data in Table 2 show that the compaction of clay soil was reduced thus appear in the decrease of soil bulk density values and subsequently the increase of total porosity. Also, the pore size distribution was improved, where the percentage of macro-pores increased by 205, 229 and 252 % due to E_1, E_2 and E_3 treatments respectively, compared to the control treatment. It is well known that the macro-pores were responsible for moisture and air movement in soils. According to the former, the data showed that the hydraulic conductivity (K) increased due to earthworms' addition with organic residues (soil class according to K values changed from very slow to slow). This may be attributed to the earthworm individuals feeding and burrowing activities incorporate organic residues into the soil, enhancing decomposition, aggregate formation and soil structural development. Similar results obtained by Eileen et al. (1986), who found that earthworm individuals affect the infiltration rate of soil through their burrowing action.

On the other hand, the data of Table (2) indicated that the loose sandy soil had the same trend of soil bulk density and total porosity, but the trend of pore size distribution and hydraulic conductivity was differed. Whereas, the values of hydraulic conductivity decreased by earthworm individuals application treatments. This is due to the increasing of micro-pores, which retain soil moisture more than control treatment. These results agree with those of Barre *et al.,* (2009).

Table (2): Soil bulk density, total porosity, pore size distribution and hydraulic conductivity of both compacted clay soil and loose sandy soil as affected by earthworm application.

Soil types	Treatment	Soil bulk density g cm^{-3}	Total porosity %	Pore size distribution %			Hydraulic conductivity cm hour^{-1}	Soil class
				Macro-pores	Meso pores	Micro pores		
Compacted clay soil	Control	1.45	44.20	4.50	12.44	27.26	1.11	Very slow
	E_1	1.36	47.70	8.59	14.31	24.80	1.10	Slow
	E_2	1.27	51.20	11.00	15.45	24.75	1.15	Slow
	E_3	1.20	53.80	12.75	16.66	24.39	1.20	Slow
Loose sandy soil	Control	1.52	41.54	35.50	4.25	1.79	23.65	Rapid
	E_1	1.47	43.46	35.28	5.88	2.30	22.95	Rapid
	E_2	1.43	45.00	36.04	6.11	2.85	22.00	Rapid
	E_3	1.40	46.15	36.25	6.85	3.05	21.85	Rapid

E_1=50, E_2=100 and E_3=150 individuals.

2- Effect of earthworms (*Aporrectodea longa*) on soil aggregate stability and mean weight diameter.

The results of Table (3) indicated that the earthworm individuals application had a marked effect on structural stability, through improving the soil physical properties of both soils. In this concern the aggregate size distribution (ASD) and mean weight diameter (MWD) affected by addition of earthworm individuals. Where, the macro-aggregates of two soils were increased, while the micro-aggregates decreased. Consequently, the increase of mean weight diameter (MWD) values was observed compared to the control treatment, the highest values of MWD obtained due to addition of 150 earthworm pot^{-1} compared to the control treatment. This may be attributed to earthworms coat soil particles with gummy polysaccharides exudates, improving soil aggregate stability. This is in agreement with those of Shipitalo and Protz (1989) elucidated some of the mechanisms by which earthworms enhance soil aggregation. Ingested aggregates are broken up in liquid slurry that mixes soil with organic material and binding agents, Zhang and Schrader (1993) and Blanchart *et al.,* (2004), who reported that the presence and activity of earthworm individuals influence organic matter decomposition and nutrient cycle and affect soil structure and porosity.

Table 3: Aggregate size distribution and mean weight diameter of both compacted clay soil and loose sandy soil as affected by earthworm application.

Soil types	Treatment	Aggregate size distribution %								MWD
		8.00- 2.00 mm	2.00-1.00 mm	1.00-0.50 mm	0.50-0.25 mm	0.25-0.10 mm	0.1-0.08 mm	0.08- 0.061 mm	0.061-0.00 mm	
Compacted clay soil	Control	2.10	8.15	16.45	22.90	13.00	11.28	11.12	15.00	0.482
	E_1	4.15	10.25	16.75	23.11	12.00	10.29	10.20	13.25	0.615
	E_2	6.00	10.85	17.12	23.30	10.48	9.50	9.75	13.00	0.716
	E_3	6.95	11.15	17.28	23.50	9.47	9.00	9.65	13.00	0.768
Loose sandy soil	Control	23.75	16.18	13.50	7.00	7.20	9.25	11.62	11.50	1.591
	E_1	25.50	17.25	13.90	8.75	7.35	8.35	9.90	9.00	1.710
	E_2	28.70	18.65	14.25	6.07	6.00	8.18	9.40	8.75	1.872
	E_3	30.15	20.10	14.50	5.50	5.00	8.10	9.15	8.50	1.964

Mm= sieves diameters., $E_{1=}50$, E_2=100 and $E_{3=}150$ individuals.

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تـأثير إضـافة أفـراد الديـدان الأرضـية *Aporrectodea longa* علـى تحسـين الخواص الطبيعية للأرض الطينية المندمجة والأرض الرملية المفككة

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أقيمت تجربة في مزرعة كلية الزراعة – جامعة الأزهر – مدينة نصر بالقاهرة والهدف منها دراسة تأثير إضافة أفراد الديدان الأرضية(*Aporrectodea longa*) بمعدلات مختلفة مع بقايا نباتات الفول البلدى والقمح كمصدر للمادة العضوية على تحسين خواص الأرض الطينية المندمجة (تقليل الاندماج , تحسين حركة كل من الماء والهواء فيها)وأيضا تحسين خواص الأرض الرملية المفككة (ثبات التجمعات الأرضية , زيادة قدرتها على حفظ الرطوبة الأرضية)

وقد أوضحت النتائج ما يلى :-

- أدت إضافة أفراد الديدان الأرضية(*Aporrectodea longa*) بصفة عامة إلى تحسين الخواص الطبيعية لكل من التربة الرملية المفككة أو التربة الطينية المندجة
- أدت إضافة أفراد الديدان الأرضية (*Aporrectodea longa*) إلى انخفاض قيم الكثافة الظاهرية للتربة الطينية وبالتالي زيادة قيم المسامية الكلية وتحسن التوزيع الحجمي للمسام ، حيث زادت المسام الكبرى وزاد التوصيل الهيدروليكي لها.
- أدت إضافة أفراد الديدان الأرضية (*Aporrectodea longa*)إلى انخفاض قيم الكثافة الظاهرية للتربة الرملية وبالتالى زيادة قيم المسامية الكلية وتحسن التوزيع الحجمى للمسام ، حيث زادت المسام الصغرى وانخفض التوصيل الهيدروليكى لها.
- أدت إضافة أفراد الديدان الأرضية(*Aporrectodea longa*) إلى زيادة نسبة التجمعات الأرضية الثابتة الكبرى وأيضا القطر المتوسط الموزون للتجمعات فى كلا الأرضين. كما أدت عملية الإضافة إلى انخفاض نسبة التجمعات الأرضية الصغرى.
- مما سبق يتضح تحسن ملحوظ في بناء التربة وتكوين التجمعات الأرضية الثابتة فى كلا من نوعي التربة وكانت أفضل النتائج ملحوظة مع المعدل 150 دودوه أرضية من النوع (*Aporrectodea longa*) لكل أصيص.

قام بتحكيم البحث

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